Portland General Electric

All Source RFP Technical Specifications – Solar Projects

Release / Revision Version: 0

Release / Revision Date: 4/14/2023

Document Status: Published

Content Owner: Craig Armstrong

APPENDIX M – SOLAR PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

TABLE OF CONTENTS

APPENDIX M3

ATTACHMENT 01

EXHIBIT 01

SOLAR PHOTOVOLTAIC PLANT SPECIFICTION

STATEMENT OF WORK - PV

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

1.1 Purpose

Without limiting the information summarized herein, the purpose of this document is (a) to summarize the minimum scope of work responsibilities for Contractor, which generally include the complete development, engineering, procurement, and construction of the Project as defined herein; 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 References

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.

A. 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-Solar) ("PGE Exhibit M1-01-02-01") attached thereto.

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

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

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

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

1.3 Definitions

A. "AC" or "ac" shall mean alternating current.

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

C. "AC System Losses" shall mean the resistance losses (I^2R) through the AC cabling and magnetization and winding losses associated with the inverter step-up transformers and is exclusive of Auxiliary Loads.

D. "Agreement" shall mean the [Engineering, Procurement and Construction Agreement] to which M3-01-01 is attached.

E. "Array" shall mean a collection of solar modules connected in series, all tying into one Inverter Skid Assembly (ISA).

F. "Auxiliary Loads" shall mean power consumption from activities not directly associated with power generation or transmission losses. These include, but are not limited to, inverter power and SCADA system power.

G. “Circuit” shall have the definition set forth in M3-01-6.

H. “Contractor” shall mean qualified developer or Engineering, Procurement, and Construction firm responding to Request for Proposal (RFP).

I. “DC” or “dc” shall mean direct current.

J. “DC Voltage Drop Maximum” shall be the maximum allowable voltage drop of any one inverter array (from module string to inverter DC input) at full load and STC.

K. “DC/AC ratio” shall mean the ratio of the ISA installed DC power to the Inverter power rating operated at maximum expected inverter-level power factor to meet power factor requirements at the POI. For example, a 2.75MVA inverter operated at a power factor of 0.92, with a total installed DC power of 3.5MW_{DC}, would have a MW_{AC} rating of 2.53MW and a DC/AC of 1.38.

L. “Equipment and Materials” as defined in section 1.2.

M. “HZ” shall mean hertz.

N. “ISA” shall mean the Inverter Skid Assembly consisting of the static power inverter(s), inverter step-up transformer, associated controls, monitoring, cabling, and grounding systems.

O. “kV” shall mean kilovolts.

P. “kW” shall mean a measure of instantaneous power as measured in kilowatts. If not specified, it shall be assumed to be in Alternating Current (AC).

Q. “kWh” shall mean kilowatt-hours. If not specified, it shall be assumed to be in Alternating Current (AC).

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

S. “Operation and Maintenance Building” shall mean the building that houses the Project Control Room and offices. Refer to M3-01-01 and M1-02-02 for O&M Building scope.

T. “Owner” shall mean solicitor of RFP to who will own the facility upon Final Completion, i.e., PGE.

U. “POI” shall mean the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider as defined in the Interconnection Agreement.

V. “PV” shall mean photovoltaic.

W. “Solar Substation” shall mean the interconnection facility which collects the feeds from the ISA and transforms the voltage (as required) for electrical interconnection to the Transmission Provider. Refer to M3-01-02 for Solar Substation Statement of Work.

X. “Project” shall mean the solar Project as defined in the Agreement. The Project shall include all equipment and systems producing solar energy, from the solar modules up to the POI, including the collector system, substation and Generation Tie-line between the project substation and the POI, as applicable.

Y. “SCADA” shall mean the Supervisory Control and Data Acquisition system, including all monitoring/control hardware and software, field instrumentation and communication devices.

Z. “STC” shall mean standards test conditions, which is 1000 watts per square meter insolation, 25ºC module temperature, 1.5 AM (air mass).

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

Capitalized terms not otherwise defined above shall have the meaning given such terms in the Agreement.

1.4 CONTRACTOR Scope of Work Overview

A. Contractor shall furnish a ground-mounted single-axis solar-tracking utility-scale Project for Owner at the specified capacity and energy production (defined in M3-01-05).

B. The Project shall be capable of operating in accordance with the terms and conditions of the Agreement, this “Statement of Work” and associated attachments.

C. Contractor shall design and construct the Project in accordance with the Agreement and this Specification. Scope of Work shall consist of:

1. Specify and furnish the Equipment and Materials which shall include, but not be limited to perimeter fences, structural support and tracking systems, module string DC wiring harnesses and CAB system (as applicable), DC combiner boxes or load break disconnects (LBDs), ISAs, SCADA system, MET Stations, AC collection, and ancillary hardware required to connect and operate listed equipment. Scope shall also include that defined in M3-01-2 for the Solar Substation and section 6.0 for O&M Building.
2. Project design engineering, software models, and drawing packages for construction permitting, installation and “as-built” documentation.
3. Project construction including all site/civil work, structural, electrical, mechanical, and monitoring/control systems.
4. Third party verifications shall include soils, concrete and shall also be performed where required to comply with Applicable Permits and codes.

5. Project and construction management, including quality assurance/quality control, site safety, site material control and management of all subcontractors.

6. Design Review meetings in accordance with M1-01-02 and table M1-01-02-01-Solar. All design review meetings will be held at agreed upon meeting place and may be broken up into several meetings as required to meet schedule.

7. Project commissioning and testing in accordance with M3-01-04 and M3-01-05.

8. Project turnover including Owner training and Project operations and maintenance documentation.

D. Contractor shall provide all temporary electrical and internet services for use during construction and commissioning.

E. Contractor shall provide all temporary lighting, including at trailers and parking lot.

F. Contractor shall provide all design documents required to support Owner in obtaining Owner-Acquired Permits and other regulatory agreements.

G. Temporary Facilities

1. Contractor shall provide Owner with one furnished office trailer complete with electrical, internet service. Minimum space shall include two (2) offices, conference room, restroom (running water) and common areas.

2. Contractor shall be responsible for establishing and maintaining all restroom, lunchroom, and other office and meeting areas for the duration of the construction and commissioning portion of the Project.

3. Contractor shall provide temporary running water sanitary facilities for the temporary office trailer complex. For in-field work areas Contractor shall provide temporary sanitary facilities consisting of above ground Porta-John type. Contractor shall be responsible for decommissioning the temporary sanitary facilities at the termination of construction.

4. Contractor shall maintain on-site dumpsters and personnel to maintain a clean and rubbish free work site.

5. Contractor shall be responsible for designing and implementing temporary traffic control measures as required by applicable County or local agencies throughout construction duration.

6. Contractor shall be responsible for permitting, installation, and removal of a temporary water storage facility to satisfy water requirements for dust control purposes.

7. Contractor shall be responsible for establishing and maintaining temporary parking areas for construction and office personnel. Temporary

parking areas shall be returned to design grades and surfacing at the termination of construction.

G. Contractor shall be responsible for design, permitting and implementation of dust suppression and erosion control measures.

H. Contractor shall be responsible for permitting, and installation of a temporary water storage facility to satisfy water requirements for dust control purposes and other uses during construction as required by local authorities. Sizing of temporary water storage facility shall be of adequate volume for dust suppression. Temporary water storage facilities shall be removed, and the area returned to design grades and surfacing. All costs for water during construction shall be paid for by Contractor.

H. Contractor shall be responsible for site security throughout construction duration until turn over.

I. Contractor shall provide fire mitigation, and fire protection and access as required.

J. Contractor shall provide temporary barriers (snow fence or agreed upon barrier) to physically separate Circuits turned over to Owner prior to Substantial Completion.

K. Contractor shall provide traffic management as necessary to ensure safe site access from nearby public roads for all vehicles and equipment.

L. Contractor is responsible for meeting storm water quality requirements and retention basin requirements as dictated by Applicable Law.

M. Contractor shall provide all relevant electrical engineering studies for a comprehensive and complete design. This will include, but not be limited to, grounding study, arc flash study, short circuit study, ampacity study, temporary over voltage study, load flow (reactive power) study, harmonics analysis, and relay settings and coordination study.

N. Contractor shall conduct a Geotechnical Study suitable for the project level design work.

1.5 OWNER Provided Facilities, Information and Services

A. Owner will provide all applicable Owner permits for the Project.

1.6 Site and Environmental Criteria

A. Project design shall be based upon the design conditions listed below (Spaces marked with ‘X’s to be filled in by Contractor):

Table 1-1
Existing Site Design Conditions

Project Location	**Approximately XX miles XXX of XXXX, XX.**
Minimum/Maximum Dry Bulb Temperature (for inverter design)	X°F/X°F (ASHRAE extreme annual)
Extreme low temperature (for module string design)	X°F (ASHRAE extreme low annual) (OR Contractor can use SAM simulation to determine and submit to Owner for review)
Design Wet Bulb Temperature or relative humidity (for HVAC design)	X°F (ASHRAE 0.4% Design)
Maximum Elevation	X feet above mean sea level
Site Road Access	TBD
Seismic Criteria	SDS = XX, SD1 = XX, Seismic Design Category (SDC) = XXX, Site Class = D (assumed), Importance Factor = 1.0 unless otherwise approved by the local authority having jurisdiction (AHJ)
Wind Design	For Risk Category I structures (trackers), V = X MPH (X sec gust), Exposure = C (assumed), in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction For Risk Category II structures (ISAs and MET stations), V = X MPH (X sec gust), Exposure = C (assumed), in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction Wind on Ice shall be considered
Snow Load	XXXX psf For Risk Category I, Importance Factor = 0.8, in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction For Risk Category II, Importance Factor = 1.0, in accordance with the most recent edition of ASCE 7, unless otherwise approved by the local authority having jurisdiction
Risk Category	Unless indicated otherwise by the AHJ: For racking structures and racking foundations, Risk Category I For all other structures, Risk Category II

Project Location	**Approximately XX miles XXX of XXXX, XX.**
Maximum storm water velocity and depth	To be determined as part of design
Average Annual Rainfall	X inches
100 yr /Maximum 24 hr Rainfall	X – X inches
Design Maximum Rainfall Rate	100yr – Shall comply with applicable county requirements
Environmental Constraints	See Constraints Map
Floodplains	XXXX
Subsurface Soil Conditions	Per final Geotechnical Report

1.7 Design Criteria

A. Project and individual components shall have a minimum design life of 25years.

B. Project shall be designed for automatic operation.

C. Project electrical design will be in compliance with applicable codes and standards listed under section 1.8 unless otherwise noted.

D. Dissimilar metals in contact anywhere in system shall be avoided where possible to eliminate the possibility of galvanic corrosion. Lugs shall be rated for dissimilar metals where applicable.

E. During engineering design, Contractor shall work with the Owner when determining all signage, labeling and nomenclature.

1.8 Systems and Equipment

A. Provisions shall be included in the design of all systems to allow the performance of all routine maintenance without requiring a plant shut down.

B. Contractor shall:

1. Receive, inspect, store, unload, maintain, erect, clean, align, and prepare all equipment in strict accordance with equipment manufacturer's instructions prior to Substantial Completion.

2. Provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.

3. Select materials of construction and design equipment and systems to provide a minimum of a 25-year operating life at all operating conditions specified.

4. Design the facility for a life of 25 years consistent with good engineering practice for solar generation facilities. However, it is understood that some of the equipment will require routine maintenance and possible replacement during the life of the facility.

1.9 Operating Criteria

A. DC grid voltage: 1500 volts DC negatively grounded.

B. AC Medium voltage: 34.5 kV, 60Hz

C. DC & AC electrical systems under 1000V shall be radially configured. Medium voltage AC transformer systems shall be radially configured with open-loop feed features. No redundancy is required.

D. Convenience Power: 120VAC

E. Instrumentation voltage: 24VDC or 125VDC

F. Communications network: Ethernet via direct buried fiber optic within the arrays to the Communications Interface. Fiber optic to all field equipment shall be designed in a ‘collapsed loop’ configuration, at a minimum, to provide redundant path back to SCADA system. The network shall be 1 Gigabit and shall include adequate spare capacity to run parallel networks.

G. The DC/AC ratio of each inverter array shall be within 5% of the overall project DC/AC ratio.

1.10 Codes, Regulations and Standards

A. In the event that any Applicable Law or Industry Standard does not govern specific features of any item of Equipment and Materials, Temporary Work or system, Contractor or Original Equipment Manufacturer (OEM) standards shall be applied, with Owner’s approval. Where local codes or ordinances will have an impact on the design, Owner and Contractor shall jointly address these with the local authorities having jurisdiction.

B. Listed herein are the principal codes and standards applicable in the design, fabrication, and installation of the Project; these are not intended to be all inclusive. Where local codes or ordinances will have an impact on the design, Contractor shall be responsible for meeting the codes or obtaining variances from local authorities having jurisdiction.

C. Contractor shall design and construct the Project in accordance with the most recent versions of the following standards, as applicable:

D. ACI - American Concrete Institute

E. AISC - American Institute of Steel Construction

F. ANSI - American National Standards Institute

G. AISI – American Iron and Steel Institute

H. ASCE – American Society of Civil Engineers

I. ASME – American Society of Mechanical Engineers

J. ASTM - American Society for Testing and Materials

K. AWS – American Welding Society

L. IBC - International Building Code

M. ICEA - Insulated Cable Engineers Association

N. IEC - International Electrotechnical Commission

O. IEEE - Institute of Electrical and Electronics Engineers

P. ISA – Instrumentation Society of America

Q. NEC - National Electrical Code

R. NEMA - National Electrical Manufacturers Association

S. NESC - National Electrical Safety Code

T. NETA - National Electrical Testing Association

U. NFPA – National Fire Protection Association

V. OSHA - Occupational Safety and Health Act

W. TUV SUD America

X. UL – Underwriters' Laboratories

In the case where standards have conflicting requirements, Owner and Contractor will develop a mutual agreement of the prevailing standards.

2.0 SPECIAL CONDITIONS

2.1 Construction Water

A. Contractor shall size and provide all construction-water related infrastructure necessary to support Contractor's construction and schedule.

2.2 Flood Protection

A. Associated flood hazard requirements shall be incorporated into the design and construction of the Project. Contractor shall elevate and/or provide flood protection for structures subject to the approval of the [To be filled in by Contractor] County Engineering, Surveying, and Permit Services Department/Floodplain Management.

3.0 EQUIPMENT AND MATERIALS

Contractor shall furnish all Equipment and Materials as required to construct a fully functioning Project. Minimum requirements for major equipment are described herein:

3.1 PV Modules

A. Contractor shall provide PV modules and will submit the module type and specifications for project reference and use.

3.2 Tracker and Support Structure

A. The module support structures shall be designed and constructed to provide a stable support system for the PV modules that will remain effective throughout the design life of the Project.

B. Foundation shall be driven galvanized or equivalent corrosion-resistant steel members, mini-cast augured piles or equivalent. Corrosion resistance shall be as required by the findings of the Geotechnical Study and Corrosion Study. Corrosion Study shall be performed by an Owner-approved Corrosion Engineer.

C. Module support sub-structure frame may be corrosion-resistant steel or extruded aluminum.

D. Mounting hardware shall include corrosion resistant clips and fasteners.

E. Corrosion protection to be evaluated by Contractor to verify soil conditions are compatible with the module support structures.

F. The maximum support structure deflections shall prevent PV module and electrical system damage and shall not exceed allowable limits provided by the manufacturer and the most recent edition of IBC and ASCE 7 codes.

G. The module support system shall be designed and constructed to withstand environmental conditions and applied loads for the design life of the Project.

H. Dynamic force conditions from wind shall be considered and included in design.

I. Horizontal single-axis with backtracking.

J. Tracker drives electric motors or hydraulic. If hydraulic, oil must be bio-degradable type oil, not considered an environmental hazard.

K. Galvanized steel structural components.

L. Accurate stowing required for wind events based on design tolerance. Capable of quick stow or stowing based on accurate wind predictions or measurements.

M. Designed and manufactured per applicable AISC, AISI, ASTM, ANSI & AWS codes and standards.

N. The tracking system shall be designed and constructed to withstand environmental conditions and applied loads for the design life of the Project.

O. Bearings and gears shall have Basic Rating Life (L_{10}) of 100,000 hours.

P. Tracker supplier must have robust proven QA/QC program installed at shops supplying torque tubes, torque arms, drive struts, and other main components of tracker.

Q. DC cable management system - open cable tray or CAB systems may be used.

R. Racking system and module mounting shall meet the requirements of UL 3703 and 2703, respectively.

S. All modules shall be a minimum height of twelve (12) inches and a maximum height of eight (8) feet above the ground. Combiner boxes, disconnect switches, inverter/transformers, and any other electrical equipment shall be a minimum 12” above the 100-year flood level. Module height at stow position shall be above the 100-year flood level unless otherwise required by AHJ.

3.3 DC Fused Combiner Boxes (as applicable)

A. Enclosure shall be rated NEMA 3R or 4.

B. Combiner boxes shall be installed above ground.

C. Factory assembled back panel complete with finger safe fuse holders rated for maximum VDC, reinforced, plated bus bars and power distribution blocks.

D. Combiners shall have a load-break DC disconnect switch with the capability of being pad-locked in the off position.

E. Enclosures doors shall have provisions for pad locking.

F. Completed assemblies shall be listed to UL 1741.

G. Combiner shall be labeled to meet NEC code requirements and labeled with an arc flash warning.

H. All feeders and cables into combiner boxes shall have preprinted labels with unique tags/identifiers.

I. Safety covers shall be provided for live components.

J. Surge suppression devices shall be mounted internal to combiner box.

K. All terminals shall be 90°C rated.

3.4 DC Load Break Disconnects (as applicable)

A. Enclosure shall be rated NEMA 3R or 4.

B. Load Break Disconnects (LBDs) shall be installed above ground.

C. Provisions for pad locking in the off position.

D. Completed assemblies shall be UL listed.

E. Combiner shall be labeled to meet NEC code requirements and arc flash warnings.

F. All feeders and cables into LBDs shall have preprinted labels with unique tags/identifiers.

G. Surge suppression devices shall be mounted internal to LBD.

H. All terminals shall be 90°C rated.

3.5 Inverter Skid Assembly (ISA)

A. Each ISA shall consist of inverters with step up transformer, DC cabling/bus, AC cabling/bus, auxiliary equipment, and grounding system.

B. Inverters

1. Inverter shall be on Approved Supplier List and approved by Owner.

2. Inverter shall be UL 1741 Supplement A listed.

3. Inverter shall be rated for use in 1500 Vdc applications.

4. Inverter shall have California Energy Commission (CEC) weighted efficiency greater than or equal to 98% (without medium voltage inverter step-up transformer).

5. Environmental ratings:

    a. Inverter shall be capable of operation at full nameplate rating from ambient air temperatures between -20 ºC to 50ºC (-4 ºF to 122ºF). Depending on Site Design Temperature a 45 ºC upper limit may be acceptable.

    b. Inverter electronic compartments (IGBTs, communications, etc.) shall be NEMA 4 or better (or European equivalent) and the overall enclosure rating shall be NEMA 3R or better (or European equivalent).

6. Nameplate: Inverter shall be sized to deliver rated power at ±0.95 power factor up to 50°C.

7. Quantity: Adequate inverters shall be provided, considering losses and reactive power, in order to deliver the required power at the POI at the design temperature.

8. Inverters shall have the capability of dynamic power factor adjustment from 0.95 lag to 0.95 lead, unless more stringently defined by Interconnect Agreement.

9. Inverters shall not de-rate while operating within their rated DC voltage range for an ambient temperature of 50˚C and below. A gradual de-rate may be experienced in the case that the operating conditions are outside the rated DC voltage or ambient temperature range(s).

10. Current and voltage harmonics: <3% THD and IEEE-519-2014 requirements at the POI.

11. Inverter shall be designed to the requirements of IEEE C57.159 to be compatible with its step-up transformer in terms of harmonics and resonance.

12. Inverter cooling system shall not be susceptible to particle contamination and require minimal maintenance.

13. Inverters shall be provided with surge suppression devices on both the DC Input and AC Output.

14. Inverter shall have protective measures to prevent single IGBT failures from causing cascading failures.
15. Inverter AC breaker shall be externally operated and capable of remote operation to minimize arc flash hazards.
16. Inverter shall be provided with ground isolation detection devices where used with systems having ungrounded PV arrays.
17. Inverter shall be operated in accordance with manufacturer's recommendations. Any deviation shall be authorized in writing from the manufacturer and not before notification and acceptance by Owner.
18. Inverter shall have built-in protection against undervoltage, overcurrent, overvoltage, and transients.
19. Inverter shall have capabilities for voltage and frequency ride-through and the features shall be compliant with NERC and FRCC requirements.
    a. Inverter shall be compliant with NERC PRC-024-2 ride through requirements.
20. Inverter shall integrate Inverter Step-up Transformer signals (low oil, high pressure, high-temp warning, and high-temp trip) into SCADA system and trip/warn/de-rate signals appropriately.

3.6 Inverter Step-up Transformers

A. Transformers shall be of the compartmental pad-mount design with dead front and loop feed features.

B. Ratings: Transformer kVA rating shall match ISA combined inverter rating. Impedance shall match inverter manufacturer requirements. Cooling class = KNAN

C. Low-side voltage: Matched to selected inverter.

D. High-side Voltage: 34.5kV Delta/ with elbow surge arrestors located on transformers that do not contain a loop feed out.

E. High efficiency: 99.2% or greater at nameplate output.

F. No-Load losses shall be limited to 0.15% of full KVA rating.

G. BIL ratings: To be stated in data sheet for Owner review.

H. Winding insulation: 65ºC rise over 45ºC ambient.

I. Number of windings: Maximum of three.

J. De-energized tap changer with high voltage taps: (2) 2.5% above and below nominal position – fully rated.

K. Hook stick disconnect switch shall be located such that Arc Flash protection is not required for operation.

L. Over-current protection via bayonet fuse (with holder) in series with partial range current limiting fuse, or internal expulsion fuse in series with oil immersed with current limiting fuse shall be provided.

M. Top powder coat of ANSI 70 light grey or Munsell Green.

N. Oil level, pressure/vacuum, and oil temperature gauges. All instrumentation shall be read into SCADA. Oil temperature gauge to be furnished with two alarm contacts (warning and trip). Oil temperature and pressure transmitters shall provide binary outputs. Oil level gauge to be furnished with alarm contacts. Instrument gauges shall be located in a separate cabinet such that gauges can be read without requiring Arc Flash protection. Access to the equipment shall be provided in accordance with NEC and OSHA standards.

O. Drain valve with oil and dissolved gas analysis (DGA) sampling provisions, readily accessible in normal operation.

P. Transformer mounting pad design may be required to incorporate features for secondary containment of oil. Contractor shall conform to requirements of local authorities having jurisdiction and design shall be reviewed and accepted by Owner.

Q. In addition to all routine factory testing per most recent standard of ANSI/IEEE standard C57.12.90 and C57.12.00, the following tests shall be conducted:

   5. Full ANSI impulse test on one (1) unit, preselected during production by Owner.

   6. Heat run test on one (1) unit, preselected during production by Owner.

R. Shall comply with the following latest ANSI/IEEE standards:

   1. C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

   2. C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers

   3. C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers

   4. C57.159 – IEEE Guide on Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems

   5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers

S. Baseline DGA, conducted at factory or on Site, shall be provided with each transformer.

3.7 PROJECT SCADA

A. SCADA system shall be composed of hardware and software, field instrumentation, meteorological stations, and communications devices designed for remote monitoring, control, and historical trending of the Project.

B. Shall be NERC CIP compliant and meet cyber security requirements, following Owner's compliance and security addendum M1-01-07. For further information refer to M1-05-04.

C. Site SCADA and telecom shall be fully protected and behind a firewall.

D. Shall allow for multiple external connections and be able to accommodate private networks (MPLS, etc.).

E. Shall be able to communicate with external parties in their protocols For further information refer to M1-05-04.

F. All power plant controller set points, etc. must be logged (set point, user, etc.).

G. The SCADA system shall include 10% spare hardware I/O points for Owner's future use.

H. The SCADA system shall meet all data frequency and duration requirements specified in M3-01-05.

I. Contractor shall supply, install, and commission the SCADA System hardware at the Site in connection with the performance of its services pursuant to the terms of the EPC Agreement.

J. SCADA system shall display data in real time and record and log performance data at regular intervals from the Project.

K. All SCADA data shall be made available for a Pi interface and other third parties as required for remote access, monitoring and data collection.

L. Communications infrastructure shall be fiber optic based and incorporate a collapsed-loop ring fiber network or equivalent.

M. SCADA System

7. Contractor shall program the control software for the Project on an industry-standard SCADA platform for easy integration into Owner's operation. Software shall employ both remote monitoring and control and an Antivirus server.

8. Contractor shall provide a historian capable of capturing all data points, at one second intervals (or fastest available or permitted by each device) and log data for at least 1 year or minimum required to meet local ISO, NERC, or other requirements. All data must be made available to Owner at native resolutions.

9. IP addressing to be coordinated with Owner.

10. All SCADA and network equipment must be of utility grade substation quality equipment by standard industry grade suppliers.

11. Field Area Network (FAN) shall maintain a dedicated redundant fiber gigabit Ethernet backbone from the central control room to each ISA. Inverter structures switch sub connections to Ethernet based inverter devices may be 10/100 megabit minimum connectivity.
12. Field network connectivity shall be established using Owner approved protocol and a physical ring topology. Each ring will be comprised of less than 34 switches. Loop connectivity for field network may be achieved through the use of 2 parallel fibers within the same cable (closed-loop).
13. All fiber shall be terminated on bulkheads/enclosures.
14. All fiber networks shall support 1 Gigabit network architecture.
15. Contractor shall install minimum one operator station for access to the SCADA system and historian server and provide all SCADA/historian licensing for the Project. Such hardware/software shall be located at the Site, and title to such hardware/software shall be transferred to Owner.
16. SCADA shall employ Remote I/O to be deployed at major data collections points in the Project. Typical locations for the Remote I/O include the ISAs.
17. The Remote I/O shall function as the input/output point for the command and control signals.
18. The SCADA system shall be either connected to its own UPS or connected to the substation backup energy system. 8hr run-time required.
19. The SCADA shall be designed with redundancy in mind, i.e. power supplies, network paths, etc. UPS system is required at Control Room.

N. Power Plant Controller: The Power Plant Controller shall be able to accept commands from the the following locations and distribute these commands to all equipment on Site as necessary:

1. Local operator station
2. Owner’s centralized remote command center
3. Utility or ISO dispatch commands (such as Automated Dispatch System in CAISO) .

At a minimum, the following controls capabilites shall be available at the plant level:

1. Power factor control
2. Reactive power (VAR) control
3. Output power curtailment
4. Power and VAR ramp rate adjustment
5. Frequency droop control (freq vs. kW)

6. Automatic voltage regulation (AVR) at the point of interconnection (POI) utilizing reactive power (VAR) control

O. Power Plant controller shall utilize an SEL-3530 RTAC or similar quality controller.

P. Control Room (Shall be located in either O&M Building or Control House of the Solar Substation)

1. The Project shall have a Control Room that will act as the central point for the SCADA System. The Control Room will also function as the SCADA room. SCADA network and all associated hardware will be located here.

2. The Control Room shall also function as the communications center for the site.

3. The Control Room shall also contain the Contractor supplied SCADA communications equipment which will transport all SCADA to the Solar Substation control house via fiber optic cable. The Contractor will be allowed access to this data via the remote system for an agreed upon time period (if applicable). The access method must be agreed upon by the Owner.

Q. Meteorological Station (the “Met Station”). The Met Station shall consist of instruments to measure the meteorological parameters listed below. The minimum number of stations corresponding to facility size is listed in the table below shall be installed. Accuracy requirements of Met Station sensors are specified in M3-01-05. Met Station must have a backup power supply to allow normal data collection for a period of 48 hours without external power. Additional MET Station equipment required by the Utility shall be provided by the Contractor. Proposed locations shall be reviewed and accepted by the Owner.

Project Size	Met Stations	POA Pyranometers	GHI Pyranometers
<=50MW	3	3	3
<=100MW	5	5	3
<=150MW	7	7	5
<=300MW	9	9	7

R. Typical SCADA points monitored include the following:

1. Meteorological Parameters shall conform to all Participating Intermittent Resource Program (PIRP) requirements including but not limited to the following unless otherwise specified in these Contract documents (accuracy requirements specified in M3-01-05):

a. Outside Air Temperature and Relative Humidity

b. Secondary Standard Horizontal Thermopile Pyranometer (Direct & Indirect Irradiance)

c. Secondary Standard Plane-of-Array Thermopile Pyranometer (Direct & Indirect Irradiance)

d. Rainfall Amount

e. Barometric Pressure

f. Back of module Temperature (see PV Module Points below)

g. Anemometer and Wind Vane (Wind Speed and Direction. Wind speed should be ranged for the full design spec of the site.)

2. ISA Points (per ISA)

   a. Inverter Performance Points

      i. To include real time AC and DC electrical characteristics, including but not limited to power, energy generated, inverter status and diagnostics, alarms, cooling system and component temperatures, and all data available from inverter system.

3. PV Module Points

   a. PV Module Back Surface Temperature (minimum two (2) per MET Station). Temperature sensors shall be placed so as to accurately represent the average module temperature in the inverter array.

4. PV Sub-Array DC Current Points

   a. PV Sub-Array DC Current Transmitters (one for each Inverter DC Sub-Array or inverter feeder input)

5. Inverter step-up Transformer at ISA Points

   a. Transformer Oil Temperature Warning (Digital)

   b. Transformer Oil Temperature Trip (Digital)

   c. Transformer Pressure (Digital)

   d. Transformer Low Oil Level (Digital)

6. Tracker

   a. Tracker angles (setpoint and actual position)

   b. Tracker status and operating state (including stow)

   c. Tracker alarm states

   d. All other applicable and industry standard data points

7. Soiling Station (as required for Capacity Test, see M3-01-05)

a. Soiling Ratio

b. Voltage of clean and dirty panels

c. Current of clean and dirty panels

8. Solar Substation Points

a. SCADA system shall be open architecture and support bidirectional data exchange between the Owner supplied equipment and the Contractor supplied equipment. See M3-01-02.

9. AC Revenue Meter Points

a. Shall include real time AC electrical characteristics, including but not limited to power, energy generated, meter status and diagnostics.

b. All points required by utility and ISO

4.0 ELECTRICAL INSTALLATION

4.1 General

A. Cable runs shall only be made parallel and perpendicular to array mounting system.

B. Grounding lugs installed outdoors within 18” of grade shall be UL-listed for direct burial. Other grounding lugs installed outdoors shall be copper or brass with brass or stainless steel hardware, or tin-plated aluminum with stainless steel hardware. All grounding lugs shall be UL listed.

C. All ground grids must be installed at a depth below the frost line.

D. Backfill and compaction of trenches shall meet geotechnical recommendations and shall be performed with compaction equipment specifically designed for such duty. Lifts shall not exceed 12”.

E. All cables and cable ties shall u.v. resistant. This means their exterior materials shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements. Materials shall contain u.v. inhibitors and a minimum of 2% carbon black, with a particle size no larger than 35 nm.

F. Direct-buried wiring shall meet NEC requirements for burial depth and warning ribbon. Warning ribbon width shall be 4” minimum. Cables shall be surrounded by a minimum of 4” of clean fill free of stones larger than 1-inch in diameter.

G. Electrical equipment shall be located a minimum of 12” above the 100-year floodplain elevation unless otherwise noted.

H. Conduit openings shall be sealed to protect against intrusion of pests and other wildlife.

4.2 DC System Wiring

A. Contractor may combine strings in combiner boxes or with factory-supplied in-line fused connections and load break disconnects (LBD).

B. System shall be designed such that the DC Voltage Drop Maximum for any one inverter array (from module string to inverter DC input) at full load and STC does not exceed 1.5%.

C. Series string connections between modules will be via locking multi-contact connectors and jumpers factory-supplied with modules.

D. All wiring shall be supported per NEC and manufacturer’s requirements.

E. DC cabling may run above grade where allowed by code. Method to be reviewed and accepted by Owner.

F. Contractor shall submit cable data sheets and project cable schedule to Owner for approval for each application prior to procuring the cable.

G. DC cable for the wiring from the combiner box or trunk cable to the inverters shall be 1.5kV minimum, 90ºC (wet or dry), power cable type RHW-2 or XLPE with UL 1581, VW-1 rating, and suitable for direct burial. Conductors may be stranded copper or aluminum.

H. DC cable for the wiring from the modules to the combiner boxes or trunk cables shall be 1.5kV minimum, 90ºC (wet or dry), power cable type XHHW-2 or PV wire (as applicable), with UL 1581, VW-1 rating, and suitable for application. Conductors shall be stranded copper or aluminum.

I. Harnesses or cabling shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements. For ultraviolet protection materials shall contain a minimum of 2% carbon black with a particle size of 35 nm or less.

J. Fuses shall be accessible and replaceable. All fuses shall be mounted greater than 12” above the 100-year flood plain.

K. Factory cable assemblies may be pre-cut to length.

L. Locking multi-contact connectors shall mate with module terminations.

M. Wiring harnesses and cabling shall be UL listed.

N. Metal wire loom clamps or approved equivalent shall be used for cable fastening.

4.3 Low Voltage AC System Wiring

A. All conductors, lugs and cable accessories shall be UL listed.

B. No splicing shall be allowed.

C. System wiring installed in raceways shall be type THHN/THWN-2, or XHHW-2. Conductors may be stranded copper or aluminum.

D. System wiring installed in direct burial applications shall be type USE-2 with XLP insulation. Conductors may be stranded copper or aluminum.

E. When terminating aluminum conductors, coat conductor with oxide inhibitor and install per terminator manufacturer's instructions.

4.4 Medium Voltage AC System Wiring

A. Phase conductors shall be 35kV type MV105 or MV90 (if temperatures are low enough), (dry or wet) single compact or compressed concentric conductor, aluminum, 100% or 133% TRXLP or EPR insulation, copper tape shield or concentric neutral.

B. Equipment grounding conductor shall meet the requirements of the Short Circuit Study.

C. Conductor size to not exceed temperature rating of conductor insulation at full generation and to allow for no more than 2% voltage drop at full generation at Solar Substation connection.

D. System shall be designed such that MV conductor kW losses (from high-side of MV ISA transformer to Solar Substation) at full load do not exceed 1.25% in total across the entire facility at Project nameplate rated capacity.

E. Medium voltage terminations shall be 600 A-rated dead break elbows that meet the requirements of ANSI/IEEE 386. Allow sufficient slack to facilitate re-termination.

F. Provide directional fault current indicators on the field-side of all MV junctions, and the substation-side of all MV feed-through transformer connections.

G. No splices shall be allowed unless long AC collection cabling runs required due to site geometry. In such cases, only above ground splice boxes, approved by Owner, shall be acceptable.

4.5 Overhead Medium Voltage AC Wiring

A. Overhead conductors shall be used where economically efficient in routing power to Solar Substation with minimal losses.

B. Overhead wiring and poles shall be routed so as to minimize shading on the solar arrays.

C. All overhead lines shall be designed to maintain all applicable code and regulatory clearance requirements.

4.6 Grounding

A. Grounding system shall meet the requirements of NEC, NESC, IEEE 80, and ANSI C2 at a minimum. Grounding design shall be verified in grounding study.

B. All grounding hardware shall be listed and approved for the application.

C. Where applicable, ground equipment per the manufacturer's requirements.

D. A ground test well shall be furnished at each ISA. A flush cover over the test well shall expose one ground rod and cable with mechanical cable to rod connectors to allow disconnection for testing purposes.

E. Contractor shall install supplemental fence grounding or isolation sections where deemed necessary by the grounding study.

4.7 Labeling and Identification

A. For diagnostic and troubleshooting purposes, all string harnesses and combiner boxes, or load break disconnects (LBD), shall be uniquely tagged and identified with such tagging on the record construction drawings. These cables shall have a label affixed to the outer jacket with a cable marker tape at each termination. The marker tapes shall be vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process. Marker tapes to be approved by Owner before installation.

B. As part of the Contractor Deliverables that must be delivered prior to Final Completion, Contractor shall provide to Owner a Microsoft Access database including all module serial numbers which can be sorted by array, combiner box or LBD, and harness. Contractor shall also submit an "As-Built" drawing depicting the physical location of each array, combiner box or LBD, and harness indicating the unique tag number for each combiner box or LBD and harness. Electrical equipment shall be labeled to meet applicable safety codes and requirements.

4.8 Electrical Studies

A. Contractor shall prove the design meets Contract requirements and all relevant standards by performing the following studies:

1. Short Circuit Study: fault analysis of collection system. Contractor shall show that all equipment is rated for the relevant fault current.
2. Ampacity Study: Contractor shall prove equipment will not exceed its temperature rating at full load. Ambient temperatures shall be per ASHRAE. Contractor shall use no less than a 60% load factor for cable design. Greater values for AC cables shall be used if the interconnect agreement requires VAR-at-night support or energy storage is included. If Geotechnical Study is not available at time of bid, Contractor shall assume a soil temperature of 28°C and a thermal resistivity of 200 °C-cm/W.
3. Load Flow and Reactive Power Compensation Study: Contractor shall prove Project performance will meet all GIA and IEEE 399 requirements.
4. Harmonics Study: Contractor shall prove Project meets all IEEE 399 harmonics requirements.
5. Grounding Study: Contractor shall prove Project meets all IEEE 80 requirements, taking into account considerations in IEEE 2778. Show that step and touch potentials on all exposed conductors, including tracker tubes and fence, do not pose a hazard to site personnel or the public. Perform the analysis using a soil model based on the Geotechnical survey, taking freezing and thawing conditions into account. Assume a 50

kg body and no PPE. Fault duration shall be per Protection Coordination Study, or 0.5s if it has not yet been performed.

6. Arc Flash Study: Contractor shall perform an arc flash hazard analysis in accordance with NFPA 70E and IEEE 1584, taking the relevant switching and generation scenarios into account. All electrical junctions and terminations shall be labelled with the calculated arc flash hazard, minimum approach distance, and minimum PPE.

4.9 Electrical Equipment Enclosures

A. Control Cabinets, pull boxes and junction boxes shall be in accordance with NEMA Standards and type number and shall be suitable for the location conditions. Base design shall be:

1. Indoor:NEMA 1
2. Outdoor: NEMA 3R

B. All enclosures shall be provided with pad locking provisions.

4.10 Lightning Protection for Field Enclosures

A. Lightning protection, (where required) shall be limited to air terminals, down conductors and a connection to the ISA grounding electrode loop as well as surge arrestors at the inverter step-up transformer and inverter. Lightning protection (where required) shall comply with the requirements of NFPA 780 Standard for the Installation of Lightning Protection Systems. Master label certification is not required.

B. All components shall be un-insulated, copper, and exposed for inspection purposes.

5.0 FIRE PROTECTION

5.1 Fire Protection System

A. As necessary, the Contractor shall provide a complete fire protection system in accordance with the recommendations and requirements of NFPA, UL, FM, and the local Fire Marshall. The systems shall receive the approval of the Owner's insurance carrier.

B. The engineer responsible for the fire protection system shall be a practicing fire protection engineer registered as a Professional Engineer in the applicable State. All drawings and specifications shall be signed and sealed by the Professional Engineer.

C. The fire protection and detection systems requirements for specific plant locations are summarized in Table 5-1.

D. Portable CO_2 fire extinguishers of sufficient size shall be provided in all areas requiring handheld fire protection.

E. Fire walls for oil-filled transformers shall be provided between transformers and adjacent structures in accordance with Section 5.0 of NFPA 850.

F. Adequate access roads and spacing to PV arrays and equipment shall be provided as required by local Fire Marshall.

G. General

1. Fire protection during plant construction shall meet requirements and recommendations of NFPA 241.

2. All fire protection systems are subject to the review and approval of the local fire department authorities.

TABLE 5-1
Plant Fire Protection and Detection Systems

Plant Location	Type of Fire Protection	Fire Detection
ISA	handheld CO2 fire extinguishers*	N/A
O&M Building Offices, conference room/multi-purpose room, restrooms, storage room, and kitchen area Control room	Fixed, automatic, wet-pipe sprinkler & Handheld extinguishers* FM200 plus handheld extinguishers*	Smoke and heat detectors

(*) or as required by local Fire Marshal

6.0 O&M BUILDING (IF APPLICABLE)

6.1 General Requirements

A. Contractor shall design and construct the O&M Building in accordance with this Specification and the referenced applicable standards. The O&M Building shall comply with the Project's future service provider requirements 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.

B. Where feasible and economically more efficient, O&M BULDING shall be combined with the Solar Substation control house, without direct access between the two areas (only sharing the same roof and power). O&M Building shall not allow for any direct access to Solar Substation or Solar Substation control house.

6.2 Scope of Work shall consist of:

A. Prepare design documents, size equipment, generate drawings and specifications, and other supporting activities to the degree of detail required to fully and clearly define design and construction work requirements.

B. Prepare calculations as required for design decisions, equipment and material selection and preparation of construction drawings.

C. Prepare system descriptions indicating equipment data, operating characteristics, sizing basis, functions, air flow rates and other process information for all building systems.

D. Prepare mechanical, electrical and instrument equipment lists with summary descriptions, vendors and pertinent data.

E. Prepare arrangement drawings for Owner's Review and finalize arrangement drawings for construction. At a minimum, O&M Building to include:

1. Control room with HMI screens interconnected SCADA system.
2. Office with 2 desks.
3. Break room with sink, table, and refrigerator.
4. Men and women's bathroom.
5. Storage/spare parts room.
6. Reception area.

F. Provide all architectural, civil, electrical, mechanical and structural construction drawings for the building and supporting systems including but not limited to the following:

1. Site Arrangement
2. Architectural Plans, Elevations and Details
3. Control Room and Electrical Room Arrangements
4. Access Roads, Curbs, Walkways and Parking
5. All Grading
6. All Drainage
7. Foundations
8. Structural Steel
9. All above grade and below grade piping
10. Conduit, Cable, and Raceways
11. Fire Protection Systems

12. One-Line Electrical Diagram
13. Lighting

G. Prepare technical specifications and other documentation to support all equipment procurement, materials, and construction requirements.

H. Obtain necessary plan approvals and building permits from appropriate state, county and local building authorities. These permits may include but are not limited to the following:

1. Storm Water Pollution Prevention Plan
2. Dust Control Permit
3. Building Permit
4. Grading Permit
5. Septic Tank Permit
6. Construction Trailer Permit

I. All Architectural, Civil, Structural, Mechanical, Electrical, and Instrument and Control design documents that are issued for construction or procurement shall be prepared by or under the direct supervision of a Registered Professional Engineer or Architect according to the requirements in the applicable state. Each engineer or architect responsible for the design shall stamp or certify that the design documents have been prepared by him/her or under his/her direction.

7.0 SITE WORK

7.1 General Requirements

A. This section covers the minimum scope and quality for the plant civil design and construction.

B. Contractor shall develop a Worker Environmental Training Program based on AHJ requirements and own safety plan meeting industry standards. All site personnel shall undergo the Worker Environmental Training Program prior to being allowed to work on the site.

C. Contractor is responsible to inspect the Site, obtain all necessary Site data, obtain all required geotechnical and drainage investigations, and determine all Site data for the design and construction of the PV power plant. This shall include determination of local code requirements for seismic and wind design loads. It is Contractor's sole responsibility to ensure that the Site work complies with all federal, state, and local code requirements and all applicable industry codes and standards, including standards of applicable authority having jurisdiction.

D. The scope shall include, but not be limited to the following:

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water drainage, grading, roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.
2. Coordinate design with other engineering firms and utilities responsible for scope outside of the Contractor's own scope.
3. Obtain all necessary permitting associated with civil site work construction such as grading permits, haul permits, dust permits, storm water pollution prevention plans, etc., in compliance with City or County requirements and other jurisdictional government agencies as may pertain.
4. Construction of all civil site work, including the storm water drainage infrastructure, earth grading, roads, security fencing, etc. Construction of any temporary civil site work such as temporary security fencing, temporary construction roads, etc.
5. Perform flood damage management and storm water pollution management during construction in compliance with state and local sediment and erosion control rules, regulations, ordinances, and approved Storm Water Pollution Prevention Plan (SWPPP).
6. Perform dust control measures during construction in compliance with state and local rules, plans, regulations, permits and ordinances for fugitive dust emissions.
7. Perform the geotechnical evaluations as necessary for the civil site work.
8. Prepare the drainage report(s) to meet applicable agency's permit requirements.
9. Perform all construction surveys (construction staking).
10. Prepare record drawings that depict any deviation from original design drawings.

E. The Project design shall take into account existing site conditions with respect to soil characteristics, site clearing, grading, and drainage. The Contractor shall be responsible for all site preparation including any demolition, soil stabilization, grading, drainage, roadways, and temporary parking areas.

7.2 Units

A. All design dimensions and design calculations shall be in British (United States Customary) units.

7.3 Geotechnical

A. The Contractor's final design shall be based on the recommendations of a final Geotechnical investigation and report performed by a licensed professional Engineer in the applicable state. If a preliminary geotechnical study is provided by Owner, it is recommended that a final report be executed by the Contractor.

B. Because the Geotechnical Study forms a large portion of the design basis for Civil, Structural, and Electrical disciplines, the report shall be thorough and comprehensive, and shall cover the following topics at a minimum:

1. Include appropriate quantity and depth of test bores to result in a representative characterization of all soils on the site, including the substation area.
2. Identify soil types at each depth.
3. Chemical makeup.
4. Excavation, fill, backfill, and compaction requirements.
5. Thermal resistivity with dry out curves.
6. Electrical conductivity.
7. Earth pressure and hydrostatic pressures.
8. Groundwater levels.
9. Identify presence of aggregate, caliche, rock, etc. and map out locations
10. Soil bearing values.
11. LPILE design parameters.
12. Corrosion characteristics. If Geotechnical firm does not perform Corrosion Studies, at a minimum will identify corrosivity of soils based on pH, sulfates, and electrical conductivity.
13. Seismic considerations.
14. Pile load testing.
15. Grubbing depths.
16. Recommendations

7.4 Construction Surveys

A. Contractor will provide the boundary and topographical survey(s) for the site.

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

C. Contractor is responsible for all surveys required for environmental and cultural permitting and shall meet all such permit requirements during the execution of the Project. If required by environmental permits, Contractor shall retain a qualified biologist to clear the site of sensitive species in advance of ground-disturbing activities. Nesting birds or other species protected by state or federal law shall be avoided by an appropriate buffer until the species have fledged or left the site of their own accord, in connection with the Worker Environmental

Training Program. The qualified biologist shall guide flagging of environmentally sensitive areas, as appropriate.

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

7.5 Site Preparation and Maintenance

A. Site Clearing and Grubbing

1. Immediately prior to Substantial Completion, Contractor shall remove all weeds and trim all native vegetation from areas surrounding PV Modules, other electrical equipment and site infrastructure, in compliance with the Revegetation Plan. The Contractor shall be responsible for all applicable permitting with jurisdictional agencies for use of herbicides should the decision be made to use them during construction.

B. Debris

1. All construction-related debris and unsuitable material including material from site clearing and grubbing shall become the immediate property of Contractor and shall be removed from the premises and lawfully disposed of off-Site by Contractor at Contractor’s cost.

C. Stormwater Management and Erosion Control

1. Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) for its construction activities. Contractor shall be responsible for installing and maintaining the storm water controls and best management practices in compliance with the SWPPP. The Contractor shall provide for sediment and erosion control during and after construction in accordance with project permits and local and state laws and regulations. Best management practices such as check dams and sedimentation basins shall be used during construction to minimize erosion. Long-term operational best management practices shall be installed prior to substantial completion and be designed to minimize erosion on site and sedimentation of waterways.

2. Drainage facilities shall be designed and constructed in a manner to minimize erosion and prevent excessive erosion within the Array areas. Excessive erosion shall be considered as anticipated erosion exposing the pile such that the design embedment depth is no longer met. Drainage facilities should also be designed to limit off-site sedimentation

of waterways per applicable regulations or permits and may include retention basins as appropriate to achieve these objectives.

3. Drainage design shall be approved by AHJ, as applicable.

4. Contractor shall design and construct site grading/drainage to minimize potential for site flooding and ponding. The working area of the site shall be well drained during and after construction. The civil drainage infrastructure design shall conform with the standard of the jurisdictional government agencies.

5. Contractor shall prepare drainage report(s) to support obtaining construction permits for the project, as applicable. The report(s) shall meet the standards and requirements of the applicable agency and shall describe the final design of the storm water drainage infrastructure and provide the hydrologic and hydraulic calculations applied.

6. The Contractor shall prepare a design meeting the acceptance of Owner, such acceptance shall not be unreasonably withheld, which incorporates permanent, long-term measures which mitigate the flood potential associated with on-site generated storm water runoff.

7. Waters of the United States shall not be impacted, filled, or used in connection with the site drainage plan unless proper permits are obtained.

D. Road Maintenance

1. All temporary access roadways used by Contractor, as well as the new site permanent roads shall be maintained in serviceable condition. Contractor shall keep the surfaces of those roadways free from spills, mounds, depressions, and obstructions, which might present a safety hazard or annoyance to traffic.

2. Contractor shall be responsible for securing authorization and permits to transport oversized/overweight loads on local, County and State roads for the supply of materials under Contractor’s scope.

3. Contractor shall supply and install any temporary or permanent facilities required to facilitate delivery of Contractor and Owner equipment/materials. Contractor shall also be responsible for removing all such temporary facilities.

E. Signs and Barricades

1. Signs and barricades shall be provided and maintained by Contractor and shall be in accordance with jurisdictional regulations for accident prevention and Contractor’s safety plan. Signs shall further comply with any County-specific design standards.

F. Dust Control

1. Dust Control for Construction Activities

a. Contractor shall be responsible for obtaining dust control permits, if required, and complying with requirements of said permit. Contractor shall be responsible for compliance with State and local requirements for fugitive dust emissions and shall obtain local authority approvals and conform to the dust control regulations and reporting requirements.

b. Contractor is responsible for locating source of construction water to support dust control and construction activities.

G. Open Burning

1. Onsite open burning is not permitted without Owner's approval and without first obtaining any applicable burn permit.

H. Earth Grading

1. Contractor shall balance the earth grading and leave no stockpiles or pits remaining at the completion of the full build-out of the project. (Stock piling in accordance with applicable regulations may be permitted in support of phased construction.) The grading design shall balance the earth work such that no major volumes of soils will be imported or exported from the Site for grading purposes. Any permitting, or costs for import or disposal will be the responsibility of the Contractor.

2. The Contractor is responsible to meet the grades and slopes as necessary to support the solar installation. The Contractor is responsible for any re-grading or repair costs associated with not providing ground surfaces which adequately support the solar installation.

3. Contractor shall identify site specific grading restrictions, if any.

I. Excavation, Filling, and Backfilling

1. Excavation, filling, and backfilling shall meet the requirements of the Geotechnical Study.

2. Excavated native material may be used on the site for embankment and backfill, if suitable. All unsuitable materials such as; rock, concrete, wood, metal, and other materials from the excavation shall be considered debris and disposed of as described herein.

3. Structural fill, bedding material, topsoil, and other materials not readily available on site shall be procured, tested, and delivered to the site by the Contractor.

4. Contractor shall be solely responsible for maintaining the stability of all excavated faces and shall provide adequate sheeting, shoring, and bracing to support any lateral earth pressure.

5. Contractor shall be solely responsible to protect personnel and adjacent structures against any damage from cave-ins, heaving or other earth movements. Sheeting, shoring, and bracing shall be removed as

backfilling proceeds or it may, with the approval of Owner, be left fully or partially in place.

6. Fill characteristics and compaction requirements shall be determined by Contractor's geotechnical investigation and report recommendations.

7. All equipment used to meet compaction requirements shall be specifically designed for such duty.

7.6 Roads

A. Site Access:

1. Site access road improvements shall be the responsibility of the Contractor.

2. Access to the Site will be constructed in accordance with applicable agency requirements, including, but not limited to the local fire department.

3. Contractor shall be responsible to obtain and comply with all encroachment permits required to construct driveway aprons or otherwise connect access roads to county-maintained roads, as applicable.

B. Roads on-site shall consist of the following:

1. The perimeter roads shall be routed around the exterior of the solar arrays, connecting the Solar Substation, O&M Building (if applicable), inverter access driveways, and any areas designated for flood management. Roads shall be stabilized in accordance with the recommendations of the geotechnical evaluations.

2. Array access driveways shall be constructed to provide access to the interior array inverters. Array access driveways shall consist of a compacted dirt roadway. Widths will vary depending on design, but design should consider access requirements for operations and maintenance.

C. Access Design Characteristics

1. The following plant design characteristics shall be adhered to:

a. Inverter access road width shall be at minimum 12-feet wide within a 20-foot corridor to allow access by larger vehicles.

b. Substation/O&M access road width shall be at minimum 20-feet wide to allow access by larger vehicles.

c. Site design shall include a 20-foot width from module edge to fence line to allow for operations and maintenance access after plant is in operation.

d. The perimeter road width shall be at minimum 16 feet with an additional 6 feet of cleared ground on either side to allow sufficient space to get a tractor trailer and or crane down a row to replace transformers or inverters in the event one fails.

e. All roads shall have sufficient turning radii (30' minimum) for expected use of large construction vehicles.

f. All roads shall meet minimum requirements of local fire department or AHJ, if required.

g. The minimum distance between an inverter and the nearest module shall allow for maintenance and repair of any and all components of the ISA with locally available equipment.

7.7 Security

Refer to PGE Exhibit M1-01-07 for Owner security requirements.

7.8 Site Revegetation

A. Prior to substantial completion, Contractor shall prepare the site in compliance with the Revegetation Plan that meets Owner and permitting requirements. Owner requires re-seeding with an approved ground cover that will prevent erosion and be easily controlled and managed. If there are requirements beyond this from permitting, those must be adhered to as well.

7.9 As-Built Drawings

A. Contractor shall prepare as-built drawings as may be necessary to meet the standards of the Owner and jurisdictional government agencies. At minimum, Contractor shall prepare as-built drawings for the Owner's record which contain as-built elevations, dimensions, etc. and any variation from the design drawings, sealed by an engineer or surveyor licensed in the applicable state.

8.0 STRUCTURAL

8.1 Materials

A. Steel

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

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

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

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

c. Structural Plates and Bars: ASTM A36

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

e. Pipe: A53, Grade B

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

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

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

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

7. All structural welding shall conform to the requirements of AWS D1.1.

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

9. Stainless steel shall conform to ASTM A167.

B. Aluminum

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

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

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

C. Concrete

1. Design of structural concrete shall be in accordance with the latest version of the American Concrete Institute (ACI) - "Building Code Requirements for Structural Concrete," ACI 318. All concrete formworks shall conform to ACI 347.

2. Concrete intended for use on native soil shall be specified consistent with the properties of the soil. Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted and approved by the Owner prior to placing concrete.

3. Minimum concrete strength classes for various structures shall be as follows:

Item	Minimum Ultimate Compressive Strength (psi) (at 28 Days)
Electrical Duct banks	3,000
Major equipment/structures where required and all other construction	4,000

4. Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60. Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.

5. Cement shall be Portland cement conforming to ASTM C150, Type I or Type II or as required by the Engineer of Record.

6. Aggregates for normal weight concrete shall conform to ASTM C33.

7. All foundations shall extend a minimum of 6 inches above the adjacent finish grade.

8. Slump of concrete, if pump truck is used, for foundations shall be 4 inches plus or minus 1 inch, unless otherwise noted.

9. All concrete trucks may be rinsed out at one designated location on-site. Rinse material shall be properly disposed of off-site.

8.2 Concrete Testing

A. Field testing and sampling shall be performed by an independent testing laboratory at Contractor’s expense. The testing technician shall be an ACI Concrete Field Testing Technician Grade 1.

B. Compressive strength determinations shall be made from 6-inch diameter by twelve inch long concrete cylinders tested in accordance with ASTM C39. Cylinders shall be prepared for compressive strength tests on concrete with a designed compressive strength of 2,500 psi or higher for the following conditions:

1. Each one hundred (100) cubic yards or fraction thereof of concrete poured;

2. At least once per day
3. For each 5,000 square feet of surface area for slabs or walls.
4. A minimum of four concrete cylinders shall be prepared from each composite sample.

C. Field slump tests shall be performed in accordance with ASTM C143 and shall be performed for the following conditions:

1. The first batch produced each day,
2. For every 50 cubic yards or fraction thereafter, and
3. With every set of test cylinders.

D. 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 the American Society of Testing Materials (ASTM). Test results shall be provided to Owner for records within 30 days of test completion. In the event of failure of any aforementioned test, the Owner shall be notified.

8.3 Structural Loading

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

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

C. Dead Loads

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

D. Live Loads

1. Live loads shall be in accordance with the IBC and ASCE 7 as modified by the applicable agency Local Additions and Addenda.

E. Snow Loads

1. Snow loads shall be in accordance with the IBC and ASCE 7 as modified by the applicable agency Local Additions and Addenda
2. Snow drift shall be evaluated and considered in the design.

F. Wind Loads

1. Wind loads shall be in accordance with the adopted versions of the IBC and ASCE 7, as modified by the applicable agency Local Additions and Addenda. Wind tunnel testing method is permitted upon explicit Owner

consent. Irrespective of any wind tunnel testing results, the minimum design wind pressure shall be no less than 10 pounds per square foot (psf) applied normal to the face of each PV module. The PV module rack shall be designed in such a way that deflections due to wind will not damage the PV modules. Contractor shall ensure that the PV modules support foundations can withstand the uplift due to wind loading.

G. Seismic Loads

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

H. Thermal Loads

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

I. Vehicle Loads

1. Design loading, for areas accessible to trucks, shall be (AASHTO) HS20.

J. Soil and Hydrostatic Pressure Loads

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

K. Transmission Line Loads

1. In addition to the aforementioned loading criteria, overhead transmission loads shall also conform to ASCE Manuals and Reports on Engineering Practice No. 74 “Guidelines for Electrical Transmission Line Structural Loading” and to NESC requirements.

L. Load Combinations

1. Load combinations shall be in accordance with the IBC and ASCE 7. If the county that the project is located in has any Additions or Addenda to this code, it is the Contractor’s responsibility to determine this and adhere to it.

8.4 Structural Foundations

A. Type of foundations required and allowable bearing values for soil and rock shall be as recommended by Contractor's Geotechnical Engineer based on the subsurface conditions found in the Contractor’s Geotechnical report. 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 2000 psi (minimum) concrete. Total foundation settlements will be limited to 1 inch or as required by applicable building or industry codes, and equipment supplier's recommendations.

B. A minimum of 18 inches of the native soil to be removed and compacted to 95% of relative compaction as a subgrade for various concrete housekeeping pads.

1. All equipment used to meet compaction requirements shall be specifically designed for such duty.

C. Building and Equipment Foundations

1. Building and equipment foundations shall be of reinforced concrete and their construction shall incorporate formwork, appropriately sized and configured rebar, waterstops, expansion joints, etc.

D. Transformer Foundation and Containment

1. Transformers shall be provided with secondary oil containment equal to 110% of the volume of oil present in the transformer, .

8.5 Corrosion Protection

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

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

2. Carbon steel exposed to soil conditions below grade (i.e., driven or augured piles, if applicable). This coating shall be designed such that it is not damaged during installation. The Contractor shall consult a corrosion engineer to recommend corrosion protection measures based on the soil conditions. Submit the corrosion engineer's recommendations to the Owner for information and acceptance of the recommendations. In no case, however, shall a galvanized coating be assumed to last the life of the project.

B. Stainless steel and galvanized steel shall not be painted.

8.6 Buildings/Structures (if applicable)

A. The Contractor shall obtain Owner's approval of building arrangements prior to detailed design.

9.0 COMMISSIONING AND PROJECT ACCEPTANCE TESTING

A. See M3-01-04 and M3-01-05 for requirements of Commissioning, Functional Testing, and Capacity Testing.

10.0 PROJECT AND CONSTRUCTION MANAGEMENT

10.1 Staffing

A. Contractor shall provide the appropriate personnel to manage all aspects of the Work.

B. Contractor shall ensure an OSHA "competent" person be present during all work hours.

C. Contractor may work on Site at any time subject to applicable laws and permit requirements.

10.2 Reporting/Meetings

A. Contractor shall provide progress and schedule reporting on a weekly basis. A two-week look ahead of activities shall be provided at weekly reoccurring meetings with the Owner, Contractor and Contractor's subcontractors.

B. Progress meetings shall be held at the Site on a monthly basis on dates mutually agreeable to Owner and Contractor.

10.3 Safety Plan

A. Contractor shall maintain a safety plan and observe all safety practices required for performing construction work of this type including OSHA standards.

B. Contractor shall submit final Safety Plan, per the requirements of M3-01-03, a minimum of 30 days before the start of construction for review and approval.

10.4 Work Schedule

A. Contractor shall submit a detailed schedule in native file using Primavera P6 or similar mutually agreed upon project management software which also meets the requirements of M3-01-7.

B. The Project Schedule shall be updated monthly against the baseline schedule and submitted to the Owner.

11.0 DESIGN ENGINEERING

11.1 Engineering Design Package

A. Contractor shall develop a comprehensive design package consisting of drawings generated in a format in accordance with M1-01-02 and table M1-01-02-01-Solar. Design packages and submittals shall be provided for Owner review in native or PDF format.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 02

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

STATEMENT OF WORK - HV

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

1.1 Introduction

M3-01-02 describes the main requirements of the Substation, interconnection, and gen-tie requirements. Refer to PGE Attachments and Exhibits for further information.

Wherever 'X's are shown, these are areas for the Contractor to specify or fill in.

1.2 References

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.

A. 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-Solar) ("PGE Exhibit M1-01-02-01") attached thereto.

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

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

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

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

1.3 Definitions

Capitalized terms not otherwise defined in this M3-01-02 shall have the meaning set forth in Article 1 of the Agreement or as defined in M3-01-02.

A. "Agreement" shall mean the Engineering, Procurement and Construction Agreement to which M3-01-02 is attached.

B. "AC" or "ac" shall mean alternating current.

C. "Contractor" shall mean the successful bidder which designs, procures, constructs, and commissions the proposed Project.

D. "DC" or "dc" shall mean direct current.

E. "HV" shall mean high voltage.

F. "HZ" or "Hz" shall mean hertz.

G. "kV" shall mean kilovolts.

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

I. "POI" shall mean the Point of Interconnection which defines the location of the physical electrical interconnection to the Transmission Provider.

J. "Project" shall mean the solar Project as defined in the Agreement. The Project shall include all equipment and systems producing solar energy, from the solar modules up to the POI, including the collector system, substation and Generation Tie-line between the project substation and the POI.

K. "PV" shall mean photovoltaic.

L. "Solar Substation" shall mean the facility which collects the feeds from the PV Field and transforms the voltage (as required) for electrical interconnection to the Transmission Provider.

M. "SCADA" shall mean the Supervisory Control and Data Acquisition system and shall include all monitoring/control hardware and software, field instrumentation and communication devices.

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

1.4 General Specifications

A. The purpose of the Technical Specifications is to define the minimum scope, substation, gen-tie line features, and quality standards for the design, procurement, construction, testing, and commissioning of the electrical interconnection systems supporting the new Solar Plant.

B. Owner has prepared a conceptual arrangement for specifying the minimum scope and features of the Project. Contractor shall provide final design and detailed specifications and drawings for the system in conformance with M3-01-02.

1.5 Contractor Scope of Work Overview

A. Contractor shall design, fabricate, furnish, install, test, and commission a complete functional, operating, interconnection system as specified herein with a high degree of reliability, integrity, maintainability, efficiency, and environmental compatibility which conforms to normally accepted standards of HV substation and gen-tie facilities. Contractor shall provide all components necessary for a fully functional substation.

B. Contractor shall furnish a new XXXkV single circuit Gen-Tie line from the POI to the new XXX/34.5kV Solar Substation.

C. Contractor shall furnish a new XXX/34.5kV Solar Substation. The substation will consist of one (1) XXXkV line position to the POI, one (1) or more XXX/34.kV transformer(s) (Owner Provided), [Contractor to specify number of]

34.5kV collection circuit positions, and one a 34.5kV-coupled aggregated reactive power resource sufficient capacity when coupled with inverters to deliver a power factor between 0.95 lead and 0.95 lag (over entire plant operational temperature, power and voltage range) to the POI and as necessary to meet the requirements of the Generator Interconnection Agreement and NERC compliance obligations.

D. The Project shall be capable of operating in accordance with the Agreement and M3-01-01, "Statement of Work - PV", and this M3-01-02.

E. Contractor shall design and construct the Project in accordance with this Specification and the Agreement. Scope of Work shall consist of:

1. Specify and furnish the equipment and materials which shall include, but not be limited to, disconnect switches, circuit breakers, instrument transformers, main and auxiliary voltage transformers, capacitor banks, substation structures, relay equipment, control enclosures, gen-tie line structures, all foundations, and associated ancillary hardware.
2. Project design engineering and drawing packages for construction permitting, installation and "as-built" documentation.
3. Project construction including all final grading site/civil work, structural, electrical, mechanical and monitoring/control systems.
4. Project and construction management, including quality assurance/quality control, site safety, site material control and management of all subcontractors.
5. Project commissioning and testing in accordance with M3-01-04 of the Agreement.
6. Project turnover including Owner training and Project operations and maintenance documentation.

F. Except as specified otherwise, provide all equipment, materials, transportation services, labor, labor supervision, technical field assistance, scheduling, consumables, construction equipment, construction tools, special tools, construction utilities, permanent utilities, testing services, instruments, spare parts, and other services and items required for, or incidental to the engineering, design, procurement, installation, construction, startup, testing, commissioning, and training for the Project. The supply of construction equipment shall include fuel, lubricants, spare parts, and any other elements required for operation and maintenance.

G. Contractor shall procure and obtain all permits required for the construction of the project with the exception of permits acquired by Owner.

H. Design, fabricate, install, inspect, examine, and test each system in accordance with the specified industry standards, Applicable Permits and Applicable Laws.

I. Perform specified, code required, and Contractor's standard quality assurance testing, inspection, examination, and documentation.

J. Submit design, fabrication, and quality assurance documentation, and operating and maintenance manuals in accordance with the submittal requirements M1-01-02 of the Agreement.

K. Contractor shall provide all design documents required to support Owner in obtaining permitting and other regulatory agreements.

L. Receive, inspect, store, unload, maintain, erect, clean, lubricate, align, and prepare all equipment in strict accordance with equipment manufacturer's instructions. Contractor shall arrange for and provide properly conditioned storage in strict accordance with manufacturer's requirements for all equipment and material to be incorporated into the Project.

M. Except as specified otherwise, provide all technical assistance, equipment, and supplies required, specialized and non-specialized, for erection, testing, commissioning, and start-up of equipment furnished and installed by Contractor.

N. Contractor shall procure, deliver, unload, install, commission and test main step-up transformer(s). Contractor shall be responsible for securing transformer to foundation and connecting it to electrical and SCADA and testing any protection or monitoring devices it installs for operation of the transformer.

O. Coordinate start-up and commissioning operations with Owner's operating and maintenance personnel and involve Owner's personnel in start-up and commissioning activities to the extent desired by Owner.

P. Train Owner's operators and maintenance personnel on all operating and maintenance aspects of the Project prior to system start-up in accordance with the Agreement. Contractor shall complete all formal training efforts prior to start-up of associated system, including training for Owner supplied equipment. Contractor shall provide all facilities necessary for all required training.

Q. Fire protection during construction shall meet the requirements of NFPA 241. All fire protection systems shall be subject to the review and approval of the local fire department authorities.

R. Provide all special tools and lifting devices for equipment supplied by Contractor as required for maintenance and operations of Contractor furnished Equipment and Materials.

S. Contractor shall furnish and maintain temporary construction facilities and provide construction services including, but not limited to, the following aspects applicable to the Solar Substation Site:

   1. Temporary Storage Facilities at the Site for the proper unloading and storage of all Contractor furnished substation equipment and material delivered to the Site. If adequate facilities are not available, such material

shall be stored at suitable off-site facilities (e.g. warehouses, storage yards, etc.) provided by Contractor.

2. Construction Power and Distribution.
3. Contractor shall be responsible for all transmission and distribution electric power tie-ins at the Site.
4. Temporary communication system
5. Temporary lighting system
6. Site drainage, erosion and sedimentation control, and dewatering systems
7. Temporary roads
8. Fire protection
9. Temporary water supply and distribution (potable and non-potable). Potable water shall be high quality bottled water.
10. Parking Facilities
11. Site Security
12. Construction testing services (e.g., welding, megger testing, concrete strength and placement, fill and backfill compaction testing, etc.)
13. Safety and first aid services
14. Contractor shall provide temporary sanitary facilities consisting of above ground Porta-John type. Contractor shall provide separate male and female facilities. Quantity shall be per OSHA requirements.
15. Contractor shall maintain on-site dumpsters and personnel to maintain a clean and rubbish free work site.

T. Contractor shall be responsible for design, permitting and implementation of dust suppression and erosion control measures.

U. Contractor is responsible for storm water quality requirements or retention basin requirements during construction as required. Permanent storm water quality requirements shall be installed in accordance with the drainage requirements of the associated Authority Having Jurisdiction.

V. Contractor shall provide:

- Protective Device Coordination Study including time coordination curves and a narrative document explaining relay settings philosophy and calculations.
- Electronic settings files for insertion to applicable relays.
- Load Flow Study.
- Short Circuit Analysis.

- Facility Rating Report in accordance with FERC and NERC regulations.
- Grounding System Study (including step and touch potential).
- Any other studies required by the Interconnection Agreement, Power Purchase Agreement, or by local utility/ISO.

These engineering studies and documents shall be prepared by a licensed Professional Engineer in the corresponding state. Contractor shall furnish completed study to Owner for review.

W. Contractor shall provide all necessary information and facility models (PSCAD, PSS/E, PSLF, short-circuit, or other) required by NERC, FERC, local utility, or ISO.

X. Contractor will furnish and install a communication link between the Solar Substation and the operations building (if applicable).

Y. Contractor shall furnish and install primary Optical Ground Wire (OPGW) and secondary fiber optic communication link from POI to the Solar Substation. The secondary path must be physically separate and diverse from the primary communication path.

Z. Contractor shall upgrade the access road(s), as required, to allow delivery of 34.5kV-XXXkV step-up transformer.

AA. Contractor shall coordinate with applicable Transmission Provider for the Solar Substation regarding the control and integration of the Solar Substation including but not limited to the control and monitoring 34.5kV-coupled reactive power resources, 34.5kV breakers, XXX kV breakers, XXX kV disconnects, monitoring of the 34.5kV to XXX kV transformer and all revenue meters located in the Solar Substation. Contractor shall comply with all requirements of the Transmission Provider.

BB. Contractor shall coordinate with Transmission Provider regarding the SCADA and protection relaying (including testing).

CC. Contractor shall provide all water for dust suppression.

DD. If local utility power is available, Contractor shall supply main power for Substation through local distribution system and back-up from the Solar Substation aux transformer. If local utility power is not available, Contractor shall supply a stand-by emergency generator (12-hour capacity) as back-up source.

EE. Contractor shall be responsible for geotechnical information which is required by Contractor in performance of the Work, and Contractor shall conduct geotechnical studies required for detailed design.

1.6 Owner Provided Facilities and Services

A. [RESERVED]

1.7 Construction Facilities and Services

A. Coordination

1. Contractor shall attend pre-construction meetings as may be requested by Owner. At the initial meeting, Contractor shall present a construction plan including, but not limited to, the following: safety, procurement plan, major equipment receipt, inventory and storage plan, construction sequence, methods and equipment to be used in all phases, proposed access and right-of-way roads, locations of staging areas, and a construction schedule showing all activities for the entire construction phase of the project. Pre-construction coordination meetings and design review meetings shall be held in Owner's or Contractor's office.

2. Contractor shall be responsible for contacting all involved utility companies prior to starting any work to coordinate schedule of work (including outage windows) and location of all temporary and permanent utilities in the Project area.

3. Contractor shall prepare an outage plan for all scheduled interruptions of electrical power or other utilities that would affect the Solar Plant, or third parties. This plan shall be submitted by Contractor to Owner and the affected parties at least six (6) weeks prior to outage.

4. Representatives of Contractor shall attend weekly coordination meetings to discuss matters relative to the progress and execution of the construction and startup of the project. Current week progress and three-week look-ahead schedules shall be presented by Contractor and reviewed at these meetings in addition to other site coordination items. Past and current safety statistics shall also be provided.

5. Owner shall be given the opportunity to attend any and all factory acceptance tests and perform shop visits for equipment procured by Contractor. Contractor shall notify owner at least two weeks in advance of factory acceptance test dates and shall coordinate all such events with Owner.

B. Safety and Security.

1. Contractor shall develop Safety Plan and submit to Owner for review and approval. Contractor shall ensure all personnel adhere to Safety Plan provisions and wear proper personal protection equipment (PPE) at all times. Contractor shall conduct a safety briefing each day before work, and before each construction activity. Refer to section 11.3 of M3-01-02, and M3-01-01, for further information.

2. Sufficient access space shall be provided for maintenance of all equipment.

3. Substation shall meet requirements of Critical Infrastructure Protection (CIP) and NERC for security.

C. Fire Protection

1. Only work procedures which minimize fire hazards to the extent practicable shall be used. Combustion debris and waste materials shall be collected and removed from the site each day. Fuels, solvents, and other volatile or flammable materials shall be stored away from the construction and storage areas in well-marked, safe containers. Good housekeeping is essential to fire prevention and shall be practiced by Contractor throughout the construction period. Contractor shall follow the recommendations of the Associated General Contractors "Manual of Accident Prevention in Construction" regarding fire hazards and prevention.
2. Formwork, scaffolding, planking, cabling, and similar materials which are combustible, but which are essential to execution of the work shall be protected against combustion resulting from welding sparks, cutting flames, and similar fire sources.
3. Contractor shall provide qualified personnel for fire control as appropriate. Contractor shall provide adequate fire protection equipment in each warehouse, office and other temporary structures, and in each work area that he is occupying. Suitable fire extinguishers shall be provided in enclosed areas, in areas that are not accessible to fire protection water, or in areas that may be exposed to fire that cannot be safely extinguished with water. Each fire extinguisher shall be of a type suitable for extinguishing fires that might occur in the area in which it is located. In areas where more than one type of fire might occur, the type of fire extinguisher required in each case shall be provided. Each extinguisher shall be placed in a convenient, clearly identified location that will most likely be accessible in the event of fire.
4. Contractor shall be responsible for providing adequate fire protection of the construction areas.

D. Cleanliness

1. Contractor shall keep the Site and surrounding grounds clean and free from trash and debris. Contractor shall require all disciplines to thoroughly clean their work areas each working day. Contractor's Construction Manager shall be responsible for Site maintenance and cleanliness. This shall include sweeping the floor, collecting and disposing of trash, and all other functions required to keep the site clean. All hoses, cables, extension cords, and similar materials shall be located, arranged, and grouped so they will not block any access way and will permit easy cleaning and maintenance.
2. A roll-up of all hoses, welding leads and electrical cords will be executed once a month as a minimum or as determined by site management. Material and equipment not required for immediate use or installation will be stored in designated laydown and warehouse areas.

3. All trash, debris, and waste materials shall be collected, sorted, and deposited in waste collection receptacles near the work. These receptacles shall be emptied by Contractor regularly and the waste disposed of properly and off-site.

4. Promptly upon the completion of a construction task, Contractor shall thoroughly clean the equipment or structure affected by the task activity by removing all accumulations of dirt, scraps, waste, oil, grease, weld splatter, insulation, paint, and other foreign substances. Contractor, without additional cost or burden to Owner, shall properly and adequately restore surfaces affected by deposits of insulation, concrete, paint, weld metal, or other adhering materials.

E. Energized Facilities

1. Contractor shall be completely responsible for the safety and protection of its personnel, the Owner's personnel, any and all other personnel of 3rd parties and other contractors, and the public, and shall employ all methods necessary to achieve such safety and also assure continuity of all service systems encountered. These methods shall include, but not be limited to, providing barriers, guard structures, insulating guards and sleeves, warning signs, and prevention of unauthorized access to service system areas. Refer to section B above for further information on safety and security.

F. Reference Points

1. Contractor shall establish baselines, monuments, and reference points for construction as necessary to proceed with layout of the work. Contractor shall be responsible for laying out the work to such lines and grades indicated on the drawings and shall protect and preserve the established reference points.

G. Dangerous Materials

1. Contractor shall not use explosives, radioactive, or other dangerous material without prior notification to the Owner. Contractor shall be responsible for the proper handling, transporting, storage, and use of such materials. When the use of such materials or methods is necessary, Contractor shall exercise the utmost care and carry on such activities under supervision of its properly qualified personnel. Contractor, at its expense, shall repair any damage caused by its handling, transporting, storage, and use, and shall be responsible for obtaining permits as applicable.

H. Waste Disposal

1. Contractor shall be responsible for removal and lawful disposal of all discarded material, debris, rubbish, unusable excavated material, and waste, including hazardous substances, if any, generated by Contractor and its subcontractors and suppliers during construction of the plant.

I. Hazardous Material Management

1. Contractor shall be responsible for managing hazardous materials and hazardous wastes as described in the Agreement. Contractor shall obtain an EPA I.D. Number for its work.

J. Adjoining Utilities

1. Contractor shall make necessary efforts to protect the existing power gen-tie facilities, any and all parallel, converging, and intersecting electric lines and poles, telephone lines and poles, highways, waterways, railroads, and any and all property from damage as a result of its performance of the Work. Contractor shall bear all liability for and shall at its expense repair, rebuild or replace in kind any property damaged or destroyed caused by the Contractor in the course of its performance of the Work.

1.8 Site and Environmental Criteria

A. Project design shall be based upon the design conditions listed in M3-01-01 Table 1-1.

1.9 Design Criteria

A. Project and individual components shall have a minimum design life of 25 years.

B. Project shall be designed for automatic, unmanned operation.

C. Project electrical design will be in compliance with applicable codes and standards listed under section 1.9 unless otherwise noted.

1.10 Operating Criteria

A. Convenience Power: 120VAC

B. Instrumentation voltage: 125VDC

C. Communications network: Ethernet via direct buried fiber optic.

D. Solar Substation Voltage.

1. High Voltage (phase-to-phase, maximum): XXX kV

2. Medium Voltage (phase-to-phase, maximum): 38 kV

E. Supply voltage wave form: per IEEE 519-2014 requirements.

F. System phase rotation: [to be determined by Contractor and Transmission Provider]

G. Volts per hertz ratio: 1.05

H. Electrical system ambient temperature range: -XX°C to XX°C

I. 24 hour average ambient temperature: XX°C plus adjustment factors for the Site

J. Relative humidity range: 10-95% without condensation

K. MPTwindings BIL ratings shall be determined per IEEE C57.12.00:

1. HV: [by Contractor]
2. MV: [by Contractor]

L. MPT Bushings BIL ratings shall be determined from insulation coordination study and IEEE Standard C57.19.01:

1. HV: [by Contractor]
2. MV: [by Contractor]

M. Steady State XXXkV substation maximum current: [to be determined by Contractor] (per phase)

N. Steady State 34.5kV substation maximum current: [to be determined by Contractor] (per phase)

O. Maximum XXXkV fault current – sym.: [to be determined by Contractor].

P. Isokeraunic activity: In accordance with standard nationally published maps for thunderstorm activity.

Q. Soil resistivity: According to results of Geotechnical Study

1.11 Codes, Regulations and Standards

A. In the event that any Applicable Law or Industry Standard does not govern specific features of any item of equipment and materials, Temporary Work or system, Contractor or Original Equipment Manufacturer (OEM) standards shall be applied, with Owner's approval.

B. Listed herein are the principal codes and standards applicable in the design, fabrication, and installation of the Project; these are not intended to be all inclusive. Other recognized standards may be utilized when required in Contractor's opinion and when not in conflict with the standards listed below. Contractor shall notify and obtain Owner approval prior to us of any such other standards.

C. Contractor shall design and construct the Project in accordance with the latest accepted edition of the following standards:

1. AA – Aluminum Association
2. AASHTO – American Association of State Highway and Transportation Officials
3. ACI - American Concrete Institute
4. AISC - American Institute of Steel Construction
5. AISE – Association of Iron and Steel Engineers
6. ANSI - American National Standards Institute,
7. AREMA – American Railway Engineering and maintenance Association
8. ASCE – American Society of Civil Engineers

9. ASME – American Society of Mechanical Engineers
10. ASNT – American Society of Nondestructive Testing
11. ASTM - American Society for Testing and Materials
12. AWS – American Welding Society
13. CMAA – Crane Manufacturer Association of America
14. CRSI – Concrete Reinforce Steel Institute
15. EPA – United States Environmental Protection Agency
16. FAA – Federal Aviation Agency, Department of Transportation
17. IBC - International Building Code
18. ICEA - Insulated Cable Engineers Association
19. IEC - International Electrotechnical Commission
20. IEEE - Institute of Electrical and Electronics Engineers
21. ISA – Instrumentation Society of America
22. ISO – The International Organization for Standardization
23. NEC - National Electrical Code
24. NEMA - National Electrical Manufacturers Association
25. NERC – North American Electric Reliability Council
26. NESC - National Electrical Safety Code
27. NETA - National Electrical Testing Association
28. NFPA – National Fire Protection Association
29. OSHA - Occupational Safety and Health Act
30. UL – Underwriters' Laboratories

1.12 Refer to M3-01-01 for Special Conditions

2.0 EQUIPMENT AND MATERIALS

2.1 Equipment

A. Contractor shall furnish all equipment and materials as required to construct a fully functioning Project. Minimum requirements for major equipment are described herein:

2.2 34.5kV Capacitors, Reactors, or combination.

A. Nominal system voltage: 34.5kV

B. Reactive power: To be determined by Load Flow Study meeting Interconnect Agreement requirements, minimum of [by Contractor] kVAR.

C. Stepped Capacitor [by Contractor] MVAR

D. Stepped Reactor [by Contractor] MVAR

E. Frequency: 60 Hz

F. Capacitors shall be equipped with an internal discharge device which will reduce the residual voltage to 50 volts or less within 5 minutes.

2.3 34.5kV Circuit Breakers (Collectors)

A. Model/Type: Vacuum

B. Rated Voltage; Nominal: 34.5kV

C. Rated Voltage; Maximum: 38kV

D. BIL: 200kV

E. Rated Current-RMS: Continuous: [by Contractor] A

F. Rated Current-RMS: 3 seconds: [by Contractor] kA

G. Rated Current-RMS: Interrupting: [by Contractor] kA

H. Current Transformer:

X	Y	Z	Bushing		Z	Y	X
B	B		5	6		A	A
B	B		3	4		A	A
B	B		1	2		A	A

Ratio

A: [Ratio by Contractor]

B: [Ratio by Contractor]

Relay accuracy classification: C800

C57.13 metering accuracy current transformers: 0.3

I. Control Voltage: 120/240 VAC

J. Control Voltage: 125 VDC

K. Voltage for Space Heater: 120V Single Phase

2.4 XXXkV Circuit Breaker(s)

A. Model/Type: SF6

B. Rated Voltage; Nominal: XXXkV

C. Rated Voltage; Maximum: XXXkV

D. BIL: XXXkV

E. Rated Current-RMS: Continuous: XXXXA

F. Rated Current-RMS: 3 seconds: [by Contractor] kA

G. Rated Current-RMS: Interrupting: [by Contractor] kA

H. Current Transformer:

X	Y	Z	Bushing		Z	Y	X
B	B		5	6		A	A
B	B		3	4		A	A
B	B		1	2		A	A

Ratio

A: [Ratio by Contractor]

B: [Ratio by Contractor]

Relay accuracy classification: C800

C57.13 metering accuracy current transformers: 0.3

I. Control Voltage: 120/240 VAC

J. Control Voltage: 125 VDC

K. Voltage for Space Heater: 120V Single Phase

2.5 XXXkV Disconnect Switches

A. Nominal System voltage: XXXkV

B. Basic Impulse Level: XXXkV

C. Continuous current:

1. [by Contractor]

D. Momentary current: XX-kA minimum [by Contractor]

E. Three-pole, single throw

F. Switches rated XXXkV shall be vertical break or center side break horizontally mounted.

G. Switchblades and related current-carrying parts shall be of aluminum alloy construction and contact-making components shall be of silvered inlay copper or other approved metals.

H. Provide 4-hole or 6-hole NEMA terminal pads at each high-voltage connection.

I. Design to provide smooth, completely controlled simultaneous movement of switchblades throughout the entire cycle of operation with mechanism continually loaded to prevent switch from alternately leading or lagging the control.

J. Furnish group operated mechanism with necessary rods, bell cranks, interphase operating connections, bearings, supports, linkages, and vertical operating pipe. All operating pipe connections shall have set screws. All operating pipes shall be furnished precut to the specific lengths required for the phase spacing and bus height indicated.

K. Provide with permanently double sealed maintenance free automotive steel ball bearing assemblies.

L. Provide for individual adjustment of the operating mechanism of each pole; all hardware shall be fabricated with non-corrodible metal.

M. Provide a semaphore to be located at or near each operating mechanism to give positive indication of the open or closed position of the switch.

N. Operating handles or cranks shall have provision for locking in both the open and closed position.

O. Provide bolted ground connector and flexible grounding jumper for operating handle.

P. Switch bases shall be heavy-duty galvanized steel.

Q. Switches shall be of an essentially maintenance-free design.

R. XXXkV switches shall be provided with worm gear operating mechanisms operated with a non-detachable crank having a clockwise operation of crank to close switch, with all gears and worms completely sealed, and requiring a torque of no more than 40-pound feet to operate the switch. Motor-operated switches shall have means of de-coupling the motor operator and locking out operation of the mechanism.

S. Furnish mechanically operated auxiliary switches with operating points individually adjustable over the entire travel of the operating mechanism.

2.6 34.5kV Disconnect Switches

A. Nominal System voltage: 34.5kV

B. Basic Impulse Level: 200kV

C. Continuous current:

1. [by Contractor] A – QTY [by Contractor] (Transformer)
2. [by Contractor] A – QTY [by Contractor] (Feeders and Cap Bank)

D. Momentary current: 40-kA minimum

E. Three-pole, single throw

F. Switches rated 34.5kV shall be vertical break horizontally or vertical mounted.

G. Switchblades and related current-carrying parts shall be of aluminum alloy construction and contact-making components shall be of silvered inlay copper or other approved metals.

H. Provide 4-hole or 6-hole NEMA terminal pads at each medium-voltage connection.

I. Provide with ball studs for grounding, minimum one ball stud per phase, per 20kA of AIC.

J. Design to provide smooth, completely controlled simultaneous movement of switchblades throughout the entire cycle of operation with mechanism continually loaded to prevent switch from alternately leading or lagging the control.

K. Furnish group-operated mechanism with necessary rods, bell cranks, interphase operating connections, bearings, supports, linkages, and vertical operating pipe. All operating pipe connections shall have set screws. All operating pipes shall be furnished precut to the specific lengths required for the phase spacing and bus height indicated.

L. Provide with permanently double sealed maintenance free automotive steel ball bearing assemblies.

M. Provide for individual adjustment of the operating mechanism of each pole; all hardware shall be fabricated with non-corrodible metal.

N. Provide a semaphore to be located at or near each operating mechanism to give positive indication of the open or closed position of the switch.

O. Operating handles or cranks shall have provision for locking in both the open and closed position.

P. Provide bolted ground connector and flexible grounding jumper for operating handle.

Q. Switch bases shall be heavy-duty galvanized steel.

R. Switches shall be of an essentially maintenance-free design.

S. 34.5kV switches shall be provided with worm gear operating mechanisms operated with a non-detachable crank having a clockwise operation of crank to close switch, with all gears and worms completely sealed, and requiring a torque of no more than 40 pound-feet to operate the switch. Motor-operated switches shall have means of de-coupling the motor operator and locking out operation of the mechanism.

T. Furnish mechanically operated auxiliary switches with operating points individually adjustable over the entire travel of the operating mechanism.

2.7 XXXkV Surge Arrester

A. Nominal System Voltage: XXXkV

B. Arrester rating: [by Contractor] kV MCOV

C. Outdoor Station Class

D. Polymer

E. Mounting: Vertical

2.8 XXXkV CCVTs

A. Nominal System Voltage: XXXkV

B. Basic impulse level: XXXkV BIL

C. Frequency: 60 HZ

D. Secondary Windings: 2

E. Base mounted with potential adjusting unit mounted in the capacitor base or in separate weatherproof housing.

2.9 Station Service Transformer

A. Size to be determined by Contractor for review and approval by Owner.

2.10 Tubular and Strain Bus

A. Provide schedule 40, 6063-T6 seamless aluminum bus. Provide corona-free and watertight welded end covers on all exposed ends. Bus diameter shall be determined in accordance with the methods given in IEEE 605. Provide corona rings as required for High Voltage fittings. Provide internal damping cable to reduce Aeolian vibration. Damping cable dimensions and weight shall be determined in accordance with the methods given in IEEE 605. Bus shall withstand the stresses from short circuit forces stated in design criteria.

2.11 Bus and Switch Insulators

A. Provide station post bus insulators rated as indicated in design criteria. The minimum cantilever strength shall be determined in accordance with the methods given in IEEE 605, including wind and short circuit overload factors.

2.12 Bus Connector and Fittings

A. Provide connectors and fittings as required. Connectors shall be welded type for aluminum tubing connections and compression or puddle welded type for aluminum cable connections. Use expansion type connectors with internal ball-type alignment guides where tubing connections are made to switches. Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

B. Bus support clamps for rigid bus shall be fixed or slip type as required to firmly support the bus while allowing for temperature expansion and contraction. Provide bolted ground connector and flexible type grounding jumper for operating handles of disconnect switches. Provide bus grounding stud weldments on main bus in at least three locations. Provide wire guides and bundled conductor spacers as required and indicated to maintain adequate clearance and support on cable jumpers, connections, and overhead lines. Provide corona shields for all XXX-kV connections.

2.13 Relaying

A. 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.

B. Relay panels shall be located in the Project Substation control building and shall include all hard-wired and soft-wired protection and control interlocks.

C. Programming of devices shall be provided in electronic format straight from the device.

D. All protection device settings shall be provided for Owner’s review no later than 60 days prior to the system energization date. Final design and procurement are contingent upon Owner review and approval.

E. The Contractor shall coordinate with local utility confirm line protection and signal exchange requirements.

F. 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.

G. 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.

H. High-side lines shall include primary and backup relaying

I. Relays shall be SEL and of the model and type as required by Owner and compatible with Transmission Provider for substation relays:

   1. Line Differential,

   2. Line Distance

   3. Breaker Failure

   4. High Side Bus

      a. Bus Differential Primary

      b. Bus Differential Secondary

   5. High Side Transformer Breaker

      a. Breaker Failure

6. Transformer
    a. Transformer Differential Primary
    b. Transformer Differential Secondary
7. 34.5kV Collectors
    a. Collection System Protection
8. 34.5kV Supplemental Reactive Power Resources
    a. Overcurrent
    b. Voltage

2.14 Main Power Transformer

A. Contractor shall furnish one (1) or more XXX/34.5kV step-up transformer(s) for the PV Plant. This main power transformer shall be high efficiency type configured with its primary (low side) winding as solidly grounded WYE to allow ground fault sensing and protection of the 34.5kV distribution system. Transformer shall be sized to at least 10% above MVA rating of plant.

B. Submittals:
    1. Contractor shall submit complete specification for review and approval by Owner per timeline defined in M1-01-02 and table M1-01-02-01-Solar.
    2. Contractor shall submit transformer design drawings for review and approval by Owner per timeline defined in M1-01-02 and table M1-01-02-01-Solar.

C. On Load Tap Changer (OLTC) required for voltage regulation at POI.

D. Performance Requirements:
    1. No load losses shall not exceed 0.10% of rated power.
    2. Load losses shall not exceed 0.70% of rated power at full load.

3.0 ELECTRICAL

3.1 General

A. This section covers the minimum scope and quality standards for the systems. Contractor shall provide all material and labor for the engineering, design, procurement, installation, construction, startup, inspection, and testing of all electrical systems specified herein and necessary for a complete substation in conformance with generally accepted practices.

B. Contractor shall develop a detailed design based on Owner's conceptual layout. Alternative designs may be acceptable if they meet the functional requirements of this specification. Any changes must be approved by the Owner.

C. The design and specification of all work shall be in accordance with all applicable industry codes and standards and accepted standards of good engineering practice.

3.2 Substation System Studies

A. Contractor shall perform a set of studies and analyses to demonstrate the adequacy of the proposed electrical system design, by performing the following studies as a minimum. The design and construction of the electrical systems shall reflect the findings and conclusions of these studies. These system studies shall be subject to review and comment by Owner.

1. AC System Studies:

   a. The capacity of the Solar Substation low voltage AC system to determine size of station service.

2. DC System Studies:

   a. A load profile shall be developed for all DC loads to determine the capacity of the batteries and chargers with the DC service required for the equipment at the Solar Substation. The studies shall determine if the minimum voltages are maintained as specified and required by equipment vendors.

3. Short Circuit and Grounding Studies:

   a. Ensure equipment is rated to handle expected fault currents.

   b. The study shall assure that the ground grid modifications maintain touch and step voltages within tolerable limits. The study shall determine the ground potential rise (GPR) with respect to remote earth.

   c. The analysis of the ground grid shall have the following basis:

      A. Fault current per project characteristics.

      B. 50 kg body weight

      C. A fault split factor may be applied.

      D. Ground resistivity determined from the Geotechnical Report.

      E. Fault duration of 0.25 seconds.

   d. Ground grid design, including tolerable step and touch voltage and conductor fusing temperature, shall be in accordance with the procedures, data, and recommendations given in IEEE 80.

4. Relay coordination Study: To ensure designed protection devices will function properly to protect plant and its systems, as well as high side components.

5. Bus Design Analysis:

a. Analyze the performance of the substation buses, disconnect switches, and separately mounted current transformers to determine 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.

6. Bus Ampacity:

   a. Continuous current rating as given on the one-line diagram.

   b. Fault current as appropriate for the Project.

   c. A temperature of 50˚C with a minimum wind speed of 2ft/sec perpendicular to the bus.

   d. Solar radiation with material absorptivity and emissivity to 0.5.

7. Bus Structural Design (bus, insulators, bus structures and foundations):

   a. Use wind speeds and ice loads as appropriate for the Project.

3.3 Mast for Direct Stroke Protection

A. Steel masts for direct stroke protection shall be round tapered seamless extruded or spun aluminum tubes.

B. The overall height of the masts above grade shall be determined from the Direct Stroke Protection Study. Mast design shall be for the site design.

C. Masts shall have a single uniform taper from top to bottom. Each mast shall be capped with a suitable finial. Each mast shall be equipped with an internal vibration dampening device. The design of masts shall have a safety factor of 2 based on the allowable yield stress for the mast material in accordance with the latest ASCE specifications governing design of structures. The horizontal deflection at the top of each free-standing mast shall be limited to L/20 of its height above foundation.

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

3.4 Lighting

A. A lighting system shall be furnished for the Solar Substation. The lighting system shall provide personnel with illumination for substation operation and maintenance under normal conditions and means of egress under emergency conditions.

B. The lighting system shall be designed in accordance with the Illuminating Engineering Society (IES) to provide acceptable illumination levels.

C. Lighting sources and fixture selections shall be based on the applicability of the luminaries for the area under consideration and shall comply with all local codes and standards.

D. Lighting levels shall meet the requirements of ANSI C2, the NESC.

3.5 XXX/34.5kV Solar Substation

A. Contractor shall design and install the substation and associated equipment and materials for the XXX/34.5kV substation. Coordinated design between the substation, gen-tie, and Solar Plant will determine the final placement of the structures and equipment; feedback of equipment status to the RTU; and associated details. Contractor shall provide all interface points. Contractor shall provide for status to the RTU of all substation equipment including open/close indication, voltage, currents, and alarms (including battery/battery charger related alarms), and revenue meter information (power, energy, accumulators).

B. Contractor is responsible for all site preparation, foundations, fencing, control building, grounding, crushed rock, structures, switches, instrument transformers, surge arresters, station service, instrument metering, relaying, conduit, cable, bus, conductor, connectors, insulators, and other associated equipment.

C. Contractor to furnish main power transformer (MPT) and deliver the transformer(s) to Site meeting all necessary transportation requirements to maintain manufacturer warranty. Contractor will unload, install, dress-up, and fill transformer, and have initial commissioning of transformer performed as required for warranty. Contractor shall provide foundations, oil containment, high voltage bus work, and low voltage power and control cables for the MPT.

D. The substation shall conform to the requirements of IEEE 605, the IEEE C37 and C57 family of standards, and, in general, conform to the preliminary arrangements provided by Owner. Minimum conductor clearance criteria shall be per ANSI C2 (NESC). Clearances shall be increased at locations where additional clearances are required for access to site equipment.

E. Design of the interconnect voltage and 34.5kV systems shall be based on short circuit study.

3.6 Installation of Major Solar Substation Equipment

A. Contractor shall provide all equipment required for the installation of substation equipment and materials.

B. Contractor shall receive, inventory, and store substation equipment. Equipment to be installed at substation shall be stored and protected. Installation and assembly of equipment and materials shall be according to manufacturer's recommendations complete as specified and as required for operation and continuous service at the locations in accordance with Contractor's detailed design.

C. Contractor shall erect structures in strict compliance with the manufacturer's drawings, code markings and instructions, after foundations have completely cured. Contractor shall repair all cuts, welds, and damaged areas.

D. Contractor shall assemble, install, lubricate, and adjust all switches and operating mechanisms in accordance with the manufacturer's instructions. Erect and install all buses, bus supports, bus support insulators, strain insulators, conductors, shielding wires and masts, and interconnections as required by manufacturer's drawings.

E. Welded aluminum bus erection shall include fabricating all buses and interconnections to the correct length and shape. Bends shall be made with a hydraulic bender without kinks or surface damage. Field weld all pipe-to-pipe and pipe-to-fitting connections using inert gas arc welding. Submit to Owner complete details of the proposed welding procedure, experience record, and certification data on the person(s) proposed to do the welding, as well as samples of welds made at the jobsite in all four standard positions.

3.7 Battery System

A. Codes and Standards

1. All equipment furnished under these specifications shall conform to applicable standards of IEEE, ANSI, and NEMA. All materials and devices shall be in accordance with the applicable requirements of the Federal "Occupational Safety and Health Standards." The latest edition of each code and standard shall apply.

B. Design and Construction

1. Batteries shall be provided with racks, connection devices, tools, instruction books, and other standard items.

2. Solar Substation battery chargers shall be 125VDC output, sized as required for 8-hour recharge while serving continuous load. 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. The chargers shall maintain output voltage (in a settable range between 125 and 140 volts DC) within 1/2 percent from no load to full load even with input voltage variation of 10 percent, maintain output voltage automatically without requirement for voltage readjustment, and automatically vary the charging rate in accordance with the requirements of the substation battery.

3. For the Solar Substation, provide DC systems including batteries, chargers, and panelboards. Batteries shall be lead antimony. Battery size shall be determined using the battery load profile. Nominal voltage shall be 125VDC with 60 cells. Battery shall be capable of being recharged to

rated capacity from a discharge down to zero volts per cell, following an equalization charge. The battery shall be capable of being recharged within 8 hours following a complete discharge. Design shall be based on an 8-hour discharge time to 1.75 volts per cell and the voltage is to be maintained for the minimum 20 year life of the battery. The battery shall be sized accordingly to accommodate ultimate design loads but shall be no less than 240 Ah capacity.

4. Each battery cell shall be wet cell, lead-acid pasted plate-type with lead-calcium alloy plate grids or sealed type with 20-year expected life. 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 2-step configuration.

5. The DC switchboard and panel 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. Each panelboard shall include the feeder breakers required to supply the connected loads. Switchboard shall include bus voltmeter, battery ammeter with shunt, ground detection and alarm, and low voltage alarm.

C. Rating

1. Contractor shall determine the capacity of each battery in accordance with the methods of IEEE 485 and these Specifications. 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. An aging factor of 25% and design margin of 20% shall be used. Contractor shall submit battery calculations for approval.

D. Duty Cycle – The duty cycle for battery sizing shall include:

1. One minute at the level of current required to operate Solar Substation circuit breakers plus the continuous load.

2. Duration of continuous load to be reviewed and approved by Owner.

3. One minute at the level of current required to operate all Solar Substation circuit breakers plus the continuous load.

E. Battery Charger Requirements

1. 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 these

Specifications. Charger shall be able to provide the DC load requirements in the event that battery is disconnected.

2. The chargers will be served from the substation AC system.
3. The battery charger shall maintain output voltage within plus or minus ½% from no load to full load, with an input power supply deviation in voltage level of plus or minus 10% and an input power supply deviation in frequency of plus or minus 5%.
4. 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.
5. Charger shall be a full capacity charger and shall have the capacity to recharge the battery in 8 hours following complete discharge. Battery 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. The battery charger shall require only front access and will allow either top or bottom conduit/cable entry.

3.8 Raceway

A. This section covers furnishing and field installation of a complete raceway system in accordance with these specifications.

B. Raceway shall conform to the recommendations included in IEEE 525.

C. The raceway system is defined to include conduit, flexible conduit, 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.

D. Raceway that contains multiple cable circuits shall have all cables with identical insulation ratings.

E. Individual raceway systems shall be established for the following services:

1. 600-volt control cable, AC power and control cables.
2. Special electrical noise-sensitive circuits.

F. Routing of Above Grade Raceway and Conduit

1. Contractor shall route raceway and conduit and shall coordinate conduit locations with other equipment and structures.
2. All raceway and conduit shall be installed in a neat, rectangular form. Special attention shall be given to securing a neat appearance. All raceway and conduit shall be installed perpendicular or parallel to the major equipment, and bus structures.

G. Material:

1. Underground duct system materials furnished under these Specifications shall be new and undamaged and shall conform to the following requirements:

   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, 36 inch minimum radius.

   e. End bells – Plastic

   f. Plugs – Plastic, high impact, tapered to fit end bell provided.

   g. Duct binder – Hemp or sisal twine coupling

   h. Riser termination – Rigid hot-dip galvanized mild steel coupling.

   i. Riser bends - Rigid steel conduit elbows, factory or field made, 36-inch 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.

3.9 Conductors

A. Power conductor size and ampacity shall be coordinated with circuit protection devices. Conductor size shall be determined for 125% of connected load, or the short circuit duty, at the design basis maximum outdoor ambient temperature. Below grade power cable conductor size shall be determined in accordance with the methods in IEEE 835.

B. 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.

C. Installation shall be defined to include placement, splicing, terminating conductors; coiling and taping of spare conductors; identification, testing, and verification of each circuit, cable, and conductor. Manufacturer’s pulling or side wall tension shall never be exceeded. Contractor shall submit recorded cable tension reports.

D. All Solar Substation control and instrument cables shall be shielded. Connectors, sizes 12 - 2 AWG, shall be vinyl or nylon pre-insulated ring-tongue type and power connectors, sizes 1 AWG – 750 MCM, shall be uninsulated two-hole rectangular tongue.

E. Cable Specifications

1. The cable furnished shall be flame retardant construction in accordance with the applicable ICEA standards and suitable for wet or dry locations. All cable shall have surface printing showing manufacturer's name, insulation type, jacket type, conductor size, conductor type, voltage rating, and numbered footage markers. Control and instrument cables shall be terminated with ring tongue connectors, compression connections, or. as required to meet equipment supplier requirements.

2. The cable furnished shall conform to the cable descriptions included below:

CABLE TYPE	DESCRIPTION
Low Voltage Power	600 volts, single-conductor, Class B stranded copper; EPR or XLP insulated; CPS, PVC, or CPE jacketed.
Low Voltage Power	600 volts, three-conductor; concentric lay, stranded copper with a ground wire in the interstices; FRXLPE or FREPR insulation; CSP, PVC, or CPE jacketed overall.
Control	Control cable, 600 volt, multiple-conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple-conductor, XLP insulation; CSP, PVC, or CPE jacketed overall.
Instrumentation	Instrumentation cable, 600 V, flame retardant single- and multiple-twisted pairs and triads, shielded instrument cable with individually shielded pairs, overall shield, and overall jacket; FRXLPE or FREPR insulation; CSP, PVC, or CPE jacketed overall. (Single pair or triad 16AWG, multi-pair or triad 18AWG).
Lighting & Receptacles	Lighting circuit runs totally enclosed in conduit, NEC Type RHH-RHW-USE with XLPE insulation for use in outdoor or unheated areas.
Shielded Control	Control cable, shielded, 600-volt, multiple conductor, as required, stranded copper, 10 AWG, 12 AWG, 14 AWG; multiple conductor, XLP insulation; CSP, FRPVC or CPE jacketed overall

3.10 Grounding

A. The section covers the furnishing and installation of grounding materials completed as specified herein.

B. The Solar Substation grounding system shall be an interconnected network of bare copper conductor and copper-clad ground rods (ground wells maybe used instead of ground rods if dictated by the soil analysis). The system shall be designed such that substation personnel are protected from the hazards that can occur as the substation grounding system provides the earth return electrode during power system phase to ground faults.

C. Contractor may perform ground resistivity testing prior to final design to determine ground analysis parameters. The ground resistivity shall be measured with the methods given in IEEE 81.

D. The station grounding grid shall be designed in accordance with the methods and recommendations of IEEE 80. 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. Ground conductors shall be sized for fault duration of 0.25 seconds. The ground system shall be designed to comply with IEEE 80 requirements.

E. 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 will be bonded together by an exothermal welding process.

F. Grounding connections shall be made to fences, and equipment. Equipment grounds shall conform to the following general guidelines:

1. Grounds shall conform to the NESC.
2. All equipment grounding connections shall be connected to the ground grid.

G. All substation bus and equipment support structures shall be connected to the station ground grid. Metal support structures in direct metallic contact with other metal structures do not require a separate grounding connection to the station ground grid. Fences shall be grounded in accordance with the requirements of the NESC. The Solar Substation ground grid shall be extended 1 meter outside of the substation fence. The Solar Substation fence shall be connected to the substation ground grid.

H. Ground Grid Design.

1. The final conductor sizing, grid configuration, grid depth, grid spacing, and quantities of conductor for the grid is to be determined during detailed design.

I. Materials

1. All grounding materials required shall be furnished new and undamaged in accordance with the following requirements.

a. Rods - ¾ inch 10-foot copper-clad standard type. The copper cladding shall be electrolytically bonded to the steel rod or bonded by a molten welding process. Cold rolled copper cladding is not acceptable. Ground rods shall be as manufactured by Blackburn, Weaver, or Owner-approved equal.

b. Cable

A. Bare – Soft drawn copper, Class B stranding, ASTM BB.

B. Insulated – Soft drawn copper, Class B stranding with green colored polyvinyl chloride insulation, UL 83, Type TW, THW or THHN.

c. Wire Mesh – Copper-clad, 6 AWG, 6 inch by 6 inch mesh spacing, copper weld or Owner-approved equal.

d. Bus and Bars – Soft copper, cross section not less than 1/8 inch thick by 1 inch wide, ASTM 8187.

e. Exothermal Welds - Molds, cartridges, materials, and accessories as recommended by the manufacturer of the molds for the items to be welded. Cadweld heavy duty or Owner-approved equal. Molds and powder shall be furnished by the same manufacturer.

f. Flush ground plates - Cadweld B-162 Series, B-164 Series, or Owner-approved equal ground plates with NEMA hole spacing.

2. All clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be made of copper.

3.11 Control, Protection, and Metering

A. Contractor shall design and fully manufacture, test, and deliver the control and protection system at the Solar Substation. The system shall include instruments, devices, panels, racks, protective relays, meters, switches, accessories, and wiring. Relay panels are to be installed in a Contractor furnished Solar Substation control building.

B. For the control design Contractor shall provide drawings sets for all relaying drawings including one-line drawings, three-line drawings, control panel arrangements, fabrication details, Bill of Materials, nameplate lists, DC control schematics, AC schematics, circuit schedules, auxiliary equipment schematics, wiring diagrams, index sheets, and legends. Drawings shall be provided in electronic format.

C. Each PV circuit feeder shall have its own revenue grade meter (SEL-735 or similar) and revenue grade voltage and current sensing required to meet requirements for Capacity Test (M3-01-05

3.12 Labeling and Identification

A. Substation and Electrical equipment shall be marked with signage and labeling to meet applicable safety codes, including NESC ANSI Z535, and NFPA 70E-2015 Art. 130.5(D),

3.13 Electrical Equipment Enclosures

A. Control Cabinets, pull boxes and junction boxes shall be in accordance with NEMA Standards and type number and shall be suitable for the location conditions. Base design shall be:

1. Indoor: NEMA 1
2. Outdoor: NEMA 3R or 4

B. All enclosures shall be provided with pad locking provisions.

4.0 MECHANICAL

4.1 General Requirements

This section provides requirements for major mechanical equipment, mechanical systems, and mechanical interfaces with other plant systems and off-Site facilities.

4.2 General Arrangements

A. The location of equipment shall be based on safety, economics, ease of maintenance, and operation. Sufficient space shall be provided for maintenance of all equipment including equipment removal without excessive rigging or removal of surrounding equipment.

4.3 Mechanical Systems and Equipment

A. Provisions shall be included in the design of all mechanical systems to allow the performance of all routine maintenance without requiring a plant shut down.

B. Contractor shall:

1. Receive, inspect, store, unload, maintain, erect, clean, align, and prepare all equipment in accordance with equipment manufacturer's instructions before initial operation.
2. Provide lifting lugs on all equipment components or system components requiring removal for maintenance and weighing over 25 lbs.
3. Select materials of construction and design equipment and systems to provide a minimum of a 25-year operating life at all operating conditions specified.
4. Design the facility for a life of 25 years consistent with good engineering practice for solar generation facilities. However, it is understood that some of the equipment will require routine maintenance and possible replacement during the life of the facility.
5. Provide grounding lugs and ground all equipment.

4.4 Fire Protection System

A. Contractor shall provide a complete fire protection system in accordance with the recommendations and requirements of NFPA, UL, FM, and the local Fire Marshall. The systems shall receive the approval of the Owner's insurance carrier.

B. The engineer responsible for the fire protection system shall be a practicing fire protection engineer registered as a Professional Engineer in the state of the Project location. All drawings and specifications shall be signed and sealed by the Professional Engineer.

C. The fire protection and detection systems requirements for specific plant locations are summarized in Table 5-1.

D. Portable fire extinguishers shall be provided in all areas requiring handheld fire protection.

E. All local alarms shall report status to the SCADA System.

F. Fire walls for oil-filled transformers shall be provided between transformers and adjacent structures as required in accordance with Section 5.0 of NFPA 850.

G. General

1. Fire protection during plant construction shall meet requirements and recommendations of NFPA 241.

2. All fire protection systems are subject to the review and approval of the local fire department authorities.

TABLE 5-1
Plant Fire Protection and Detection Systems

Plant Location	Type of Fire Protection	Fire Detection
Control House(s)	Handheld extinguishers*	Smoke/heat detectors
Transformer(s)	Fire walls if required by NFPA	Fire walls

(*) or as required by local Fire Marshal

5.0 SITE WORK

5.1 General Requirements

A. This section covers the minimum scope and quality for the plant civil design and construction.

B. Contractor is responsible to inspect the Site, obtain all necessary Site data, and determine all Site data for the design and construction of the Project. This shall include determination of local code requirements for seismic and wind design loads.

C. The scope shall include, but not be limited to the following:

1. Clearing and grubbing.
2. All subgrade preparation.
3. Dust control, including furnishing construction water.
4. Drainage during construction.
5. Permanent drainage system.
6. Construction wastewater and storm water disposal.
7. Final Site grading.
8. Construction of all foundations and structures.
9. Roads (permanent and temporary construction).
10. Temporary parking and laydown areas.
11. Site Security (permanent and temporary fencing including gates, card readers, and cameras as required).
12. Revegetation of disturbed areas.
13. Off-site Road Improvements and repair (if required to transport or receive equipment or if required as a result of construction work).

D. The Project design shall take into account existing site conditions with respect to soil characteristics, site clearing, grading, and drainage. Contractor shall be responsible for all site preparation including any demolition, soil stabilization, grading, drainage, roadways, and temporary parking areas.

5.2 Units

A. All design dimensions and design calculations shall be in United States Customary units.

5.3 Geotechnical

A. Contractor's final design shall be based on the recommendations of Contractor's geotechnical investigation and report.

B. If subsurface conditions are encountered at the site are inconsistent with the data found in the Contractor's geotechnical report, additional subsurface data shall be gathered and evaluated at Contractor's expense. Any subsurface anomalies discovered by Contractor shall be reported immediately to the Owner.

5.4 Site Preparation and Maintenance

A. Contractor shall be responsible for all Site preparation, backfill, and excavation. Cut and fill for the entire site, including storm water ponds (if necessary), shall be managed by Contractor. Contractor shall clean permanent site drainage system components immediately prior to Substantial Completion.

B. Site Preparation:

1. Contractor shall design and specify site grading to include all trench excavation for underground utilities which includes electrical duct banks. The Site shall be properly leveled with no construction debris or dirt piles. Contractor may store native material on Site that is suitable for use as backfill or topsoil.
2. Installation of all Site construction utilities shall be planned and constructed by Contractor. Location shall be approved by Owner.

C. Site Clearing and Grubbing:

1. Completely clear the Site of all trees, debris, rubbish, shrubs and vegetation as required for construction of new facilities. All debris from clearing and grubbing shall be removed from the Site. All root mats and stumps shall be completely removed and holes refilled with engineered fill material and compacted adequately for the ultimate expected loading for the material used.

D. Debris:

1. All construction-related debris and unsuitable material shall become the immediate property of Contractor and shall be removed from the premises and lawfully disposed of off-Site by Contractor at Contractor’s cost.

E. Erosion:

1. Contractor shall prepare a Storm Water Pollution Prevention Plan (SWPPP) for their construction activities. Contractor shall be responsible for maintaining the storm water controls and best management practices. Contractor shall provide for sediment and erosion control during and after construction in accordance with project permits and local and state laws and regulations. Best management practices such as check dams and sedimentation basins shall be used during construction to minimize erosion. Drainage facilities shall be designed and constructed in a manner to minimize erosion.

F. Road Maintenance:

1. All access roadways used by Contractor shall be maintained in serviceable condition. Contractor shall keep the surfaces of those roadways free from spills, mounds, depressions, and obstructions, which might present a hazard or annoyance to traffic.
2. Contractor shall be responsible for securing authorization and permits to transport oversized/overweight loads on local, County, and State roads for the supply of materials under Contractor’s scope. Contractor shall supply and install any temporary or permanent facilities required to facilitate delivery of these equipment/materials. Contractor shall also be responsible for removing all such temporary facilities.

G. Signs and Barricades

1. Signs and barricades shall be provided and maintained by Contractor and shall be in accordance with jurisdictional regulations for accident prevention and Contractor's Safety Plan.

H. Dust Control

1. Dust Control for Construction Activities

a. Contractor shall be responsible for dust control for the Work. Contractor shall prevent the spread of dust during its operations. Contractor shall moisten all surfaces with water to reduce the risk of dust becoming a nuisance to the public and neighbors. Contractor shall furnish labor and equipment necessary for dust control including tank trucks and hoses to apply the water. Contractor shall be responsible for compliance with State and local requirements for fugitive dust emissions and shall obtain local authority approvals and conform to the dust control regulations. Contractor shall conform to all requirements of the applicable permits.

I. Open Burning

1. Onsite open burning is not permitted.

J. Excavation, Filling, and Backfilling

1. Excavated native material may be used on the construction Site for embankment and backfill, if suitable. All unsuitable materials such as rock, concrete, wood, metal, and other materials from the excavation shall be considered debris and disposed of as described herein.

2. Structural fill, bedding material, topsoil, and other materials not readily available on Site shall be procured, tested, and delivered to the Site by Contractor. All materials brought to site shall be reviewed and approved by Engineer of Record prior to delivery.

3. Contractor shall be solely responsible for maintaining the stability of all excavated faces and shall provide adequate sheeting, shoring, and bracing to support any lateral earth pressure.

4. Contactor shall be solely responsible to protect personnel and adjacent structures against any damage from cave-ins, heaving or other earth movements. Sheeting, shoring, and bracing shall be removed as backfilling proceeds or it may, with the approval of Owner, be left fully or partially in place.

5. Fill characteristics and compaction requirements shall be determined by the geotechnical investigation and report recommendations.

6. Site dewatering during construction is the responsibility of Contractor.

K. Site Grading and Drainage

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water

drainage, grading, roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.

5.5 Site Improvements

A. Paving and fencing improvements shall be in accordance with the Site plan.

B. Storm Water Drainage System

1. Design and prepare the construction plans, final design reports, and project specifications for the civil site work, including the storm water drainage, grading, roads, temporary construction facilities, etc. All must meet the approvals of the Owner and jurisdictional government agencies.

C. Duct Banks

1. Underground banks of power and instrument conduit shall be encased in concrete. Encasements shall be reinforced to withstand AASHTO HS20 loading at roadway crossings and non-paved equipment access areas susceptible to damage by cranes, trucks, etc. Refer to Section 7.1.C.3 of this document for required compressive strength of concrete encasement. The concrete at the top of the duct bank shall be colored red.

D. Crushed Stone Surfacing

1. Crushed rock surfacing within the substation fence shall be 4 inches thick with a resistivity of 3000 ohm-meters. Crushed rock shall conform to ASTM C33, gradation 1-1/2 to No. 8 particles.

E. Roads and Parking

1. Subgrade preparation and compaction shall be in accordance with sound geotechnical engineering practice and as recommended by the geotechnical investigation and report.

2. Roadways and driveways areas shall be designed for AASHTO HS20 loading as a minimum. The laydown areas shall also be designed with consideration for concentrated loading due to handling of heavy loads.

3. Except as noted herein, no off-site road improvements are included unless required by Contractor for access or damaged by Contractor during construction.

5.6 Roads

A. Two access points to the Solar Substation shall be provided.

5.7 Fence

A. Refer to PGE Exhibit M1-01-07 for Owner security requirements.

B. Contractor shall repair and/or replace fencing damaged by construction activities.

5.8 Gates:

A. Refer to PGE Exhibit M1-01-07 for Owner security requirements.

5.9 Bollards

A. Buildings, electrical enclosures and equipment adjacent to traffic areas shall be protected with minimum 6" diameter steel pipe guard post painted yellow. Guard post shall be minimum height of 42" above finished grade, and 36" below finished grade. Post shall be set in 18" minimum diameter hole filled with concrete. Post shall be filled with concrete.

6.0 STRUCTURAL

6.1 Materials

A. Steel

1. Design of structural and miscellaneous steel shall be in accordance with the American Institute of Steel Construction (AISC) "Manual of Steel Construction". Design of structural and miscellaneous steel shall also be in accordance with the American Society of Civil Engineers (ASCE) "Substation Structure Design Guide, Manual of Practice 113"; NEMA TT1 – Design of Tapered Tubular Steel Structures; "Design of Steel Transmission Pole Structures", ASCE/SEI 48; Minimum Design Loads for Buildings and Other Structures", ASCE/SEI 7; and the International Code Council "International Building Code". Seismic design shall be in accordance with the Institute of Electrical and Electronics Engineers (IEEE) "IEEE Recommended Practice for Seismic Design of Substations", IEEE 693.

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

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

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

    c. Structural Plates and Bars: ASTM A36

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

    e. Tubular – a structure composed of closed sections (tubes) of circular, multi-sided, or elliptical cross section and tapered or untapered: NEAM TT1

    f. Pipe: A53, Grade B

3. High strength bolts, nuts, and washers shall conform to ASTM A325, ASTM A563, and ASTM F436 respectively and shall be galvanized in accordance with ASTM A153.

4. Bolts, nuts and washers under one-half inch in diameter shall conform to ASTM A307, Grade B, ASTM A563 and ASTM F844 respectively and shall be galvanized in accordance with ASTM A153.

5. Anchor bolts, anchor bolt assemblies and concrete embedments shall be galvanized in accordance with ASTM A153.

6. Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307.

7. All structural welding shall conform to the requirements of AWS D1.1.

8. Galvanizing, as specified herein, shall conform to the requirements of ASTM A123, ASTM A143 and ASTM A153 as applicable.

9. Stainless steel shall conform to ASTM A167.

B. Aluminum

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

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

3. Bolts and nuts shall conform to ASTM F468 and ASTM F467, respectively and shall be aluminum alloy 6061-T6. Washers shall be aluminum-clad steel Alclad 2024-T4 or approved equal.

C. Concrete

1. Design of structural concrete shall be in accordance with the latest version of the American Concrete Institute (ACI) - "Building Code Requirements for Structural Concrete," ACI 318. All concrete formwork shall conform to ACI 347.

2. Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted, and approved by the Owner prior to placing concrete.

3. Minimum concrete strength classes for various structures shall be as follows:

Item	Minimum Ultimate Compressive Strength (psi) (at 28 Days)
Electrical Ductbanks	3,000
Major equipment/structures where required and all other construction	4,000

4. Reinforcing bars shall be deformed bars conforming to ASTM A615, Grade 60. Welded wire fabric shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.

5. Cement shall be Portland cement conforming to ASTM C150, Type I or Type II or as recommended by the Engineer of Record.

6. Aggregates for normal weight concrete shall conform to ASTM C33.

7. Slump of concrete used for substation foundations shall be 4 inches plus or minus 1 inch, unless otherwise noted.

8. All foundations shall extend a minimum of 6 inches above the adjacent finish grade.

9. All concrete trucks may be rinsed out on-site. Rinse material shall be properly disposed of off-site.

6.2 Structural Loading

A. Contractor shall determine all Site data for the design and construction of the plant. This shall include determination of local code requirements for seismic and wind design loads. It is the Contractor’s sole responsibility to ensure that the plant structural and architectural facilities comply with all federal, state, and local code requirements and all industry codes and standards. Occupancy Category III shall be used for all structural loading in the design of this plant.

B. Dead Loads

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

C. Live Loads

1. Live loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

D. Snow Loads

1. Snow loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

2. Snow drift shall be evaluated and considered in the design.

E. Wind Loads

1. Wind loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

F. Seismic Loads

1. Seismic loads shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency. The soil profile type shall be determined by Contractor based on the results of Contractor’s subsurface investigation.

G. Thermal Loads

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

H. Vehicle Loads

1. Design loading, for areas accessible to trucks, shall be (AASHTO) HS20.

I. Soil and Hydrostatic Pressure Loads

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

J. Gen-tie Line Loads

1. In addition to the aforementioned loading criteria, overhead gen-tie line loads shall also conform to ASCE Manuals and Reports on Engineering Practice No. 74 “Guidelines for Electrical Transmission Line Structural Loading” and to NESC requirements.

K. Load Combinations

1. Load combinations shall be in accordance with the International Building Code as modified by the applicable Local Additions and Addenda Agency.

6.3 Structural Foundations

A. Type of foundations required and allowable bearing values for soil and rock shall be as recommended by the geotechnical engineer based on the subsurface conditions found in Contractor’s geotechnical report. 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 2000 psi concrete. Total foundation settlements will be limited to 1 inch or as required by applicable building or industry codes, and equipment supplier's recommendations.

B. Building and Equipment Foundations

1. Building and equipment foundations shall be of reinforced concrete and their construction shall incorporate formwork, appropriately sized and configured rebar, waterstops, expansion joints, etc.

C. Transformer Foundation and Containment

1. Transformers shall be provided with secondary oil containment equal to 110% of the volume of oil present in the transformer.

6.4 Corrosion Protection

A. Stainless steel and galvanized steel shall not be painted.

6.5 Solar Substation Control Building

A. The Solar Substation control building shall contain relay and communications panels, telecommunication panel, an RTU, station service equipment, and other items associated with the Project including any required utility/ISO equipment.

B. To reduce site congestion, building shall be delivered as a single, completely assembled unit to the greatest extent practical. Contractor will unload and place on foundation.

C. Roof and supporting structure shall be designed for minimum 30 psf uniformly distributed load plus a 200-pound concentrated load over a 1'x1' area located anywhere on the roof surface plus any interior loads imposed by suspended equipment or cable tray. For wind and uplift loads, structure and anchorage shall be designed for 100-mph winds. Floors shall be designed for a minimum of 150 psf loading. Design for loading of battery rack; batteries; charger; electrical equipment and raceways; heating, ventilating, and air conditioning equipment; relay switchboards; and transformers, lighting, and other miscellaneous items as required.

D. The enclosure base shall be all welded steel frame construction. The enclosure floor shall be a minimum of 3/16-inch steel plate welded to the base. Provide special anchoring and support members under the battery racks and relay control panels. The floor shall be finished with a non-skid coating. The floor and walls shall be insulated to a minimum R11 value. Provide a bottom plate to enclose and protect the insulation. The entire enclosure shall be framed with an equivalent of three (3) inch square tubular steel. All openings, such as doors, windows, etc., shall be similarly framed with three-inch square tubular steel or structural equivalent. The height from floor to ceiling shall be ten (10) feet minimum

E. The exterior and interior walls shall be a minimum of 16 gauge paint quality galvanized steel. The walls shall be designed and assembled to allow for future lateral expansion of the enclosure. Interior walls and supporting panels shall be designed so that interior loads of 400 pounds per linear foot of wall length may be attached to the wall without compromising the design wind loads. If additional reinforcement is required to mount equipment, the manufacturer may use Unistrut or equivalent.

F. The exterior of the roof shall be 16 gauge paint quality galvanized steel panels. The roof shall be sloped away from door openings, at a 2-degree pitch, to allow for adequate drainage. The roof shall be designed to support interior loads of 100 pounds per linear foot of truss length without compromising the roof design load. Screened, louvered ventilation openings shall be provided, to prevent condensation in attic space. The ceiling shall consist of formed 16 gauge paint quality galvanized steel panels. It shall be designed to retain the insulation and to provide a smooth ceiling surface. Ceiling shall be insulated to a minimum value of R30. Interior ceiling and supporting structure shall be designed so that interior loads of 100 pounds per linear foot of truss length may be suspended from the ceiling without compromising the specified roof design load. Design for additional load, as required, to support cable tray, lighting, conduits, and other items provided by this Contract.

G. The enclosure shall have two (2) separate 16 gauge heavy-duty steel doors; one (1) 36 by 84 inch and one (1) 72 by 96 inch with removable transom. The doors shall be equipped with low profile panic-type door hardware and an automatic door closer. A drip shield shall be provided above all doors. Each set of door hinges shall include one entry alarm hinge comprised of an integral SPST electric switch rated 125VDC. Contractor shall provide and terminate a two-wire circuit from each alarm hinge to the RTU.

H. The room-type heat/cool air conditioners shall be sized and provided by the Contractor based on the heat loads and cooling loads. Consideration shall be given to the ambient site conditions, the dimensions and heat retention of the enclosure building, and the heat dissipated by the control/monitoring equipment inside the building. Equipment shall be capable of maintaining a building temperature of not more than 75 degree F for cooling and not less than 65 degree F for heating. Contractor shall provide calculations of heating and cooling capacity requirements. Furnish and install one staging thermostat with two-stage heat and two-stage cooling that cycles equipment of both heating and cooling stages. Air conditioning and heating shall have 100% redundancy.

I. Interior lighting shall consist of fluorescent lights that provide 40 foot candles of light at a level three feet above the floor. Lighting shall be controlled by heavy-duty 3-way switches located near each door. Lighting locations indicated on Contract drawings shall be modified to meet illumination requirements. External lighting shall be provided above each personnel door with automatic operation provided by a photo-electrically controlled lighting contactor. Provide 100 watt, enclosed, weatherproof, heavy-duty high-pressure sodium fixtures. Emergency lighting shall consist of self-contained, battery powered units with two illuminating heads. The units shall switch-on automatically upon loss of AC power, shall provide 1.5 hours of continuous illumination, and shall recharge when AC power is resumed. Duplex receptacles, polarized, arc resistant, specification grade, shall be rated 120V AC, 20A. Lighting contactors and switches shall also be provided for all yard lighting.

J. Provide cable risers to extend from yard cable trench and duct bank to cable entrance wall openings to access the building cable tray. A generation interface junction box containing terminal blocks shall be integral to one of the cable risers. Risers shall be designed and sealed to prevent infiltration of water, snow, dust, and animals into the cabinet or building. Cabinet shall be constructed of corrosion-resistant aluminum or stainless steel and meet or exceed NEMA standards. Risers shall be provided with removable, gasketed covers to accommodate easy access for cable installation and termination.

K. Provide wall mounted exhaust fans sized and located as required to provide proper ventilation for the selected battery arrangement. Provide a gravity intake damper with an exterior weather hood associated with each exhaust fan. Provide exhaust fan on/off toggle switches to control the exhaust fans and intake dampers

L. Furnish and install AC panelboards sized as required and located generally as shown on the drawings. Furnish and install all cable tray as shown on the drawings. Furnish and install conduit and wireways as necessary to wire the control building. Provide an automatic transfer switch for the incoming station service sources to allow immediate restoration of AC service in the event of loss of the primary station service source. provide safety switches for AC and DC systems. Provide station service transformers for 208V three-phase service.

M. Provide a battery system as described in Section 4.

N. Furnish and install one combination smoke and heat detector unit with one normally open and one normally closed alarm contact rated 5A at 125V DC. Provide LED or fluorescent illuminated exit signs above each door. Provide an appropriate eye wash station, a dry chemical fire extinguisher (ABC rated), and other items required or indicated for a complete building system.

7.0 GEN-TIE LINE (AS APPLICABLE)

7.1 Introduction

A. Section 8 of M3-01-02 shall form the technical basis for the design, material procurement, and construction of the Gen-Tie line between the Solar Substation to POI.

7.2 General

A. A new single circuit XXX kV Gen-Tie line, to be installed on existing self-supporting tubular steel poles (or Owner approved structures), shall begin at the Solar Substation and terminate at the POI or Point of Change of Ownership as defined in the Interconnection Agreement.

B. Contractor shall be responsible for the following:

1. Perform Gen-Tie line engineering, analysis, and design.
2. Prepare a complete construction package to include the following: final plan and profile drawings, sag charts, complete bills of material, structure foundation drawings, structure erection drawings, insulator and hardware assembly drawings, right-of-way constraints, outage constraints with complete schedule, and construction technical provisions.
3. Procure equipment and material.
4. Receive, inventory, store, and protect equipment and material.
5. Install the line.
6. Test and commission.
7. Prepare as-constructed documents, which shall include the gen-tie facilities, right-of-way widths, easement areas, fences and gates, and labeling of all major roads and points of interest in both AutoCAD and pdf formats.

C. It shall be Contractor’s responsibility to complete all tasks necessary to provide Owner with a complete and fully functional Gen-Tie line facility that meets all Owner’s standards and specifications, including the Interconnection Agreement.

D. Contractor shall review and comply with all permit requirements and stipulations.

7.3 Gen-tie Line Engineering and Design

A. General Requirements.

1. The design specifications and drawing requirements provided or referenced in this document are to be considered as minimum requirements. Any criteria not specifically addressed in this specification shall as a minimum meet or exceed the requirement of the current edition of the National Electric Safety Code (NESC) C2.
2. Contractor shall use PLS-CADD software to spot and perform detailed analysis and design of the gen-tie line.
3. Gen-tie shall fit within defined right-of-way while adhering to all NERC and NESC regulations.

B. Survey.

1. The survey firm is responsible for establishing a ground control network and collecting controlled, color, digital, ortho-rectified photography and terrain data. The survey firm is also responsible for processing the raw data and delivering a digital elevation model in a format readily imported into PLS-CADD.
2. Contractor shall be responsible for identifying and obtaining any additional survey data needed for design.

C. Geotechnical.

1. Contractor shall be responsible for obtaining all geotechnical data needed for foundation design.

D. Loading Conditions and Load Cases: For evaluation of existing gen-tie poles and design of new poles:

1. Contractor shall apply the load cases and load factors appropriately for Gen-Tie poles according to NESC 250 as applicable for tangent and dead end structures.
2. Maximum Deflection at the pole tip shall be limited to the 1% of the total structure length.
3. The structure shall be designed and analyzed for any combination of intact and/or dead-ended wires that result in the highest stress in the pole.
4. The construction load case shall incorporate any and all loading conditions which may occur as a result of wire stringing and/or other construction activities.

E. Wire Tension Limits.

1. Tensions shall be limited to protect conductor against damage due to vibration.
2. Stringing tensions for the OPGW shall not exceed 20% of the ultimate cable strength.
3. Wire tension limits for design of the conductor, shield wire, and OPGW shall be based on applicable weather cases (wind, ice, temperature).
4. Vibration Protection.
5. Contractor shall consider and design all wire systems (OPGW, shield wire, and conductor) to prevent wire damage due to Aeolian vibration.
6. Contractor shall incorporate manufacturer (wire and damper manufacturers) recommendations.

F. Structure Loading and Electrical Clearances.

1. Contractor shall be responsible for wiring on the existing structures such that electrical clearance requirements are met and design loads are not exceeded.
2. Calculation of the design loads is the responsibility of the Contractor.

G. Phasing.

1. Phasing shall be determined in the field by the Contractor.
2. Phasing shall be placed on the Plan & Profile Drawings.

7.4 Material

A. Material shall be of new manufacture and unused and be free of defects and irregularities.

B. All assemblies, hardware, and components of assemblies shall be designed to meet the strength requirements of most recent edition of NESC C2.

C. Contractor shall verify that all material, assemblies, hardware, and components of assemblies meet the strength requirements for the application and intended use.

D. Any piece of hardware in an insulator assembly must at a minimum match the ultimate strength of the insulator.

E. Corona-free hardware shall be used.

F. Galvanized steel shield wire shall be ½ inch extra high strength (EHS) steel.

G. Optical ground wire (OPGW) shall be 24-fiber OPGW or as specified in the Interconnection Agreement.

H. If conductors are bundled horizontally, Contractor shall install spacers per conductor and spacer manufacturer's recommendations.

I. Mid-span spacers are not required for vertically bundled conductors.

J. Contractor shall be responsible for design of the jumper assemblies such that all electrical clearances are maintained.

7.5 Construction

A. Contractor shall prepare, compile, issue, and update a construction specification for the work described in Section 8 of M3-01-02.

B. Contractor shall procure material and construct the gen-tie line such that, when in operation, does not cause nuisance audible noise or radio or television interference.

C. Contractor shall make all reasonable efforts to minimize all damages due to construction activities.

D. Contractor shall be responsible for preparing and acquiring all crossing permits from the owners of the foreign overhead or underground facilities crossed.

E. Contractor shall be responsible for preparing and acquiring all construction access permits from the state and local agencies with jurisdiction.

F. Contractor shall be responsible for preparing and acquiring all stormwater construction permits.

G. All temporary openings in fences created by the Contractor shall be removed and the fence repaired when access is no longer required. Contractor shall be held responsible for damage to crops, livestock, or other property resulting from failure to keep fences, gates, or fence gaps in proper condition.

H. Contractor shall be responsible for grounding all fences and structures along the gen-tie route.

I. Contractor shall repair and restore the right-of-way and clean up each structure location to the satisfaction of the Owner and the landowner/tenant. All earthwork, culverts, bridges, and drainage structures constructed by the Contractor shall be removed when no longer required.

J. All parts of the structure shall be purchased and installed by the Contractor.

K. Conductor, shield wire, and/or OPGW shall be installed in accordance with "IEEE Guide to the Installation of Overhead Transmission Line Conductors", Std. No. 524.

8.0 SECURITY PERFORMANCE GUIDELINES

8.1 Refer to PGE Exhibit M1-01-07 for Owner security requirements.

8.2 Security Lighting

A. Basic security lighting shall be provided to assist in maintaining acceptable levels of facility protection. This includes, but is not limited to, lighting at entrance gates, employee entrances, building entrances, employee parking areas, and areas around the building perimeter.

B. Boundary lighting must consist of a series of fixed lights to light the boundary or area from which an intruder could approach.

C. Area lighting shall supplement existing street lighting to provide a maximum level of illumination from a minimum number of fixtures. The system shall be designed to illuminate the entire area evenly, including doorways, structures and all opening into the structures.

D. Lighting shall be provided to cover the building faces evenly. Doorways and other openings in the building must be lighted to eliminate shadows.

E. Pedestrian and vehicle entrances that are actively used are to be provided with sufficient illumination to permit recognition of individuals and examination of credentials. All vehicle entrances must be lighted so that the entire vehicle, occupants, and contents can be viewed. Doorways and other recesses must be lighted to eliminate shadows.

F. Lighting Minimum Requirements:

Location	Minimum Foot-Candles (fc) on a Horizontal Plane at Ground Level
Vehicular entrances***	1.0**
Pedestrian entrances	2.0
Security-sensitive site areas	2.0
Employee parking and maneuvering areas	1.0**

* Lighting should be directed inward from the property line.
** Lighting must be increased to 2 fc if an exterior security CCTV system is provided. This is based on the worst-case or reflective light conditions (asphalt).
*** Lighting must be increased as necessary to allow proper identification of the individuals in the vehicle.

G. Contractor must document security lighting requirements by providing a point-by-point, computerized photometric plan or other method that demonstrates that appropriate lighting has been planned.

H. Alternate circuitry must be used in the power circuits so that the failure of any one lamp does not leave a large portion of either the site perimeter or critical or vulnerable area in darkness.

8.3 Building Utilities

A. To the extent possible, all utilities associated with the Security Performance Requirements are to be run underground. All circuits must be run in conduit.

8.4 Electronic Security System (Exterior Design)

A. The exterior security system encompasses the required exterior lighting and fencing with top guard as well as all exterior electronic security equipment (i.e. access control, intrusion detection, and CCTV).

B. When the electronic system is required there must be sufficient lighting throughout the site so that the cameras can operate effectively and record the required information. The electrical and the security systems architects or engineers shall coordinate their efforts. If there are areas of concern, e.g., lack of or limited coverage, alternatives or additional camera locations shall be approved by Owner.

8.5 Security CCTV System

A. The security CCTV system consists of CCTV cameras housings, video and power cable, control panel, switchers, multiplexers, monitors and recorders. The system must be designed so that it is capable of recording and being monitored 24 hours per day, 7 days per week.

B. The security cameras shall provide a color picture, have an automatic iris and pan-tilt-zoom (PTZ) control lens, and, if for exterior use, installed in environmentally controlled, domed housings. The domes must be designed to eliminate the ability to observe the camera operation and location from inside the dome.

C. The entire substation area shall be covered by the CCTV system without any areas being blocked or obscured by substation equipment and/or structures. The entire exterior of the O&M Building shall be covered without being blocked or screened by any equipment and/or structures.

D. The cameras shall be mounted on light poles when possible. The camera's lens configuration shall be able to provide identifiable personnel images as well as read license plates and numbers. A separate camera coverage drawing showing camera placement as well as the focal distance and arcs for each camera shall be submitted to the Owner at a design review meeting.

E. The CCVT System shall be provided with an operator interface in the control room.

9.0 TESTING, COMMISSIONING, AND PROJECT ACCEPTANCE

9.1 See M3-01-04 for requirements of Field Testing, Functional Testing, and Commissioning. All commissioning and testing shall be coordinated with the Utility.

10.0 PROJECT and CONSTRUCTION MANAGEMENT

10.1 Staffing

A. Contractor shall provide the appropriate personnel to manage all aspects of the Work.

B. Contractor shall ensure an OSHA "competent" person be present during all work hours.

C. Contractor may work on Site at any time subject to Applicable Laws.

10.2 Reporting/Meetings

A. Contractor shall provide progress and schedule reporting on a weekly basis. A two-week look ahead of activities shall be provided at weekly reoccurring meetings with the Owner, Contractor and Contractor's subcontractors.

B. Progress meetings shall be held at the Site on a monthly basis on dates mutually agreeable to Owner and Contractor.

10.3 Safety Plan

A. Contractor shall maintain a Safety Plan and observe all safety practices required for performing construction work of this type including OSHA standards and adherence to Owner standards.

10.4 Work Schedule

A. Contractor shall submit a detailed critical path schedule using Primavera P6 or similar mutually agreed upon project management software which also meets the requirements of the Agreement.

B. The Work Schedule shall be updated monthly against the baseline schedule and submitted to Owner in its native and .pdf file formats.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 03

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

SAFETY AND SITE SECURITY REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

1.1 Requirements

A. Contractor shall take all necessary precautions for the safety and security of its employees, Subcontractors, agents, owner representatives and visitors on the jobsite and prevent accidents or injury to individuals on, about, or adjacent to the Site. Contractor shall develop and provide, for the site specific work being performed, their Site Environmental, Health & Safety, and Security Plan no later than 6 weeks after Limited Notice to Proceed. Contractor shall ensure that the Plan complies with all federal, state and local regulations and any project specific requirements. This Plan, as subsequently accepted by Owner, will become Attachment 1 to M3-01-03 to the EPC Agreement[1]. Owner shall have 15 business days to review and comment on such Plan submitted by the Contractor; provided, however, that Contractor shall remain solely responsible for performing such Work in accordance with this Agreement. If Owner provides any comments with respect to the Plan to Contractor, then Contractor shall consider Owner's comments and incorporate changes into the Plan, or otherwise address, and resubmit the revised Plan to Owner. Such resubmission of the Plan shall not be considered a Change In Work. Contractor shall perform the Work in accordance with the accepted Plan. Contractor shall not perform any Work on the Site prior to final acceptance of the Plan. In addition, Contractor shall erect and properly maintain at all times, as required by the conditions and progress of the Work, all safeguards and warnings for the protection of its employees and the general public that are reasonably prudent or required by Applicable Law.

B. Contractor shall conduct regular inspections required to ensure that safe working conditions and equipment exist. Contractor accepts sole responsibility for: (a) providing a safe place to work for its employees and for employees of its Subcontractors working at the Site and agents, and (b) ensuring the adequacy of and required use of all safety practices, procedures and equipment.

C. Contractor shall orally notify the Owner of any serious accident or near miss occurring on the Site or in connection with the Work within 24 hours of occurrence. A fatality occurring on the Site or in connection with the Work must be communicated to the Owner within 8 hours of its occurrence. Contractor shall document any serious accident or near miss occurring on the Site or in connection with the Work and shall furnish Owner Representative with a copy of the written investigation report within 72 hours of any accident or injury to any of the employees or agents of Contractor or any and all Subcontractors utilized in the performance of the Work.

D. Contractor shall immediately notify Owner of any governmental agency (OSHA, Fire Dept., Health Dept., etc.) complaint and/or inspection of the Site.

[1] Note: Contractor Safety plan also covers security

E. Contractor shall provide to Owner at least monthly, project-related safety performance data to include at a minimum recordable injuries and illnesses, days away from work injuries and illnesses (lost time), recordable and days away from work rates, and performance to project health and safety goals.

F. Contractor shall be responsible for any and all security services (which shall consist of 24 hour services) required for the performance and completion of the Work prior to the occurrence of Project Substantial Completion. Prior to the occurrence of Project Substantial Completion, Owner shall have no responsibility for the security of Contractor's equipment, or any of its Subcontractor's equipment stored at the Site during the performance of the Work including construction of appropriate fencing. When designing, procuring and implementing any securities services, and during the performance of all security services pursuant to this paragraph, Contractor shall cooperate and cause its Subcontractors performing work at the Site to cooperate with Owner.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 04

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

COMMISSIONING

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 OVERVIEW - COMMISSIONING

The Commissioning process provides a quality-oriented methodology for verifying and documenting the design, construction, functionality, and performance of the Project. The commissioning process shall ensure that all system components perform interactively to meet the defined system objectives and criteria of the Owner, as established in the EPC Agreement and its attachments.

The Commissioning representative to be used by the Contractor must be proposed to Owner as part of Commissioning Plan and agreed upon by Owner before start of work.

2.0 SCOPE

All commissioning activities shall be executed under a phased approach, as identified below. Activities of each phase shall be documented and submitted to the Owner for review, acceptance, and documentation:

2.1 Design Phase

A. Design Review: Design review is part of the Commissioning process. The Contractor shall provide regular design reviews with the Owner to ensure the Owner's project requirements are being met. There is to be a Conceptual Design Review at the launch of the project (LNTP) and at each of the design package milestones of the Construction Drawings (refer to Agreement). The Commissioning team will participate in later phases of the reviews.

B. Commissioning Plan: A project-specific Commissioning Plan shall be developed and issued by the Contractor. The Plan shall outline the proposed personnel and/or company, tasks, processes, procedures, and deliverables required to prove the function and performance of the Project and all of its systems. It will include a section on Deficiencies and Resolution Procedures for each phase and the Commissioning Schedule. The Plan shall also reference safety requirements for start-up and commissioning, including electrical safety and lock-out/tag-out procedures. The Plan shall be submitted to the Owner for review and approval. The plan shall include example forms for each commissioning activity that clearly state the pass/fail criteria, the individual(s) performing the test, the date and time of the test and the result of the test.

C. Commissioning Specifications: Commissioning specifications shall be provided by the Contractor to outline the requirements for the installing contractors.

D. Commissioning Review: A commissioning review of the design drawings shall be performed by the Contractor and shall address design fundamentals for reliability, maintainability, and commissionability (e.g., design, location, and quantity of primary and secondary measurement devices)

E. Commissioning Log: A detailed commissioning log will be developed and issued by the Contractor for the tracking of all commissioning issues, observations, and deficiencies. The commissioning log will enable current status and resolution tracking of any open items. The log will be circulated to the project team on a regular basis for review.

2.2 Construction Phase

A. Meetings: Commissioning meetings will be held on-site on a periodic basis. A commissioning kick-off meeting will be held with the project team at the commencement of project construction, or at least 30 days before commissioning. The Commissioning Team consists of, at a minimum, the Contractor's Commissioning Agent, project manager, design team representative, construction team representative, the Owner's project manager and project engineer.

B. Submittal Reviews: Approved equipment submittals shall be reviewed by the Contractor for compliance with the project design, intent and specifications.

C. Factory Acceptance Tests:

The following PV equipment shall be tested for functionality, operability, and performance:

1. Solar Modules (IEC 61215 tests and Flash Tests)
2. Combiner Boxes (or Load Break Disconnects as applicable)
3. Inverter Skid Assemblies
4. Solar Substation GSU
5. SCADA
6. Trackers
7. MET Station

OWNER and ENGINEER shall be given opportunity to witness each test and shall be given 15-day advance notice prior to any planned test. The related expense will be paid by the Contractor. Owner and/or Engineer's travel expense for attending factory acceptance testing will be paid by the Owner.

Refer to Attachment 1 of this document for the required factory tests on the inverter. Since inverter efficiency and other testing are impractical in the field, the Project requires more stringent testing in the factory. All testing results shall be fully documented and reported to Owner.

D. Prefunctional Checklists: Project and equipment-specific prefunctional checklists shall be developed and issued by Contractor to the installing contractors. The prefunctional checklists shall address proper installation methods, vendors' requirements, applicable codes and standards, and good engineering practice requirements. A master check list, with acceptance criteria, shall be included in the Commissioning Plan which is issued to the Owner. Prefunctional check out of all systems shall be required as part of Mechanical Completion [refer to Agreement section for more definition]

E. Inspections: Equipment delivery inspections shall be carried out by Contractor during the course of construction. Reports shall be issued for inspections of inverter skids. This will include signatures of the responsible personnel and verification of proper installation of all equipment, devices, and wiring per manufacturer's recommendations. This will also include observations and punch-lists from Quality Control personnel verifying installation has occurred per their design drawings and specifications.

F. Functional Testing: There are two types of functional testing required:

1. Equipment-specific functional testing and 2) PV Plant Functional Testing – these protocols will be developed and executed by Contractor to address functionality and safe operation of components and systems. The functional testing protocols shall be detailed so as to address operation, failure modes, and recovery modes.

2. Equipment-specific functional testing: The Project will consist of PV generation equipment and sub-systems: PV modules, DC wiring, combiner boxes or Load Break Disconnects (LBD), Inverter Skid Assemblies, trackers, and all associated structural elements and interconnecting cables that will allow the PV Plant to generate and deliver the AC power to the Project Point of Interconnection. Prior to energization, all NETA-ATS tests shall be completed including the following checks and testing, at a minimum:

   a. Proper mechanical and electrical installation of the PV modules.

   b. Completion of the pre-functional tests of the PV Modules and DC collection system, including but not limited to string level Open Circuit Voltage Testing, Operating Current Testing, IV Curve Tracing (to be performed on 1% of the strings, and to re-test strings that are outside acceptable tolerances), cable Megger Tests, and Grounding Tests.

   c. AC cabling Very Low Frequency (VLF) testing or Partial Discharge (PD) testing.

   d. Proper installation and operation of the Inverter Skid Assemblies.

   e. Completion of Inverter pre-functional checks and functional tests per Contractor's commissioning protocols (Including phase rotation and synch checks, emergency and safety features). Inverters shall be checked for proper firmware, installation and connection of all components and systems such as fuses, capacitors, CTs, IGBTs, grounding, and cooling. All pre-functional checks shall be followed strictly per manufacturer's instructions (Cold commissioning plans).

   f. Inverters shall have no manual deratings and shall be set to default manufacturer nameplate ratings. Inverters shall have all settings at factory default settings unless required by Project and approved in writing by inverter manufacturer in advance.

   g. Grounding tests shall be completed for each system. Grounding path from inverter skid to tracker piles shall also be checked in each inverter array and not exceed [TBD] ohms. Completion of the prefunctional checks and functional tests of the inverter medium voltage transformers, including but not limited to Megger Tests, HI-POT Tests, Oil sampling tests (Dissolved Gas Analysis required to be performed either in factory or field in order to establish a baseline), Grounding Tests, operation of alarm and indication sensors. Insulation resistance of windings and turns ratio test at all tap settings shall be performed in both the factory and the field.

h. Liquid filled transformers shall have the following field testing requirements:

  i. Verify nameplate data.

  ii. Coordinate and perform instrument transformer tests on CTs with transformer assembly.

  iii. Winding Tests:

    1. TTR at all no-load taps.
    2. Megger winding to ground.
    3. Megger winding to winding.

  iv. Set high-side voltage taps at positions determined by Engineer of Record.

  v. Check and measure equipment ground; neutral to grounding grid resistance shall not be more than one ohm.

  vi. DGA:

    1. Check insulating fluid for clear or pale amber color and report any variance to Owner. Other colors may indicate contamination from decomposition of insulation, foreign material, carbon, or other substances.
    2. Test oil samples from each transformer with standards in accordance with ASTM D1816.

  vii. Check liquid level in tanks.

  viii. If equipped with cooling fan, check operation of cooling equipment and cooling controls before energizing transformer.

  ix. Check calibration of pressure relief device, top oil temperature gauge.

  x. Test all gauges including level, temperature, and pressure gauges.

i. Dry type transformers shall have the following field testing requirements:

  xi. Verify nameplate data.

  xii. Winding tests:

1. TTR at all taps.
2. Megger winding to winding.
3. Megger winding to ground.
4. Winding resistance measurement on center tap
5. Partial discharge measurement

xiii. Check equipment ground to assure continuity of connections. Notify Owner if ground is more than one ohm.

xiv. Check for proper operation of the winding temperature gauge and cooling fans.

xv. Set high-side voltage taps at positions determined by Engineer.

xvi. Check connections for tightness; clean out dust and other foreign material.

j. Trackers: Verify trackers are fully functional. Ensure they operate in unison and adjust angle accurately remaining normal to sun even with clouds and reset to proper angles after stow or night; back-tracking function works properly with no interior shading. Proper tracker stow shall be checked and wind and hail stow shall be verified.

k. Completion of the functional test of cable terminations in all electrical cabinets including switchgear (if applicable) per Contractor’s commissioning protocols, including but not limited to PID or VLF testing, and Disconnect devices integrity and operability, insulation test on each phase conductor with respect to phase to phase and phase to ground, verification of ratios of all VTs, and CTs, insulation resistance test of all VTs, CPTs, and CTs, polarity check of all CTs, verification of protective relay settings, secondary injection test.

l. Test plant controls to verify all control features are fully functional, including reactive power control (PF/VAR/voltage) and power curtailment.

m. All auxiliary systems and devices are installed and functionally tested.

n. Proper operation of the SCADA monitoring and control system. This includes all associated instrumentation, communications and controls between SCADA and other System Devices (e.g., Inverters), alarms, data acquisition and historian, and testing of the data links between Owner’s systems and PV Plant SCADA.

o. Fiber loop feed shall be tested to verify fully functioning fiber ring, including OTDR testing.

3 PV Plant Functional Testing

a. Plant Functional Testing is required on the entire electrical generation system prior to Substantial Completion [refer to Agreement section].

b. The Functional Test will ensure that a fully functioning PV Plant is commissioned and placed into automatic operation, including confirmation of the following systems: Inverters, trackers, auxiliary systems, transformers, SCADA, Power Plant Controller (PPC), MET stations, and other equipment. For substation testing refer to Attachment 2.

c. The Contractor shall develop a detailed plan to test the functionality of the PV Plant and submit to Owner for Owner's review and acceptance. Functional Testing shall be conducted by Contractor in accordance with the agreed upon Functional Test Plan.

d. The Functional Test Plan shall define and record the pre-test start condition of each Circuit, automatic start-up and shut-down of the inverters, trackers, auxiliary systems or devices, or any other automatic operation. Basic parameters that define such automatic operation shall be recorded as part of the test (e.g., Inverter Wake-up Voltage, shutdown, etc.)

e. Energization shall have been fully completed. There shall be no power curtailment or non-standard facility set points or settings, unless approved by Owner in writing in advance.

f. During the Test, as a minimum, the following operating parameters shall be captured of the Circuit of Project under test:

ii. Irradiance

iii. Ambient Temperature

iv. Wind speed

v. Inverter Voltage, Amperage (both DC and AC)

vi. Inverter IGBT (measured at heat sink) Temperature

vii. Power, Voltage, Amperage

viii. Module Temperatures

ix. Transformer temperatures and pressures and alarm status

x. Tracker angle

xi. All faults, alarms, errors, and warnings of all equipment

g. The Test shall be carried out for 120 hours without interruption or operator intervention under Normal Operating Conditions and emergency conditions shall be excluded. The Test shall maintain a 100% time-based availability of all equipment under test for the entire duration of the Test. An allowance of one inverter's downtime for one hour will be allowed during the Test (for the avoidance of doubt, no downtime is allowed for a 2nd inverter). The Test shall provide 100% data availability for all equipment under test for the entire duration of the Test. Owner will consider allowing some secondary data reporting to be temporarily non-functioning such as angle of one tracker.

2.3 Acceptance Phase

A. Capacity Testing: The performance of the PV Project and its components and systems shall be measured and documented pursuant to the procedures set forth in M3-01-05.

B. Aerial Thermographic Survey: An aerial survey of the plant shall be completed prior to Final Completion. The survey shall use infrared imagery with adequate resolution to identify hot spots in the individual modules, strings, and ISAs. A report summarizing the findings shall be submitted to Owner for review.

C. Training: Contractor shall provide a training program to the Owner, including classroom and field training. The training program will cover operational aspects of the Project.

D. O&M Manuals: Contractor shall provide detailed and specific Operations and Maintenance (O&M) Manuals in mutually-agreed format. The O&M Manuals shall include, but not be limited to: System descriptions, method of plant operation, sequences of operation, troubleshooting procedures, maintenance procedures, as-built drawings, and all equipment vendor and subcontractor supplied manuals, warranties, and specification sheets.

E. Warranty Review: Contractor shall review all equipment warranties for compliance with contract documents. Extended warranty requirements and warranty activation dates shall be documented.

F. Commissioning Manual: Contractor shall create a Commissioning Manual, addressing the disposition of all system installation, functionality and operation tests identified in the Commissioning Plan. The Commissioning Manual shall include all relevant start-up and commissioning documentation, test data, site reports, equipment start-up data, and checklists in a logical and sequential format. Upon completion of the project, the Commissioning Manual shall be submitted to Owner electronically.

3.0 INSTRUMENTATION

Contractor shall be responsible for all standard testing instrumentation. Testing instrumentation should include, but is not limited to:

A. Power meters

B. Voltmeters

C. Clamp-on meters (Amp meters)

D. Irradiance meters
E. Power quality test equipment
F. Temperature sensors
G. Met stations: Wind speed sensors, rain gauge, ambient temperature sensors, and all other sensors.
H. Specialized electrical apparatus test equipment.

All instrumentation is to be NIST, or approved equivalent, calibrated; calibration certificates shall be current for all instrumentation used by Contractor during testing.

All irradiance meters shall be cleaned no less than once per week during testing.

4.0 SAFETY

During commissioning, Contractor shall be responsible for any requirements for specific safety procedures and equipment that are in addition to the standard site safety requirements. This shall include, but not be limited to, such items as:

A. Fall Protection
B. Electrical Safety
C. Lockout/Tagout

ATTACHMENT 1 – INVERTER TESTING REQUIREMENTS

1.0 OVERVIEW

The Inverter factory testing shall ensure that all inverter components perform interactively to meet the inverter requirements and criteria of the Owner, as related to the site-specific requirements of the Project. This includes all safety, control, performance, and environmental aspects.

The Owner's objective is to verify that the inverter is fully functional and performing to meet all Project requirements. Test instrumentation accuracy shall be according to table A-1.

Owner shall have the opportunity to witness factory testing. EPC Contractor shall give Owner fifteen business days advanced notice along with factory testing plan for review and response prior to testing.

2.0 SCOPE

The inverter manufacturer shall provide the following documentation from a certified NRTL:

1. UL 1741 Test Report
2. UL 1741 Certification
3. UL 1741 SA Test Report (if applicable)
4. UL 1741 SA Certification (if applicable)
5. IEEE 1547/519 Harmonics Test Report (including raw test data)
    a. Current THD < 3%
6. NERC PRC-024-2 Voltage and Frequency Ride-Through Test Report
7. CEC Efficiency Test Results

The inverter manufacturer shall provide the following documentation from type testing (or from a certified NRTL) to show the inverter meets the specifications outlined in the data sheet. The documentation shall include, at a minimum: active power, reactive power, frequency, DC voltage/current, AC voltage/current, and critical component temperatures (for ambient temperature testing).

1. Active Power
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the nameplate power rating (including any "overdrive" or 110% functionality).
2. Reactive Power
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the maximum reactive power capabilities.
    b. Minimum Requirement: 0.8 lead/lag in 0.01 intervals

3. Plant Controller Response
    a. Inverter manufacturer shall provide test documentation showing the inverter can receive active and reactive commands from a simulated plant controller interface.
    b. Inverter manufacturer shall provide test documentation showing the inverter can operate at the maximum and minimum ramp rates for both active and reactive power variation.
4. Edge-of-Cloud Effects
    a. Inverter manufacturer shall provide test documentation showing the inverter can track the PV array maximum power point (MPP) during high DC voltage and current transients.
5. DC Voltage
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated DC voltage operating range.
    b. Inverter manufacturer shall provide active power vs. DC voltage de-rating curves.
6. AC Voltage
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated AC voltage operating range.
    b. Inverter manufacturer shall provide active power vs. AC voltage de-rating curves from 0.9 to 1.1 p.u. terminal voltage and 0.9 lead/lag.
7. Ambient Temperature
    a. Inverter manufacturer shall provide test documentation showing the inverter can operate over the entire ambient temperature range (minimum 4 hours at each test condition).
    b. At a minimum, the test documentation must include the following operating conditions:
        i. 25°C
        ii. 45°C
        iii. Maximum Operating Temperature
        iv. Minimum Operating Temperature
        v. Any “corner points” on ambient temperature de-rating curves
    c. Inverter manufacturer shall provide active power vs. ambient temperature de-rating curves.
8. DC/AC Ratio
    a. Inverter manufacturer shall provide design calculations and/or test data showing the inverter performance and reliability information at multiple DC/AC ratios including, but not limited to, the maximum and minimum DC/AC ratios specified for the project.

9. Reliability
    a. Inverter manufacturer shall provide test documentation summarizing the accelerated life testing (ALT) and highly accelerated life testing (HALT) testing that has been completed.
    b. Inverter manufacturer shall provide mean time between failures (MTBF) and mean time to failure (MTTF) rates for critical components such as:
        i. IGBTs
        ii. DC switches/contactors
        iii. AC contactors/breakers
        iv. DC link and AC filter capacitors
        v. Communications boards
        vi. Cooling system components (fans, pumps, etc.)

At a minimum, the following tests shall be performed on each inverter during production testing:

1. Calibration of all DC and AC voltage, current, and power circuitry/sensors.
2. UL 1741 production testing such as hi-pot and PE/ground testing
3. GFDI
4. Emergency stop (fast stop)
5. Remote start/stop
6. Burn-in (minimum 4 hours per inverter)
    a. Burn-in testing should be completed under elevated ambient temperature and high DC current conditions at maximum rated power.
7. Harmonic content verification (during burn-in tests)
8. Efficiency verification
    a. Verify inverter efficiency at multiple DC voltages and power levels which shall be consistent with the levels tested during CEC testing.
        i. The official CEC test procedure is not required.
9. Reactive power control (0.95 lead/lag) at rated apparent power
10. Voltage and frequency ride-through verification per IEEE 1547 and/or PRC-024-2

Table A-1 Basic Measurement Requirements

Parameter **True RMS (V, I, P)**	**Allowable Maximum Uncertainty**
DC Voltage	± 1% of reading
AC Voltage	± 1% of reading
DC Current	± 1% of reading
AC Current	± 1% of reading
DC Power	± 1% of reading
AC Power	± 1% of reading
Temperature	± 1°C
DC Current Ripple	± 5% of reading

Table A-2 Power Conversion Efficiency Test Points

Test	**Vdc**	**Vac**	**Inverter DC Input Power Level**						
			100%	**75%**	**50%**	**30%**	**20%**	**10%**	**5%**
A	Vnom	Vnom							
B	Vmax	Vnom							
C	Vmin	Vnom							
D	Vmin	102% Vmin							
E	Vmax	98% Vmax							

ATTACHMENT B – SOLAR SUBSTATION TESTING REQUIREMENTS

1.0 INTRODUCTION

The requirements of the Commissioning specification, M3-01-04, are applicable to the Solar Substation power delivery system. The purpose of this attachment is to provide further detail on the requirements. This specification, however, is not meant to be all-inclusive or completely comprehensive but outlines the main tests that shall be performed on the Substation.

2.0 TESTING AND COMMISSIONING

The Contractor shall perform the Solar Substation testing listed below, though the list is not meant to be all-inclusive. This shall include all testing and recording required by the interconnection authority, and NETA-ATS. Equipment tests shall be in accordance with the manufacturer's recommendations. It is up to the Contractor's discretion whether or not to use an independent certified testing company in order to complete some or all of the tests. However, substation commissioning and testing will be observed by Owner's qualified personnel or representative for conformance to NETA-ATS and industry standards. Submit to the Owner for approval a proposed plan for testing 30 days prior to commencement of testing. In addition to schedule and personnel qualifications, the proposed testing plan shall also include pass criteria and a list of equipment to be used for the project testing.

A. Electrical Testing

1. Types of tests covered by this Contract shall include but not be limited to:

- Megger tests
- Instrument transformer tests
- Insulating oil tests
- Ground testing
- Power panel tests, AC and DC
- Low voltage automatic transfer switches
- Battery chargers
- Batteries
- Molded-case circuit breaker trip test
- High voltage testing
- Radio interference tests
- Lighting
- Hot-spot tests on buses, connectors, and fittings
- Miscellaneous tests on other equipment furnished and installed by the Contractor
- Other tests as required by the Owner.

2. All relay functions, control, status, alarm, and interlock functions, and metering functions shall be tested by this Contract, and meet NETA ATS requirements.
3. Record any malfunctions noted in the operations and when repairs are completed, repeat the tests and record on the connection drawings the date that the scheme functioned satisfactorily and who conducted the tests.
4. After completion of bench testing and after connection of all external wiring, conduct functional tests by forcing each relay contact to see the proper breaker is tripped and/or alarm picks up.
5. Testing of relays shall include the tests wherein current and voltage are applied to the disconnected leads to relaying at current and potential transformers as well as phase angle and current checks after relays are actually in service and carrying load current.
6. Instrument transformer tests including ratio tests and excitation current tests.
7. High current tests shall simulate actual load current and fault current operation of the substation electrical equipment.
8. Megger each high-voltage bus, PCB, transformer, switch, and CT, or other important item of equipment just before it is energized each time during construction.
9. Maintain correct phasing on all circuits and buses. Solar Substation buses and connections shall conform to the phasing of the POI. Make phasing tests on all circuits that can be energized from two or more sources to prevent paralleling of sources out of phase.
10. Immediately after initial energization, complete load tests and checks to include current checks on all applicable relays, meters, transducers, etc. Perform voltage checks on all applicable relays, meters, transducers, etc. Perform angle checks on all applicable relays, meters, transducers, etc.
11. Supplemental reactive power resources: Test capacitor banks and reactor banks (as applicable) for operability. Test in conjunction with the PPC to ensure proper power factor control is obtained.
12. Due to the critical nature of the substation and the use of high-current equipment and connections, the Contractor shall provide equipment, supervision and labor as required to perform infrared temperature inspections. Obtain infrared scanning service including equipment and an operator from a qualified source if the Contractor does not own infrared equipment. Survey all substation bus, conductors, and connections installed by this Contract and all major equipment installed by this Contract.
13. Infrared (IR) scanning of all electrical connection points including terminal points is required. Scans will be performed by an IR Technician Level 2 standard with equipment in service or operating at X% capacity or greater. A report will be submitted on all IR scans including pictures of all equipment for baseline measurements. Any problem or questionable areas must be documented. A questionable area will be defined as an area where temperature is 10 degrees

Celsius greater than its surrounding area. The Contractor shall correct any deficiencies in equipment or connections that resulted from improper installation.

14. Functional Testing: Project and equipment-specific functional testing protocols will be developed by Contractor to address functionality and safe operation of components and systems. The functional testing protocols shall include all substation interfaces and shall be detailed so as to address all facets of operation, failure modes, and recovery modes.

15. Interconnection authority testing: Documentation as required by interconnection authority (check lists and data forms) shall be submitted on time to meet project schedule for required testing of the substation at the completion of the project. Contractor shall conduct all testing as required by interconnection authority but at a minimum these shall include:

    - Primary Frequency Response (PFR)
    - Reactive Power
    - Automatic Voltage Regulation (AVR)

APPENDIX M3

ATTACHMENT 01

EXHIBIT 05

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

PV CAPACITY TEST

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 OVERVIEW

Capitalized terms not otherwise defined in this document shall have the meaning given such terms in the Agreement. The following is an overview of the procedures to be utilized in connection with the execution of performance tests of the PV Power Plant. The objective of the Capacity Test is to verify contract requirements and guarantees have been met. A PV Power Plant Capacity Test will be performed once the entire PV Power Plant is fully functional. The Contractor has the option of performing capacity tests on circuits prior to the contractual Capacity Test.

The tests are to be executed once Contractor has successfully completed all Functional Tests set forth in M3-01-04, Commissioning, however, the Capacity Test may be run concurrently with the Functional Test if approved by Owner. Contractor shall remediate the shortcomings and re-test until the guarantees are achieved.

On or before Substantial Completion of the PV Power Plant, Contractor shall commence the Capacity Test which may be witnessed by Owner or Owner's representative. In such case that Contractor fails to satisfy all requirements of the PV Power Plant Capacity Test on or before the Substantial Completion of the PV Power Plant, Contractor shall remediate the shortcomings during the Cure Period before commencing re-tests.

This Capacity Test is based on ASTM E2848 but incorporates considerations for bifacial modules. PRC is the actual power measured at the Reporting Conditions (RC). PMIN is the guaranteed power at RC. Pass/fail: PRC/PMIN *100 greater than or equal to 97% (depends on the calculation of test uncertainty). PRC is determined from filtered on-site data (5 min or 1 min), running multiple regression and calculating from resulting equation with its coefficients, at RC. PMIN is determined by running Pvsyst with site weather data (1 hr, averaged from site data) or if not available from other source such as Solar Anywhere, filtering, running regression, calculating at RC. RC is determined from site data (can also use modeled but prefer site data), finding Irradiation Irro mean +/- 20%, 40%/60% distr., above 400 W/m2, and averaging T_0 and W_0.

2.0 DEFINITIONS

Agreement

The Engineering, Procurement and Construction Agreement between Owner and Contractor.[fill in actual final document name/date here]

Circuit

Group of ISAs that make up a portion of the full capacity of the PV Power Plant. This is the total AC power associated with one circuit breaker of the Solar Substation. If there are two feeders connected to one circuit breaker this will still be considered one Circuit.

Guaranteed Capacity

This is the guarantee by the Contractor for the total Power Rating of the PV Power Plant. It shall be verified by the Capacity Test (see section 5 below) in which the guaranteed

Minimum Power Rating, $\mathbf{P_{MIN}}$, as calculated and predicted with the PV Simulation Model at the Reporting Conditions, is compared to the Power Rating, $\mathbf{P_{RC}}$, as measured by the Main Facility Meter at the Point of Interconnection. Guaranteed Capacity shall be calculated as 100% of the Facility Performance minus the Test Measurement Uncertainty. It shall be expressed as a percentage.

Minimum Facility Capacity

Shall be 95% with no correction for measurement uncertainty.

Minimum Power Rating (P_{MIN})

This shall mean the expected power output of the PV Power Plant at the Reporting Conditions, as computed by the procedure outlined in section 5 below.

Facility Performance

Shall mean the Power Rating divided by the Minimum Power Rating for the PV Power Plant at the time the Capacity Test is performed, expressed as a percentage.

PV Power Plant

The PV Power Plant (also referred to as the "Facility") will consist of XX MW_{AC} of PV generation equipment, including the PV Arrays, cable harnesses, combiner boxes, DC fuse boxes, inverters, transformers and switchgear (if required), as well as all associated structural elements and interconnecting cables that will allow the PV Power Plant to generate and output AC power to the Owner-supplied interconnection point.

Point Of Interconnect (POI)

This shall have the meaning set forth in the Agreement.

Power Rating (P_{RC})

This shall mean the actual power output of the PV Power Plant at the Reporting Conditions, per ASTM E2848-13. It shall be computed by the procedure outlined in section 5 below. Power measurements will be conducted within the range of power factor as required by the Project.

PV Simulation Model (Energy Model)

The PV Simulation Model shall be based on the most recent version of PVsyst at the time of limited notice to proceed. All of the program inputs shall be put forth by Contractor and M3-01-07 and reviewed and approved by Owner and Contractor at the time of contract execution with a corresponding Guaranteed Capacity. In the event the PV Power Plant is modified by mutual agreement between the Contractor and Owner, the program inputs may be modified to match the constructed PV Power Plant if agreed upon by Owner and Contractor.

Primary Measurement Device

An instrument which provides a measurement or reading that is used in calculating the PV Power Plant Power Rating.

Reporting Conditions

This shall be as defined as the reference irradiance (Irr_0), the reference temperature (T_0), and the reference wind speed (WS_0) as determined by the procedures outlined below and referred to in ASTM E2848-13.

Secondary Measurement Device

An instrument which provides a measurement or reading that is not used in calculating the output power but is used as check on primary measurements or for further analysis.

Supervisory Control and Data Acquisition (SCADA)

The hardware and software installed at the Project Site which is used to monitor and collect the weather and performance data from the PV Power Plant. This typically consists of programmable logic controllers, data loggers, software, and other network devices.

Test Measurement Uncertainty

Shall be calculated as described by ASTM E2848-13 (referred to as expanded uncertainty in ASTM E2848-13), but shall not exceed 3%.

Test Period

Shall mean the "data collection period" referred to in ASTM Standard E2848 and Test Period contained in this document below.

3.0 TEST MEASUREMENTS

All test measurement devices shall be fully defined for their make/model, accuracy, calibration and location. The following tables summarize these measurements that will be required for all of the tests:

Test Measurements (Minimum)

Measurement	Quantity	Type	Instrument Type	Range	Minimum Accuracy
Global Horizontal Irradiance	1 per Met Station	Secondary	Secondary Standard Thermopile Pyranometer mounted in the horizontal plane	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A
Plane of Array Irradiance	1 per Met Station	Primary	Secondary Standard Thermopile Pyranometer mounted within Array	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A
Rear Plane of Array Irradiance – for estimating bifacial gain	1 per Met Station	Primary	Secondary Standard Thermopile Pyranometer mounted within Array	0-1600 W/m2, 285 to 2800 nM	ISO 9060 Spectrally Flat Class A
Net Power Output (kW)	1	Primary	Owner's power meter(s) installed		+/- 0.2%

Measurement	Quantity	Type	Instrument Type	Range	Minimum Accuracy
			at the POI with calibrated CTs and PTs		
Net Power Output (kW)	1 per Inverter	Secondary	Inverter internal power meter		+/- 2%
Ambient Temperature	At each Met Station	Primary	Part of weather station	-50 – 60°C	+/- 0.3°C
Module Temperature	2 per Met Station	Secondary	Platinum RTD (resistance temperature detector) (.00385 TCR DIN B), on back surface of module	-10 - 140°C	+/-0.3°C
AC/DC Power, Volts and Amperage	1 per Inverter	Secondary	From inverter CTs and PTs connected to plant SCADA		+/- 2%
Meteorological Stations: Ambient Temp, Wind Speed and Direction, GHI, Rainfall, and others as required	1 per 50 MW, minimum 2	Primary	On-Site weather station		Per manufacturer
Module Soiling	1 per 50 MW, minimum 2	Primary	On-Site soiling stations		Per manufacturer

3.1 Instrument Calibration

All instruments used for primary measurements shall have current NIST-based or equivalent calibration certificates. All calibrations certificates shall be submitted for Owner Review prior to commencement of the applicable test.

3.2 Data Collection

Data shall be recorded by the SCADA system. The use of alternative means for data acquisition shall be used only with the prior written consent of Owner, which consent shall not be unreasonably withheld or delayed. Contractor shall provide sufficient means for Owner to access the test data during the Test Period. Should remote access to the SCADA system not be available Contractor shall provide daily test reports containing the 1-min interval data for the duration of the Test Period.

4.0 GENERAL TEST REQUIREMENTS

4.1 Scheduling

Contractor, in coordination with Owner Owner's Engineer, shall notify Owner in writing of proposed PV Capacity Test date not less than ten (10) Business Days prior to the proposed date for the Performance Test.

4.2 Pre-test Conditions

The Performance Tests may be performed only when the following conditions are met:

- Weather conditions as required to complete the Performance Tests, as addressed in this document and in the approved Performance Test Procedure.
- There is grid connectivity at each inverter such that the Performance Tests can be accomplished under load.
- Contractor has achieved Mechanical Completion.
- Contractor has completed Functional Test and hot commissioning and energization.

4.3 Pre-Test Meeting

Prior to each test, a pre-test meeting shall be conducted and recorded. The meeting shall review the applicable approved test procedure, instrumentation locations, calibration sheets and other relevant topics including safety requirements. Minutes of this meeting shall be recorded by Contractor and approved by all parties.

4.4 Test Duration and Data Frequency for Capacity Test

Testing duration and frequency shall be as follows:

CAPACITY TEST DATA COLLECTION	
Test Period	**The Test Period shall be a minimum of five (5) Days. The Test Period will continue until sufficient filtered measurement data has been obtained**
Data Sampling Interval	**1 minute**
Data Averaging Interval	**5 minute**

4.5 Adjustments

Any adjustments made during the tests to any portion of the PV Power Plant or test measurement devices shall be documented by Contractor and reviewed and approved by Owner prior to execution. Owner, and Owner's Engineer, shall be available during test in order to grant such approval, which will not be unreasonably withheld.

4.6 Test Reporting

Contractor shall submit a detailed test report, within five (5) Business Days of completion of successful test, to Owner consisting of the following:

1) Test procedures (as executed)
2) Instrument calibration sheets/certificates
3) Test data (manual and data acquisition) including table of averaged and filtered data
4) Test results uncertainty
5) Field notes
6) Calculations and results

4.7 Test Validation

Contractor shall validate the performance of the overall PV Power Plant through the following Capacity Test, which will be conducted by Contractor, in order to determine if the guarantees have been met:

5.0 CAPACITY TEST

5.1 General

The Capacity Test is used to determine the Facility Performance, by evaluating the Power Rating of the PV Power Plant compared to the expected Minimum Power Rating at the Reporting Conditions. The results of the Capacity Test are used to determine if Contractor has met the Guaranteed Capacity.

5.2 Data Collection - General

a) The pyranometers used to collect irradiance measurements shall be cleaned immediately prior to testing. Soiling will be accounted for by Contractor utilizing the average of the measurements from the on-site soiling stations, with data collected in accordance with the manufacturer’s recommendations.

b) Owner shall be responsible for:

   i) Routinely reviewing collected weather and operating data for the PV Power Plant following Substantial Completion.

   ii) Agreeing to the Test Period proposed by Contractor for which there are sufficient valid data to meet or exceed the data requirements necessary to perform the procedures as described below.

c) Contractor shall collect, filter, and average data until 120 valid data points are obtained.

d) For PV plants comprising bifacial modules, rear pyranometers shall be used to collect irradiance measurements from the underside of the module. Rear pyranometers shall follow the same above criteria for testing and shall be mounted in the middle of any given PV string on the underside of the torque tube for optimal and representative irradiance collection. Care shall be taken to assure that the ground conditions in the vicinity of the rear-facing pyranometers is as typical of the ground conditions under the solar arrays to the extent practicable.

5.3 Data Collection and Selection of Reporting Conditions (RC)

a) Data collected on site per the above shall be used to determine the Reporting Conditions, per the following procedure. If site measured data is not available for determining Reporting Conditions, the contractual historical weather data file for the period of the test may be used.

b) For the Plane-of-Array (POA) and Rear Plan-of-Array (RPOA for bifacial modules) irradiance measurements, the data recorded from multiple pyranometers will be averaged for each time interval.

   i) In the event that data from one of the pyranometers is excluded due to malfunction or sensor discrepancy, the data from the un-excluded pyranometers shall be averaged (in the case of malfunctions), or the data from all the pyranometers may be excluded (in the case of sensor discrepancy out of range of sensor accuracy).

   ii) In the event multiple ground coverage ratios (GCRs) exist on site, a meteorological station shall be provided in each differing GCR area.

c) The collected data set shall be filtered according to the following operations:

   i) The guidelines and calculations described in ASTM E2848-13 will be followed.

   ii) Any test data points in which the inverter is “clipping” shall also be excluded.

   iii) POA irradiance below 400 W/m^2 will be excluded.

d) After filtering, the resultant data set shall be used to determine the Reference Irradiance (Irr_0) for the Reporting Conditions.

i) In order to determine the Irr_0, the test data (or data from PV Simulation Model using the contractual historical weather data file) shall be sorted according to POA irradiance from highest to lowest and examined to determine the highest POA irradiance value for which there is a nearly equal distribution of valid data points in the range of the selected POA irradiance +/- 20%. This irradiance shall be considered Irr_0.

   ii) There shall be no more than a 40%/60% spread in the irradiance distribution, i.e., no more than 40% of irradiance data above Irr_0 and 60% of irradiance data below Irr_0, or vice versa.

   iii) All test data where the irradiance is outside of the range of Irr_0 plus or minus the irradiance band (Irr_0 ± 20%) shall be excluded. At the agreement of Contractor and Owner, the irradiance band may be increased (not to exceed Irr_0 ± 50%), in order to obtain a necessary and reasonable number of data points.

   iv) For bifacial modules, the same above criteria shall be used where POA irradiance shall be replaced with the variable Total Plane-of-Array (TPOA) Irradiance to represent the sum of the filtered POA and RPOA of the system outlined by the following Equation (Eq.1):

$$TPOA = POA + (RPOA^{*}\ \phi) \qquad \text{(Eq. 1)}$$

Where ϕ is the bifaciality factor of the module as provided in the module specification sheet. If the ϕ is available as tested by an independent nationally recognized testing laboratory then this value shall be used.

e) The Filtered Measurement Data shall be defined as the resulting data set of section d above, and it shall have a minimum of one hundred twenty (120) data points.

i) The one hundred twenty (120) or more data points are under the assumption of a five (5) minute averaged data interval.

ii) If the filtered data set does not contain enough data, then additional days (maximum 4 weeks) shall be added to the Test Period to collect enough valid data.

iii) A wider filter can be applied to irradiance band as mentioned above in section d (iii), if agreed upon by Owner and Contractor.

f) The average ambient temperature of the Filtered Measurement Data shall be calculated. This average ambient temperature shall be the reference (RC) temperature T_0.

g) The average wind speed of the Filtered Measurement Data shall be calculated. This average wind speed shall be the reference wind speed WS_0.

5.4 Minimum Power Rating (P_{MIN})

a) The PV Simulation Model, as derived from PVsyst simulations, shall be used to establish the Facility's expected output to be compared to the power output at the revenue meter as adjusted at the relevant conditions.

i) Owner and Contractor, upon execution of the Agreement, shall review and agree on all inputs to PVsyst for the creation of the PV Simulation Model, including (but not limited to): losses, weather data file, and component model files.

b) Each of the PV Simulation Model outputs shall include, as a minimum, the following columns in the respective output .csv files (or 8760 files) :

i) Date & Time (formatted with Month; Day; Hour in separate columns)

ii) POA Irradiance (GlobInc, W/m^2)

iii) RPOA Irradiance (GlobBak, W/m^2)

iv) Horizontal Irradiance (GlobHor, W/m^2)

v) Ambient Temperature (T Amb, °C)

vi) Wind Speed (WindVel, m/s)

vii) Near Shadings Beam Loss (ShdBLss, W/m^2)

viii) Inverter Loss Due to Low Voltage Maximum Power Point (MPP) Window (IL Vmin, kW)

ix) Inverter Loss Due to Power Limitation (i.e., “clipping” loss) (IL Pmax, kW)

x) Available Energy at Inverter Output (EOutInv, kW)

xi) Energy Injected into Grid (E Grid, kW)

c) For the purposes of this procedure, the Target Period shall be derived from historical or site-measured weather data. Using the contractual historical weather data is an option to simplify the procedure. The Target Period shall consist of a minimum of fourteen (14) days: the seven (7)-Day period prior to and after the Test start. The Target Period may be extended further than fourteen (14) Days upon agreement of Contractor and Owner.

d) The Minimum Power Rating (P_{MIN}) expected from the Plant at the Reporting Conditions shall be determined from the PV Simulation Model for the site in accordance with the following:

i) Run PV Simulation Model with the contractual historical weather file, or the measured site weather data from the collected Target Period. (PVsyst will receive 1- minute or 5-minute data but will convert it to one-hour data)

ii) Apply the following filters to the resulting Target Period data file:

a) Exclude any data points with beam shading values ShdBLss > 0.

b) Exclude any data points where the inverter is not in 'Peak Power Point Tracking' mode, as such term is defined in section 9.1.8 of ASTM E2848-13.

c) Exclude any data with irradiance values outside of the range established section (3)(d)(iii) above.

iii) After filtering, the resulting dataset shall have 50 one-hour data points, or more.

a) If less than 50 data points remain in the set, then the Test Period shall be shifted and a new Target Period shall be identified per to section (3)(e)(ii) above.

b) At Owner's discretion, the irradiance threshold may be expanded to a larger range as described in (3)(e)(iii) above.

iv) For the filtered Target Period dataset, a regression analysis shall be performed on the POA irradiance, ambient temperature, wind speed, and energy at the POI meter. The regression analysis shall be used to determine the modeled regression coefficients A, B, C and D in the following Equation 2 (Eq. 2):

$$E\ Grid = Irr_T * (A + B * Irr_T + C * TAmb + D * WindVel) \quad \text{(Eq. 2)}$$

For bifacial modules use Irr_T in the regression where Irr_T = GlobInc + (GlobBak * ϕ) for bifacial modules. Otherwise, Irr_T = GlobInc.

Where ϕ is the bifaciality factor of the module as provided in the module specification sheet. (above adjustment assumes bifacial modules in single portrait configuration)

v) The Minimum Power Rating (P_{MIN}) shall be calculated for the site by substituting in coefficients A, B, C and D and the appropriate Reporting Conditions (Irr_0, T_0 and WS_0) as shown in the following Equation 3 (Eq. 3):

$$PMIN = Irr_0 * (A + B * Irr_0 + C * T_0 + D * WS_0) \quad \text{(Eq. 3)}$$

For projects utilizing bifacial modules, use the Reference Irradiation, Irr0, from both sides of the module, i.e., the sum of the irradiation in the plane of array on the front side and back side as illustrated in Equation 1.

5.5 Power Rating (P_{RC})

a) The Filtered Measurement Data for the site identified in section (3)(e) above shall be used to calculate P_{RC} for the site.

b) Filtering of the test data and calculation of the P_{RC} shall be conducted according to section 9 ‘Calculation of Results’ of ASTM E2848-13. The equation used for the final calculation (equation 2 in ASTM E2848-13, modified for the terminology used in this test report) is:

$P_{RC} = Irr_0 * (a_1 + a_2 * Irr_0 + a_3 * T_0 + a_4 * WS_0)$

Where Irr_0, T_0, and WS_0, are the Reporting Conditions and the coefficients a_1, a_2, a_3, and a_4 are calculated from the measured, filtered data as described in ASMT E2848-13. The regression shall be based on the below for determining the actual coefficients from the equation using the measured site data,

Revenue meter power (for each time stamp) = TPOA * (a1 + a2 * TPOA + a3 * TAmb + a4 * WindVel)

Where TPOA (=POA+RPOA*ϕ for bifacial modules), TAmb, and WindVel are the measured values

c) The results of this section (P_{RC}) shall be reported in accordance with section 10 ‘Report’ of ASTM E2848-13.

5.6 Facility Performance

a) The Facility Performance shall be calculated as below and expressed as a percentage:

Facility Performance = $(P_{RC} / P_{min}) * 100$ - TMU

b) If the Facility Performance is greater than or equal to the Guaranteed Capacity (after deducting the Test Measurement Uncertainty), then Contractor has met the Guaranteed Capacity. If the PV Power Plant has so achieved the Guaranteed Capacity, then no further analysis is required.

c) If, however, the PV Power Plant did not so satisfy the Guaranteed Capacity, then Contractor shall follow the process outlined in the Agreement.

5.7 Test Reporting

a) Upon completion of the Capacity Test, Contractor shall submit a Capacity Test Report to the Owner consisting of the following and per the requirements set forth in M1-01-02 and table M1-01-02-01-Solar

i) Test procedures

ii) Instrument calibration sheets/certificates

iii) Test data (manual and data acquisition)

iv) Test Results uncertainty

v) Field notes

vi) Calculations and Results

APPENDIX M3

ATTACHMENT 01

EXHIBIT 06

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

PROJECT SCHEDULE

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 PROJECT SCHEDULE

Contractor is to provide a detailed Work Schedule (hard and native electronic copies) thirty days after the issuance of Full Notice To Proceed (FNTP). This Work Schedule, as subsequently accepted by Owner, shall become Attachment 1 to M3-01-06 of the EPC Agreement.

2.0 KEY DATES SCHEDULE

Key Date Schedule shall include major project milestones, including substantial completion of each Circuit. Milestones indicated in the Key Date Schedule will be used as a basis for milestone payments.

3.0 CRITICAL PATH SCHEDULE

The Critical Path Schedule shall identify Contractor's plan of execution for the installation, Commissioning and Performance Testing for the Work. The Critical Path Schedule shall be a time-scaled critical path method logic diagram schedule (resource loaded) of all design and equipment procurement for the Project and all material Work activities so that Substantial Completion occurs on the Substantial Completion Guaranteed Date. The Critical Path Schedule shall include allowance for normal delays and difficulties that may be encountered in work of this nature including weather and holidays, etc. The Critical Path Schedule, as a minimum, must show an orderly array of activities in support of all the dates established in the Key Date Schedule (refer to Instructions to Bidders), and shall be sufficiently detailed so that each of the following are included and will be readily apparent:

(a) The engineering and detailed design activities necessary to complete design, procurement and construction;

(b) Materials and equipment purchases and deliveries;

(c) Subcontractor interfaces and requirements;

(d) Construction, by Circuit and system;

(e) Dates for the completion of Key Date Items;

(f) Contractor and Subcontractor data cycles, and Owner's review cycles;

(g) Functional Tests, Commissioning and Capacity Testing;

(h) A schedule for completion of post-Substantial Completion Date items including as built drawings and specific Non-Critical Deficiencies listed on the Punchlist costing more than [$100,000] to complete.

4.0 SUBMITTAL

The Critical Path Schedule shall be delivered both in native electronic form and in hard copy, in both .pdf and Primavera P6 file formats. The Functional and Capacity Test schedules must be coded in such a way as to provide individual test progress and schedules in accordance with an agreed upon Commissioning Plan.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 07

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

ENERGY MODEL

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 OVERVIEW

A. Energy Model Overview

Using the Project Weather File, the PVSyst Parameters, and additional loss parameters, simulations will be run to model the expected energy output from the PV system at the revenue meter.

B. The general procedure is as follows:

1. Project Weather File shall be defined and agreed upon by both Owner and Contractor for preliminary models, see section 4.0. Upon project completion, weather file and system operational data shall be gathered and recorded by SCADA to update the model with site data.
2. The Project Weather File will be compiled and used to generate a file that will be loaded into PVSyst.
3. PVSyst will produce an output for the Project Weather File, which will then be loaded into the Energy Model File.
4. Calculate any losses not modeled in PVSyst.
5. Add up the contributions from all the Circuits.
6. Result is the expected net output of the PV power plant which will serve as the Energy Model.

Wherever [ ] appears in this document, it is a value to be proposed by Contractor.

2.0 ACCOMPANYING RESOURCES

A. Associated Software, Files, and References:

- **Software:**
  a. Most recent version of PVSyst.
  b. Microsoft Excel
- **Files:**
  a. Energy Model File
     i. [ ].xls
  b. Module Equipment Files for PVSyst
     i. [ ].PAN
  c. Inverter Equipment File for PVSyst
     i. [ ].OND
  d. Shading Profile File for PVSyst
     i. [ ].SHD

e. Project File, Variant Files by Array Type
   i. [ ].PRJ
   ii. [ ].VC2
   iii. [ ].VC3
f. PVSYST Output Reports by Array Type or Circuit
   i. [ ].pdf
   ii. [ ].pdf
   iii. [ ].xlsx
g. Energy prediction Report by Circuit with AC losses excluded
   i. [ ].xlsx

- **References**
   a. System design specifying module types, strings per inverter, inverters per Circuit.

3.0 DATA PREPARATION

A. Data Collection – Calibrated to actual Site data

Preliminary models to use Solar Anywhere TMY files as specified in section 4.0. Upon project completion, data points to be used in the Energy Model will be measured and recorded by the SCADA at one minute increments. SCADA recorded weather file to be submitted to Owner with updated energy model as specified in M1-01-02 and table M1-01-02-01-Solar. Measurement data recorded by the SCADA and used in running the Energy Model will include:

Measured Meteorological Data (inputs to PVSyst):

- GHI Pyranometer irradiance (W/m^2)
- Ambient temperature, T_{amb} (˚C)
- Wind speed (m/s)
- DHI (W/ m^2)
- Albedo (W/ m^2) (If bifacial modules used)

Discussion:

- GHI will be used to calculate POA in the model and ambient temperature and wind speed will be used to calculate module temperature. Though POA and T_{bom} are measured and could be input directly, the Energy Model is based on the POA/GHI transposition and T_{amb}/T_{bom} calculation and so the Energy Validation will be as well.

B. Data Preparation

- The necessary meteorological measurements will be averaged into time intervals consistent with the minimum input parameters required for analysis in PVSyst. Currently this time interval is one hour, but if a smaller time interval becomes available, this will become the default time interval. All data fed into and read from PVSyst should be in hour beginning format.
- The raw test data shall also be analyzed and reduced to eliminate data points that clearly exhibit a high degree of random error (such as errors caused by faulty instruments).
- Missing or obviously faulty data due to equipment error shall be discarded or be replaced in accordance with the Acceptance Test Procedures.
- All methods for data filtering and manipulation shall be agreed upon between Owner and Contractor. A report of all data filtering will be provided.

C. Load Weather File into PVSyst

The resulting Weather File created will be converted into a TMY3 or ASCII format compatible with the input requirements for PVSyst and will replace the existing weather bid file used for the base PVSyst energy model.

4.0 PVSYST SIMULATIONS

A. Determine PVSyst Simulations to Run

Although module types and string configurations can vary within a Circuit, each Circuit must be modeled by a single average configuration and single module degradation amount (one PVSyst .VC file per Circuit) Include 8760 data as Attachment B.

Contractor shall fill out and bracketed [ ] values.

B. PVSyst Parameters

1. Project Tab
    - Latitude = [ ] deg.
    - Longitude = [ ] deg.
    - Meteo Data File: Solar Anywhere, satellite data, SUNY model - TMY
    - Altitude = [ ] meters
    - Time zone = [ ]
    - Monthly Albedo = [These values assume a one-in-portrait tracker]

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]

Month	PVsyst Inputs
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]
October	[ ]
November	[ ]
December	[ ]

- Lower temperature for V_{max} Abs limit = [ ] degrees C
- Winter operating temperature for V_{mpp} Max design = [ ] degrees C
- Usual operating temperature under 1000 W/m = [ ] degrees C
- Summer operating temperature for V_{mpp} Min design = [ ] degrees C

2. Orientation Tab
   - Unlimited sheds
   - See attached input and assumptions for Tracker parameters
3. Horizon Tab
   - As applicable
4. Near Shadings Tab
   - As applicable
5. System Tab
   - Module .PAN file
   - Inverter .OND file
   - Nb of inverters. = [ ]
   - Modules per String = [ ]
   - Strings per Inverter = This varies by array type. See Attachment A Input and Assumptions System Definition section.
   - Detailed Losses section of System Tab
     i. Uc= 25.0 W/m^2k

ii. Uv= 1.2 W/m^{2}k / m/s

iii. Ohmic Losses = [ ]

1. 1.5% DC loss at STC
2. See AC circuit loss table below

Circuit	AC Circuit Losses: Inverter to Injection Point (@STC)
1	[ ]
2	[ ]
3	[ ]

Table 1: AC circuit losses per Circuit for *n* Circuits

(Note: Contractor to fill out table with actual values)

1. 0.10% iron loss, 0.90% resistive/inductive losses at STC. Add 0.10% iron loss and 0.40% resistive/inductive losses if including GSU transformer.

iv. Module Quality, LID, Mismatch

1. 1.5% for LID
2. [ ] Module Quality loss
3. 1.0% Mismatch loss at MPP

v. Soiling losses:

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]

October	[ ]
November	[ ]
December	[ ]

vi. Incidence angle effect: b0= see .pan file for table.

vii. Bifacial System:

1. Shed transparent fraction = 2%
2. Structure shading factor
   a. 15% for one-in-portrait
   b. 5% for two-in-portrait
3. Mismatch loss factor = 10%

6. Module Layout Tab
   - Not used
7. Hidden Parameters Menu
   - Not used
8. Preferences Menu
   - Physical Model = Perez

C. Additional Loss Parameters

Some losses cannot be calculated in PVSyst or not calculated to the specifications necessitated by the Contractor. These losses must be fully completed in Microsoft Excel with all the formulas, constants, and justification spelled out here.

D. Module Degradation Amount

To account for accumulated module degradation that has occurred for the PV Plant between the warranty start date of the Long Term Module Warranty to the end of the Life of the plant, annual, module degradation amount listed in the table below shall be applied to the Energy Model for predicting the energy output for each year.

	Module Degradation	Total
Years since Circuit Substantial Completion Start Date	Guaranteed Module Degradation Amount (GDA)	Total Module Power Output Loss Entered into PVSyst (LID + GDA)
0 < x < 1	[ ]	[ ]
1 < x < 2	[ ]	[ ]
2 < x < 3	[ ]	[ ]
3 < x < 4	[ ]	[ ]
4 < x < 5	[ ]	[ ]
5 < x < 6	[ ]	[ ]
6 < x < 7	[ ]	[ ]
7 < x < 8	[ ]	[ ]
8 < x < 9	[ ]	[ ]
9 < x < 10	[ ]	[ ]
10 < x < 11	[ ]	[ ]
11 < x < 12	[ ]	[ ]
12 < x < 13	[ ]	[ ]
13 < x < 14	[ ]	[ ]
14 < x < 15	[ ]	[ ]
15 < x < 16	[ ]	[ ]

	Module Degradation	Total
Years since Circuit Substantial Completion Start Date	Guaranteed Module Degradation Amount (GDA)	Total Module Power Output Loss Entered into PVSyst (LID + GDA)
16 < x < 17	[ ]	[ ]
17 < x < 18	[ ]	[ ]
18 < x < 19	[ ]	[ ]
19 < x < 20	[ ]	[ ]
20 < x < 21	[ ]	[ ]
21 < x < 22	[ ]	[ ]
22 < x < 23	[ ]	[ ]
23 < x < 24	[ ]	[ ]
24 < x < 25	[ ]	[ ]
25 < x < 26	[ ]	[ ]
26 < x < 27	[ ]	[ ]
27 < x < 28	[ ]	[ ]
28 < x < 29	[ ]	[ ]
29 < x < 30	[ ]	[ ]
30 < x < 31	[ ]	[ ]

Table 2: Monthly Module Degradation.

(Note: Contractor to fill out table with actual values)

5.0 COMPILE AND ADJUST SIMULATION RESULTS

Once the Weather File has been compiled and input into the PVSyst model, a simulation will be run and exported in .csv format. This data can then be input into the Annual Hourly Energy Output spreadsheet to calculate the combined plant output. The procedure for running the simulation and generating the reports includes the following steps:

1. In the Simulation Screen input a unique output file name for each run/circuit. (not to exceed the number of Circuits).
2. The output parameters will include at least the following variables:
    a. Horizontal global irradiation
    b. Global incident in coll. Plane
    c. Ambient Temperature
    d. Average Module temperature
    e. Wind velocity
    f. Effective energy at the output of the array
    g. Available Energy at Inverter Output
    h. Energy injected into grid
    i. Inverter efficiency (operating)
3. Run the simulation.
4. A .csv file will be created for this simulation and will be saved with the designated file name. The .csv file can be opened in MS Excel where the data can be parsed.Review the data for each case to verify the output calculated by PVSyst does not exceed the nameplate output of the inverter.

Copy and paste the output data into the appropriate column in the Energy Model File.

Energy Model File

There will be a single tab in the Excel file titled “Hourly Energy” that will include the energy production and subtract any additional losses (AC Losses, Aux Load, Availability, etc., if not already included in PVsyst). There will also be columns listing the metered energy production and the applicable project weather file (GHI, POA, wind speed and direction) for the corresponding time period. There will be an additional column listing the hourly energy shortfall.

6.0 FINAL ENERGY MODEL

If any changes occur to Contractor’s design (such as equipment selection) that would affect the energy model files that were used as the basis for the bid, these must be reviewed and approved by the Owner prior to modification or inclusion in Contract. If approved, updated energy model files will be created and submitted as a revision to M3-01-07. All parameters to be submitted in attachment A, with explanation for any parameters differing from the givens in this document.

Attachment A

PVSyst Assumptions

Software	Version	Comment
PVsyst		
Microsoft Excel		Provide Native Post Processing File, if applicable

PVsyst File	Type	File Name
Project	.PRJ	
Variant(s)		
Meteorological	.MET	
Site	.SIT	
Module	.PAN	
	.PAN	
	.PAN	
Inverter	.OND	
Shade	.SHD	
Horizon	.HOR	
PVsyst Report	.PDF	
8760	.xlsx	

PVsyst Parameter	Value	Comment
Transposition Model		
MET File Source (e.g., SolarAnywhere)		
Latitude		
Longitude		
Altitude (m)		

PVsyst Parameter	Value	Comment
Module/Tracker Orientation (e.g., 1-Portrait)		
Axis Tilt		
Axis Azimuth		
Minimum / Maximum Phi		
Backtracking (On/Off)		
Ground Coverage Ratio (GCR)		
Number of Sheds		
Pitch (m)		
Tracker/Collector Width (m)		
Inactive Band, Left (m)		
Inactive Band, Right (m)		
Axis Height Above Ground (m)		
Module Bifaciality Factor (%)		
Rear Shading Factor (%)		
Module Transparency (%)		
Rear Mismatch Loss (%)		
Monthly Albedo Profile	Jan =	
	Feb =	
	Mar =	
	Apr =	
	May =	
	June =	
	July =	
	Aug =	
	Sep =	
	Oct =	

PVsyst Parameter	Value	Comment
	Nov =	
	Dec =	
Module Manufacturer		
Module Model		
Total Number of PV Modules		
Number of PV Modules (Bin Class 1)		
Bin Class 1 (W)		
Number of PV Modules (Bin Class 2)		
Bin Class 2 (W)		
Number of PV Modules (Bin Class 3)		
Bin Class 3 (W)		
Number of Modules per String		
Number of Strings in Parallel		
Inverter Manufacturer		
Inverter Model		
Number of Inverters		
Monthly Soiling Profile	Jan =	
	Feb =	
	Mar =	
	Apr =	
	May =	
	June =	
	July =	
	Aug =	
	Sep =	
	Oct =	

PVsyst Parameter	Value	Comment
	Nov =	
	Dec =	
Thermal Loss Factor - Constant		
Thermal Loss Factor - Wind		
DC Wiring Loss at STC (%)		
Module Quality Loss (%)		
Module Mismatch Loss (%)		
String Mismatch Loss (%)		
LID - Light Induced Degradation (%)		
AC Circuit Loss at STC (%)		
External Transformer Iron Loss (%)		
External Transformer Resistive/Inductive Losses (%)		
Auxiliary Loss		
Grid Power Limit (MW)		
Power Factor		
Facility Availability (%)		

APPENDIX M3

ATTACHMENT 01

EXHIBIT 08

SOLAR PHOTOVOLTAIC PLAN SPECIFICATION

APPROVED SUPPLIERS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

M3-01-08 lists the acceptable suppliers/vendors that the Contractor may utilize on the Project.

2.0 ACCEPTABLE SUPPLIERS

Contractor shall provide equipment from the following vendors:

2.1 PV Module

1. Canadian Solar
2. First Solar
3. GCL
4. Hanwha Q-CELLS
5. JA Solar
6. Jinko Solar
7. LONGi Solar
8. Trina Solar
9. Yingli

2.2 Tracker

1. Array Technologies (ATI)
2. NEXTracker

2.3 DC Combiner Box and/or Load Break Disconnect

1. Bentek
2. Shoals
3. Solar BOS
4. WTEC

2.4 Inverter

1. Power Electronics
2. SMA
3. Sungrow
4. TMEIC

2.5 Medium Voltage Transformer

All MV transformers are subject to Owner review and approval prior to procurement. With proposed transformer manufacturer Owner requires 1) indication of location of proposed manufacturing facility; 2) Contractor's involvement in quality assurance/ quality control of respective facility; 3) resolution of recent field failures as applicable.

1. ABB
2. Cooper Power Systems
3. WEG

2.6 Substation Main Power Transformer

1. Delta Star
2. Fortune
3. HICO
4. Hitachi ABB
5. Hyundai
6. ILJIN
7. WEG
8. Siemens

2.7 SCADA System

1. AlsoEnergy
2. Green Power Monitor (GPM)
3. MiScout (Ovation Green)
4. NorCal Controls
5. Trimark

APPENDIX M3

ATTACHMENT 01

EXHIBIT 09

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

FORM OF MONTHLY PROGRESS REPORT

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

A. DESCRIPTION

Cover sheet to show the project name, the time span covered and the date of the report.

2.0 INDEX

1. PROJECT TEAM

List personnel and functions of team comprising of:

- Contractor
- Subcontractors
- Major suppliers

2. EXECUTIVE SUMMARY

Provide high level summary delineating project status, milestones and issues. Limit to 1 page or less.

3. HEALTH SAFETY AND ENVIRONMENTAL

Details may be represented using charts, graphs or narratives.

- Total man-hours worked, total recordables and total Lost Time Accidents (LTAs) and Lost Time Injuries (LTIs)
- Total man-hours since last LTA or LTI
- Total work force on site
- Reportable Incidents since last report
- Medical/incident details
- Details of any LTA
- Near-miss details
- Actions taken to mitigate any future near-miss, recordable or LTA
- Environmental compliance update (if applicable)

4. PROJECT EXECUTION STATUS

Describe for each category/bullet items:

- Major accomplishments/activities this month
- Goals and milestones for next month
- Key milestones – tabular form showing Plan, Forecast and Actual EPC progress

a. **<u>Project Schedule</u>**

- Include % complete against time (Engineering Procurement, Construction, Overall)
- Progress curves for planned versus actual (Engineering Procurement, Construction, Overall)
- Overall project status

b. **Permitting Progress**

Detail any permitting progress and issues that have continued into construction phase, as applicable: site access, encroachments, building permits, etc.

c. **Construction Report**

List each area of major activity and its progress and any discussion points, key milestones, and goals for next month. This should include:

- Interconnection and substation work
- PV field
- On site structures

d. **Procurement Report**

- Procurement Progress
- Manufacturing Status
- Factory Inspection and Testing
- Shipping, Expediting, and Delivery

Procurement Status Report – Include a table of major equipment to be procured by CONTRACTOR (including its subcontractors).

EQUIPMENT DESCRIPTION	MANUFACTURER	CONTRACTED DELIVERY DATE	ACTUAL DELIVERY DATE

e. **Start-up and Commissioning**

- List major systems commissioned and turned over to owner during the reporting period
- List major systems to be commissioned and turned over to owner during the next month

f. **Quality Assurance and Control**

Report on QAQC status of project. List which areas have been inspected and the % of NCRs or some other acceptable tracking method to indicate overall quality of each installation.

5. KEY ISSUES AND REMEDIES (AREAS OF CONCERN)

- Late activities which impact the Project Schedule and mitigation plan
- Interface data problems
- Deviations of Work from Quality Assurance/Quality Control Plan

APPENDIX M3

ATTACHMENT 01

EXHIBIT 10

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION
CONTRACTOR'S QUALITY ASSURANCE PROGRAM

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL REQUIREMENTS

The following sections of M3-01-10 describe the minimum requirements of Contractor's Quality Plan for this Agreement. The inspections, tests and related actions specified in this section and elsewhere in the Agreement are not intended to limit Contractor's own quality assurance/control procedures that facilitate overall compliance with requirements of the Agreement. Contractor may use its own Quality Assurance/Quality Control (QA/QC) procedures provided such procedures have been reviewed and commented on by Owner prior to start of Work. Contractor's procedures must address, as a minimum, the information contained here in M3-01-10 and referenced documents.

2.0 QUALITY CONTROL PROGRAM

A. Basic objectives of Contractor's Quality Plan shall be as follows:

- To ensure that all work adheres strictly to all requirements of the Agreement and governing agencies where the work is being performed.
- To maintain QC procedures to ensure that tasks performed will comply with the Agreement.
- To prevent deficiencies through pre-construction quality control coordination.
- To detect and correct deficiencies in a timely manner.
- To provide an auditable record of all tests, inspections, procedures, non-compliances and corrections, and any other pertinent data as required.
- Verify compliance with Contractor's QC procedures, including those QC procedures of subcontractors and suppliers.
- To provide a basis of measuring Contractor's performance for input to Owner's Contractor resource database.

Contractor may select either an outside "agency" or in-house personnel to administer Contractor's QC system. In either case, the Contractor's on-site quality control staff shall only be responsible for quality control. The QC supervisor (or person designated as the QC representative) shall report directly to Contractor's Site Manager. Contractor's QC staff shall not be involved in the management and/or control of the construction process. Contractor's QC staff members shall interface with Owner, its inspectors and consultants, as required.

3.0 TESTING CRITERIA

Contractor shall perform all testing and inspection of all Work (including materials) both on and off site as required by the Agreement. This shall include pre-functional, and functional tests. Test passing criteria shall be clearly spelled out on work instructions and check sheets.

4.0 RESPONSIBILITIES OF THE CONTRACTOR’S QC SUPERVISOR

Responsibilities and duties of the Contractor’s QC supervisor are:

- To communicate these minimum QC requirements to any suppliers and/or contractors.
- To have the authority to stop Work for cause, reject work, order work removed, initiate remedial work, propose solutions, and reject material not in compliance with the Agreement.
- Is present on-site and shall designate alternate individual(s) to assume responsibilities in the temporary absence of the QC supervisor. Designated alternate individual(s) must be trained and experienced in the Work and be qualified to inspect the Work.
- Be completely familiar with the Agreement Scope of Work and Drawings.
- Establish and implement QC programs for Contractor and with its various subcontractors and monitor their conformance.
- Inspect existing conditions prior to the start of new work segments.
- Conduct a pre-construction quality control meeting with Contractor’s responsible field and office representatives prior to the start of each major item of work required by the Agreement.
- Perform in-process and -follow-up- inspections on each of the work segments to ensure compliance with the Agreement. Upon request, accompany Owner on such inspections.
- Coordinate required test, inspections, and demonstrations with Owner or any other authority having jurisdiction.
- Inspect Contractor purchased materials and equipment arriving at the Jobsite to ensure conformance to the requirements of the Agreement. Prepare and submit documentation as required by the Agreement.
- Inspect material to ensure conformance to the requirements of the Agreement.
- Identify, report and reject defective work not in conformance with the Agreement. Monitor the repair or reconstruction of rejected work and document corrective action. Confirm repaired work meets QC requirements.
- If necessary, retain specialists or sub-contractors for inspection of Work in areas where additional technical knowledge is required. Submit qualifications of sub-contractors and specialists to Owner for approval.
- Work closely with Owner to ensure optimum quality control. Attend meetings as required by Owner.

5.0 SUBMITTALS

- A letter signed by a responsible officer of Contractor outlining the authority of the QC supervisor to include, among other things, the authority as described herein.
- Contractor shall submit its quality plan manual for review, comments, and approval prior to beginning any Work.
- Contractor shall submit an Inspection and Test Plan (ITP) for review, comments, and approval prior to beginning any Work.
- The ITP shall identify all items that are to be inspected and tested, the frequency of inspection and testing, vehicle that will be used to document the inspection, and who will witness the inspections. The ITP shall identify witness, review, and hold points.
- It shall be the responsibility of Contractor to submit all of the above documents for any and all subcontractors under their direction prior to beginning work.
- Contractor shall perform random quality audits on all disciplines and subcontractors to verify compliance of the quality program.

Contractor shall submit reports detailing the results of each test and describing each inspection. Submit separate reports for each test and inspection procedure immediately upon completion of each procedure and test.

6.0 GENERAL QC REQUIREMENTS

Inspection and test reports, as a minimum, shall include:

- Date issued
- Date of inspection or test
- Record of test conditions relevant to test
- Project title and number
- Testing agency name and address
- Name and signature of the inspector/tester
- Identification of the product (including serial number) and applicable specification section
- Type of inspection or test
- Pass/fail criteria

The results as related to requirements

7.0 INSPECTION, MEASURING, AND TEST EQUIPMENT

Contractor shall provide and maintain all measuring and testing devices. Laboratory devices shall be calibrated as required by the Agreement specifications. The standards against which the measurement equipment is periodically calibrated shall have their accuracy verified directly by, or through a precise comparison with standards traceable to the National Institute of Standards and Technology or to a recognized national standard. Refer to traceability requirements and standards in other attachments.

8.0 EXECUTION

Contractor's inspection shall be adequate to cover all operations, including both on-site and off-site and will be keyed to the proposed sequence of the Work and shall include as a minimum at least four (4) phases of inspection for all definable items or segments of the Work, as follows:

- Preparatory Inspection: To be performed prior to beginning any work on any definable segment of the Work and shall include:
  - A review of Agreement requirements
  - Verification that all materials and/or equipment have been tested, submitted, and accepted
  - Verification that provisions have been made to provide required control testing
  - Examination of the work area to ascertain that all preliminary work has been completed
  - A physical examination of materials and equipment to assure that they conform to accepted shop drawings or submittal data and that all necessary material and/or equipment are available

As a part of this preparatory work, Contractor's organization will review and verify that all documents, including but not limited to, shop drawings, submittal data, method of quality control, product data sheets, test reports, affidavits, certification and manufacturer's instructions have been submitted and accepted by Owner as required herein. Each submittal to Owner shall bear the date and the signature of the Contractor's quality control manager (or authorized designee) indicating that he has reviewed the submittal and certified it to be in compliance with the Agreement Drawings or showing the required changes.

- Initial Inspection: To be performed as soon as a representative segment of the particular item of work has been accomplished and to include examination of the quality of workmanship and a review of control testing for compliance with Agreement requirements, exclusion of defective or damaged materials, omissions, and dimensional requirements.
- Follow-up Inspection: To be performed daily or as frequently as necessary to ensure continuing compliance with the Agreement requirements, including control testing, until completion.

- Final Inspection: To be conducted immediately prior to Mechanical Completion. Contractor shall inspect the work for quality, workmanship and completeness prior to notification that the item or segment of the Work has been completed.
- Specific tests and inspection procedures (including documentation) for each material or item of work are specified in the Agreement Scope of Work and the Drawings.
- Contractor's testing laboratory shall perform tests according to method(s) of testing specified in the Agreement.
- Contractor shall ensure that Owner is given sufficient time to witness tests and re-inspect work performed by Contractor.
- Contractor shall ensure that all work that does not comply with the requirements and references specified in the Agreement Scope of Work is identified and correctly dispositioned. All work installed or fabricated by the Contractor shall be inspected (i.e., punched) and resolved prior to notifying Owner the Work is ready for Mechanical Completion. Contractor shall record all punch list items (i.e., deficiencies) on a punch list record. Material or equipment that is supplied by Owner and is found by Contractor to have deficiencies is to be immediately identified to Owner for corrective action.
- Contractor shall package and prepare all inspection and testing documentation for turnover at the completion of construction. Turnover packages are to be developed by system as determined by Owner. Each system file will contain all field inspection and testing records for the components of the system. Unless otherwise specified, Contractor shall submit two (2) clean, legible copies of all turnover packages to Owner at the completion of construction. Refer to M1-01-02 and table M1-01-02-01-Solar for submittal requirements.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 11

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION

OWNER TRAINING

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1.0 GENERAL

Contractor shall conduct site-specific training for Owner-assigned administrative, operations, technical, and maintenance personnel. The course shall be conducted during a standard 8-hour day. Classroom training will be augmented by field reinforcement and SCADA HMI viewing of the instruction topics. All students shall be taught in a one or two day class session, as required. Each training session shall be conducted in an air-conditioned classroom with the appropriate visual aids. A conference call in and online web instruction capability shall be provided. The training program will cover all related aspects of knowledge required by the individual disciplines to allow them to competently operate, troubleshoot, and maintain all plant processes and utility systems.

Beyond this classroom based training, a minimum of 12 hours of on-the-job training of operation personnel will be conducted during start-up and commissioning activities, see 2.1.7 below.

Owner shall advise one month in advance the number of personnel attending training. A training sign-up sheet shall document Owner's personnel attendance and Contractor's instructor(s). Contractor shall submit the proposed Training Schedule, Training Course Outline and Training Manual for Owner's review prior to the training, refer to M1-01-02 and table M1-01-02-01-Solar.

Owner shall ensure that all Operating Personnel attendees (i) are adequately pre-trained in ALL safety aspects of an industrial electrical generation facility as required by Governmental Authorities and Applicable Law and (ii) shall arrive at the classroom with all appropriate personal protective equipment required for touring the PV Power Plant. Contractor shall provide site specific safety training to these personnel.

In addition to the requirements set forth herein, the training shall meet the O&M service provider's requirements.

2.0 SITE-SPECIFIC TRAINING

This Program will encompass on-site training.

2.1 Contractor Responsibility

Contractor shall be responsible for:

2.1.1 Provide training facilities which present an environment conducive to learning (heating, lighting, low noise level and air conditioned and be furnished with an LCD projector or equivalent screen, white boards and markers and podium). Each student's desk (table) shall have enough working space for training manuals and the associated C size drawings.

2.1.2 Preparation of all classroom and training materials.

2.1.3 Scheduling and coordination of all classroom-training courses.

2.1.4 Provision of instructions, lesson plans, review, and on-the-job training of the students.

2.1.5 Coordination of the training schedule with Owner to allow Owner to conduct its own employee training.

2.1.6 Completion of training program scheduled close enough to the hands-on operating phase so that the material will remain fresh in the minds of the operating personnel.

2.1.7 On-the-job training throughout the start-up and commissioning period. During this time, Contractor's personnel, as well as representatives from the equipment representatives, shall be available to advise, support, and coach the operating staff.

2.2 Types of Training

This Program will be based on the Plant Operating and Maintenance Manuals to be prepared by Contractor and equipment manuals to be furnished by equipment providers. Training sessions will be grouped into logically organized modules. A trainer experienced in the specific subject matter will present each of the training modules. These modules will include lesson plans, system descriptions, and power point presentations for the systems. Each trainee will be provided with a copy of the classroom materials and other training documentation. Larger drawings of the solar power plant will be displayed for orientation and discussion.

All sessions shall be presented in an informal lecture style with each student having their own set of training material. Each student shall be encouraged to ask questions and to participate in group discussions. This shall be stated in the course objectives and expectations.

2.2.1 Two types of training shall be provided:

- PV System, Substation, and SCADA System, performed by Contractor's Training Staff.
- Vendor specific training by the appropriate equipment supplier or his duly authorized factory representative.

Training will consist of classroom instruction, discussions, site walk downs, and demonstration of ability to properly operate the facility. Contractor's training instructors will discuss the overall photovoltaic power plant, while representatives from the equipment manufacturers will address their scope of work.

2.3 Training Topics

2.3.1 PV Systems

During this section, Contractor will describe the process and discuss the principles of operation for the photovoltaic power plant.

Contractor shall provide experienced instructors to conduct its training program, which shall consist of classroom sessions bolstered by system walk downs and examinations. The course curriculum shall include the PV system design. The following outline of topics shall typically be covered but not limited to:

A. Introduction

B. PV Systems

C. Substation

D. Commissioning and Startup

E. SCADA Systems

F. Meteorological (MET) Stations

G. Security Systems

2.4 Lesson Format

Each session shall typically include the following information:

- Lesson Objectives
- Design Basis and List of Resources
- System Overview with Drawings
- Component Description with Supporting Documentation (figures, tables, graphs, etc.)
- Demonstration of ability to properly operate the facility

2.5 Lesson Content

2.5.1 Lesson Objectives

The major information the student is expected to learn and retain from the lesson shall be presented. Referenced materials utilized in the training session shall be displayed. Listed references shall include page numbers in manuals, diagram and/or drawing numbers, and appropriate procedure of section numbers.

2.5.2 Design Basis and List of References

The design basis and reference documents shall be presented. The student is expected to learn and retain this information from the lesson.

2.5.3 System Overview with Drawings

This section shall include a brief description of the intended use of the system.

2.5.4 Component Description with Supporting Documentation

This section shall include information on the major components in the system. Tables, figures, drawings and design details shall also be provided.

2.5.5 Principles of Operation, Including Start-up and Shutdown Procedures

The various operational modes of the system and documents shall be presented, including:

- Operating Philosophy
- Start-up
- Normal Operation
- Normal and Emergency Shutdown
- Understanding and responding to alarms
- Recognizing and Handling Abnormal Operating Conditions (Troubleshooting)

Trained Owner’s personnel will participate in the commissioning and start-up of Owner’s facility. Therefore, Contractor’s training shall emphasize safety practices and precautions throughout the entire program with the associated “do’s and don’ts”.

2.5.6 **Walk-downs**

Walk-downs shall be conducted to familiarize the students with the physical location and appearance of equipment and to clarify equipment features, controls, and displays, as well as site features such as drainage, roads, access, and security.

APPENDIX M3

ATTACHMENT 01

EXHIBIT 12

SOLAR PHOTOVOLTAIC PLANT SPECIFICTION

PV MODULE WARRANTY REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

1. OVERVIEW

Contractor shall supply, through the PV Module Supplier, a PV Module Warranty that is applicable to utility scale solar projects. This will include the following main features:

1. A linear module Power Output Warranty that is for the life of the project 25 years, providing no less than 82% power output at STC at the final year of the Design Life (year 30 preferably), and no more than 2.5% in the first year. See Power Output Schedule below.
2. A 12 year minimum product warranty.
3. Provisions for on-site testing methodology to verify defective products.
4. Provisions for sharing in-and-out costs. OWNER prefers a warranty which will provide for labor to remove and re-install product, and shipping, at no cost to OWNER.
5. Commitments (guarantees) to maximum timeframes for testing, removal, shipment, and reinstallation of defective or deficient product.
6. 60 day notice prior to shipping if module power output mix is different than agreed-upon values.

2. LIMITED WARRANTY

The following main elements shall be addressed in the PV Module Warranty:

1. Warranted Products.
   a) Photovoltaic modules including factory assembled junction box and cables and connectors, and
   b) Mounting products including factory assembled basic hardware, if any,
2. Warranty Descriptions and Durations
   a) Product Warranty
   b) Power Output Warranty

To include warranted degradation amount for each successive year:

Power Output Schedule at STC (values included as an example)

Year	If the module(s) has a power output less than the percentage below multiplied by the STC power nameplate rating on the back of the applicable module, then such Product shall be deemed to be in breach of the Power Output Warranty	% Degradation
1 (i.e. the first 365 days beginning on the Warranty Start Date, expiring the day before the first anniversary of the Warranty Start Date of the applicable Product)	97.50%	2.50%
2 (i.e. the second 365 days of such period until the day before the second anniversary of the Warranty Start Date of the applicable Product, etc.)	97.00%	0.50%
3	96.50%	0.50%
4	96.00%	0.50%
5	95.50%	0.50%
6	95.00%	0.50%
7	94.50%	0.50%
8	94.00%	0.50%
9	93.50%	0.50%
10	93.00%	0.50%
11	92.50%	0.50%
12	92.00%	0.50%
13	91.50%	0.50%
14	91.00%	0.50%
15	90.50%	0.50%
16	90.00%	0.50%
17	89.50%	0.50%

Year	If the module(s) has a power output less than the percentage below multiplied by the STC power nameplate rating on the back of the applicable module, then such Product shall be deemed to be in breach of the Power Output Warranty	% Degradation
18	89.00%	0.50%
19	88.00%	0.50%
20	87.50%	0.50%
21	87.00%	0.50%
22	86.50%	0.50%
23	86.00%	0.50%
24	85.50%	0.50%
25	85.00%	0.50%
26	84.50%	0.50%
27	84.00%	0.50%
28	83.50%	0.50%
29	83.00%	0.50%
30	82.50%	0.50%

3. Warranty Start Date
4. Exclusions and Limitations
5. Repair, Replacement or Refund Remedy
6. Rights and Remedies against Third Parties
7. Claims Procedure, Notice Periods, Dispute Resolution, Testing and Verification Procedures

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

Table of Contents

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.

<table>
<tr><td>60% Design</td><td>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.</td></tr>
</table>

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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, PV Module, 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 PCS/Inverter skid 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	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	Protection settings signoff	Written endorsement by the interconnection provider in respect of all protection settings of the Project		X			Prior to Plant energization	
Certification	PV Mounting structure 3rd party certificate	3rd Party Civil/Structural Engineer’s Certificate confirming the suitability of the PV Array Mounting Structure and all Civil Works, that they are in accordance with the As-built drawings and documentations and as required under the Applicable Laws, Regulations and Standards in respect of the entire Solar Farm and site building electrical works.			X			

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	
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			
Design	Electrical collector system	30% Design including the following:		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			X			

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
		• 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.						
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 • Hydraulic calculations • Room integrity test results for clean agent suppression systems • Detailed control panel drawings • Detailed communication drawings		X		X	3 months after Agreement execution	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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		
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	PV Array design drawings	30% Design: Includes the general arrangement drawings of the following: • PV Array, including Sub-Array(s), Strings and Modules • Inverter Blocks • PV String Combiner Boxes and PV Sub-Array Combiner Boxes • PCS • MV/HV Substations • Permanent and temporary buildings		X			3 months after Agreement execution	
Design	PV Array design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	PV Array design drawings	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	PV Array design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Design	PV Array design drawings	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	Substation	30% Design including the following (as applicable): • Substation general arrangement drawing • Main power transformer(s) • Manufacturer specifications for all reactive power compensation equipment (if applicable) and associated transformers • Protection equipment and switchgear specifications (including MV/HV substation, 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 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 • 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.		X		X		
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		

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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 • 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		X		X		
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			X			

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Fiber optic network • Interfacing • Power supply – SCADA distribution board SLD						
Design	Site layout/plans	Proposed Preliminary Layout including (as applicable): • PV array sections • 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	
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	Solar control drawings and documentation	30% Design: AC and DC Single line diagram, 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 Solar Project • Control system block diagram of the Solar Project • Solar Project earthing drawings		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Solar Project MV/HV system interface drawings, showing MV switchgear and HV/MV Transformer • GA drawings and schematics for Solar Project located MV/HV switchgear (if applicable), including configuration, placement, connections, civil works and/or mounting arrangements, cable terminations, and • Vendor data sheets for main electrical components in the Solar Project, including generator, main circuit breaker and converter/inverter (if present)						
Design	Solar control drawings and documentation	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Solar control drawings and documentation	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	Solar control drawings and documentation	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Solar control drawings and documentation	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	Solar electrical BOS specfications and design drawings	30% Design: Includes specifications and design drawings of all elements of the electrical system including, but not limited to the following: • Inverter Stations, including overall GA drawings and connection diagram, in addition to individual equipment specifications and compliance certification • (if applicable) Switchgear Stations, including overall GA drawings and connection diagram, in addition to individual equipment specifications and compliance certification. • Transformer specifications, including kVA rating, nominal voltage rating, tap changer configuration, 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. Design drawings, including enclosure, fittings, locations and bund details (and oil/water separator specification if applicable). Transformer type test certificate and a fitness for purpose statement (considering Environmental Conditions, corrosion, cyclic loading, peak voltages and fire risk). • Cable specifications and schedules for all MV, LV, earthing and fibre-optic cabling in the Works. Cable sizing. • Full technical specifications for all termination kits, jointing kits, lugs and connectors to be used in the primary power circuits and in the earth network • Protection equipment and switchgear specifications, including insulating medium, description of interlocking and protection, thermal, fault and insulation ratings, IP level, manufacturer and standards compliance, relevant type test certificates • Auxiliary power systems and associated equipment specifications, including battery and UPS capacities/back-up time • Revenue and power quality meter specifications • In-line cable jointing kits		X		X	3 months after Agreement execution	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Design	Solar electrical BOS specfications and design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Solar electrical BOS specfications and design drawings	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	Solar electrical BOS specfications and design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Solar electrical BOS specfications and design drawings	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	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	System Descriptions	IFC Design: Prepare system descriptions indicating equipment data, operating characteristics, design basis, functions, and other process information for: • PV Modules and DC wiring systems • Trackers • Inverter Skid Assemblies • AC Collection System •SCADA System • Substation		X		X	3 months after Agreement execution	
Design	Interconnection 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 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		X		X		

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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 • Pole erection • Conductor, and • OPGW stringing, earthing, jointing and terminations						
Design	Interconnection 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 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 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			
File	PVsyst model	The Contractor will provide their PVsyst model file (including all supporting component, horizon and other necessary files) to support their energy production figure.	X				Agreement close	
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 • 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			X		30 business days prior to commissioning activities	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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 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: • Building • 1200c (NPDES and Sediment and Erosion control) • Removal/fill • Septic • WPCF (Wastewater)		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. • Details of the equipment to be used • Any deviations • The methodology for dealing with those deviations • Details of the site calibration procedure		X		X	6 months after Agreement execution	
Plan	Civil works, concrete procedure	A procedure for on-Site concrete batching, including as a minimum: • Source of materials		X		X	2 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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.						
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 or 1 week prior to lift	
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	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 identifying long lead time equipment • Material and equipment deliveries • Construction activities • Tie-ins to existing plant systems • Equipment factory tests • Interfaces with Owner and other external interfaces • Major milestones • Milestone payments, if applicable • Startup and commissioning activities • Testing activities		X		X	8 weeks after NTP and updated monthly	
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	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Plan	Solar energy performance test plan	Plan shall include, but not limited to: • Test procedure • Project Model (PVsyst files and loss assumptions) • Project summary • Interested parties (stakeholder) details • Start and end test dates • All sensors and transducers used • SCADA channels and calibration factors • Quality concerns • Time stamp convention and data logger averaging			X	X	45 business days prior to first day of measurement period	
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	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	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	Bankability report	Including as applicable and available: • PV Modules • Solar trackers • Inverters	X				Agreement close	
Report	Civil work geotechnical investigation report	Geotechnical investigation of HV/MV substation, access roads, hardstands, underground cabling, Met Mast foundation/footing sites.		X		X	2 months after Agreement execution	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
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: • Ampacity and Loss Study • Auxiliary power study • Coordination study • Arc flash hazard study • Insulation coordination • GSU transformer sizing • DC/UPS sizing • Grounding Study • Harmonics study • Load Flow and Voltage Compensation Study • Relay Coordination Study • Short Circuit Study • Subsynchronous resonance study (if applicable) • Transient Over Voltage Study • Field effect study		X		X	As available during design	
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	Energy generation summary	Report summarising loss parameters and energy estimates for the Solar Project	X				Agreement close	
Report	Equipment list	IFC Design: Prepare electrical, instrument, and mechanical equipment lists with summary descriptions, vendors, and pertinent data.		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		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Potential failure modes and historical/expected mean time between failures • Severity on operation relative to the system provided • 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 • All partial safety factors • Decision trees • Reinforcement specifications and testing, and • Conclusions		X		X	3 months after Agreement execution	
Report	Geotechnical investigation report	Comprehensive geotechnical investigation, including and as applicable: • PV Array • 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)		X		X	6 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Earthing general arrangement (GA) drawings and schematic diagrams • 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	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Report	Project Punchlist	As generated from Construction to Commissioning Turn-over and Commissioning/Client Walkdown		X		X	As Issued after Mechanical Completion of each Circuit, and at least 10 days prior to scheduled Substantial Completion	
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 • 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		X	X	X	monthly and weekly	
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	PV Array Design Report	The Contractor shall submit PV Design Report describing the Contractor's approach in addressing Project design risks, such as PID, shading and others.		X		X	2 months after Agreement execution	
Report	PV module quality documentation	Reports demonstrating PV module quality and specifications: • Fash test reports for all modules • 3rd party workmanship audit report or testing score • EL reports for all modules • Batch flash and EL reports after accelerate lifetime tests			X			
Report	PV Mounting structure 3rd party report	3rd Party Structural Engineer report confirming the suitability of the PV Mounting Structure for the site conditions.		X		X	6 weeks prior to start of relevant work	
Report	PV Mounting structure design report	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 • Detailed foundation design drawings • Concrete and Grout Design and the mix proposed as described in this document (if applicable) • Borehole logs and relevant geotechnical test results • All partial safety factors • Decision trees		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Reinforcement specifications and testing, and • Conclusions						
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). To include but not limited to:			X			
		• Quality Plan		X			Prior to start of construction	
		• Supplier Inspections		X			10 days after inspection	
		• Quality Audit		X			As Issued	
		• Quality Dossier			X			
		• Personnel Qualifications and Certfifications Requirements		X			30 days after Agreement Execution	
		• Personnel Qualifications and Certifications		X				
		• Non Conformity Reports and Resolutions		X			As Issued	
		• Instrument calibration sheets and certificates		X			As Issued	
		• Electrical Assurance Certificates		X			As Issued	
		• Equipment Assurance Certificates incl. Vendor Equipment		X			As Issued	
		• Material Identification and Traceability Records		X			As Issued	
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	Solar cable route layout and associated design drawings	Cable Route Layout and associated design drawings including, but not limited to: • AC and DC cable route diagrams, including details of creek and road crossings and approximate in-line cable joint locations (if applicable) • Trench layout diagrams, showing cross-section of all buried cable configurations. • LV cable route diagrams between the PCS and Substations (if applicable)		X		X	3 months after Agreement execution	
Report	Solar earthing verification report	Earthing verification report, which verifies through measurement of the as-built earthing systems, that the Plant will be safe for the lifetime of the Project.		X		X	2 months prior to energization	
Report	Solar electrical 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 Electrical System, having regard to the potential output of the PV Module, Inverter, the Employer's reliability and availability requirements and good electricity industry practice. 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 annualised losses for the AC network 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 Earthing System		X		X	3 months after Agreement execution	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Earthing study, based on justifiable assumptions and proving conclusively that the Site will be safe for the lifetime of the Solar Farm, addressing transferred potentials and step and touch voltages • Protection study and protection settings report, showing compliance with the Employer's requirements • Arc flash calculations and labels • Overcurrent device coordination • Power quality study • Inverter saturation and output model calculations • Reactive power capabilities and contributions • Insulation co-ordination study • Conduit sizing calculations • EMF calculations • Detailed availability calculations showing that the availability requirement can be achieved						
Report	Solar electrical system design report	Design of proposed electrical systems including, but not limited to: • AC design single line diagram(s) and electrical drawings, including connections to the Inverters, Transformers and Protection equipment. Protection SLD to be incorporated or provided separately; • DC design single line diagram(s) and electrical drawing(s), including connections to PV Modules, Combiner Boxes, Inverters and any other equipment connected to the DC network; • Earthing GA drawings and schematic diagrams • Details of equipment redundancy		X		X	6 months after Agreement execution	
Report	Solar SCADA design report	Details of inverter station interfacing, Solar Project and Substation and 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; • Performance ratio and other applicable calculations; • Identification of all data points, interfacing points, including how the interconnection and interfacings are to be provided as described in this Employer's Requirements; and • Optic fibre architecture.		X		X	8 months after Agreement execution	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	
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:		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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. • 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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Report	Transportation study	Condition survey of the transport route to the Site access point post-delivery of all major loads & equipment.			X			
Report	PV 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 Plant, 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 Power Plant earthing system • 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		X			8 months after Agreement execution	
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	Design life	Design Life for PV Modules, Inverters, PV Mounting Structures and other major components.	X			X	Agreement close	
Specifications	Electrical control documentation	Vendor data sheets for main electrical components, 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	
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	X			X	Agreement close	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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						
Specifications	Inverter specifications	The following documents shall be submitted by the Contractor. • Datasheet • Track records • Type test certificates to Applicable Standards and test reports • Accelerated test certificates • Warranty terms	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: • Layout	X			X	Agreement close	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Elevation drawings • Structural • Architectural • Fire rating • Hold down						
Specifications	PV Module specifications	Functional description and preliminary design specifications including: • Datasheets • Latest installation figures the operational track record • Type test certificates to Applicable Standards and test reports • Accelerated test certificates • Proposed module bill of material (if available) • Warranty terms	X			X	Agreement close	
Specifications	PV Module specifications	The following documents shall be submitted by the Contractor. • Module bill of material • Estimated annual degradation justified with historical production data • Validate LID, annual degradation, IAM, or other assumptions used in the energy assessment • Demonstrate workmanship quality through a 3rd party factory audit • PID test report and information		X			3 months after Agreement execution	
Specifications	PV mounting structure specifications	Functional description and preliminary design specifications including: • Datasheets • The latest installation figures for the proposed [PV Module Mounting Structures / Trackers] along with an indication of the operational track record • Type test certificates to Applicable Standards and test reports • Accelerated test certificates • Wind tunnel test results • Warranty terms	X			X	Agreement close	
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: • Solar met station • Switchgear • Monitored equipment • Statcom equipment, and • Power Quality Metering			X			
Specifications	Solar electrical specifications	Functional description and preliminary design specifications of proposed electrical systems up to and including the Point of Connection, including:	X			X	Agreement close	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Preliminary AC design single line diagram/s, including connections to the Inverters, Transformers and Protection equipment. Protection SLD to be incorporated or provided separately • Preliminary DC design electrical drawing/s, including connections to PV Modules, Combiner Boxes, Inverters and any other equipment connected to the DC network • Cable route layout for the AC electrical system, including approximate in-line joint locations (if applicable) • Cable route layout for the DC electrical system • Cable schedules (AC and DC) and cable specifications • Protection philosophy • Primary and Secondary system key equipment specifications, including HV/MV Transformer, MV/LV Transformer, HV and MV switchgear, Reactive Plant (if applicable), Neutral Earthing Resistors or Neutral Earthing Transformers (if applicable) • Optimisation of AC power cable size and preliminary calculations showing electrical efficiency requirement can be achieved Preliminary calculations showing that electrical system availability can be achieved in excess of the value specified.						
Specifications	Updated solar specifications	Full specification of the PV Module, Inverters, Transformers, MV and HV Switchgear, SCADA and Met Stations including specifications of all main components		X		X	2 months prior to delivery to Site	
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	

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	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong

Table of Contents

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

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	15Oct21	Issued for Implementation	DNV-GL	DS	CPA	Craig Armstrong
1	14Apr23	Update from 2021 Version	PGE		CPA	Craig Armstrong

Appendix M1

Attachment 04

Exhibit 02

General Transformer Specification

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

TABLE OF CONTENTS

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

Table of Contents

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. Once installed, Contractor will turn over all equipment and licenses to Owner for configuration.

a. 1x 4-node Dell VxRail Custer. Each server should be single-socket with a Intel Xeon 6346 or better with 256GB RAM. Storage

should be all-flash with a total usable space of 15TB, with the ability to expand 45TB in the future.

b. 2x Cisco C9300X-48TX (or newer) with C9300X-NM-8Y and stack cables with 5-year DNA license

c. 2x Cisco FPR-1120 (or newer), with 5-Year Malware and Threat licenses

d. 1x 120/240V, 7200VA cabinet UPS

e. 1x 1U Mixed-use (copper & fiber) feed-through patch panel

f. Software and Licenses:

   i. All server cluster fully licensed with vSphere Enterprise Plus and vSAN.

   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 with sufficient licenses for provided system.

B. 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 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

Portland General Electric

All Source RFP Technical Specifications – Battery Energy Storage Projects

Release / Revision Version: 0

Release / Revision Date: 4/14/2023

Document Status: Published

Content Owner: Craig Armstrong

APPENDIX M – BATTERY ENERGY STORAGE PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

TABLE OF CONTENTS

Appendix M4

Attachment 01

Exhibit 01

BATTERY ENERGY STORAGE
TECHNICAL DOCUMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
1	26Oct21	Issued for Implementation	1898 & Co.	SC & KW	JAL	Jared Lathrop
2	3Dec21	Rev 2 – correction to 3.2.4 & 3.2.5, replacement of section 3.2.9	Colin Solini	Kevin Whitener	JAL	Jared Lathrop
3	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong

TABLE OF CONTENTS

Acronyms and Abbreviations

AC	Alternating Current
ACI	American Concrete Institute
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BIL	Basic Insulation Level
°C	degrees Celsius
CAD	Computer-aided design
CT	Current Transformer
DART	Days away, restricted or transferred
DC	Direct Current
EMI	Electromagnetic Interference
EMR	Experience Modification Rate
ESS	Energy Storage System
E-Stop	Emergency Stop
ESIC	Energy Storage Integration Council
FAT	Factory Acceptance Testing
HMI	Human Machine Interface
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
IEEE	Institute of Electrical and Electronic Engineers
IFC	Issued for Construction
LV	Low Voltage
MV	Medium Voltage
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PCS	Power Conversion System
PDF	Portable Document Format
PF	Power Factor
POI	Point of Interconnection
psi	pounds per square inch
PT	Potential Transformer
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SEC	Site Energy Controller
SOC	State of Charge or Energy: Nominal Energy Remaining / Nominal Full Pack Energy Available
Specification	Project Technical Specification
TRIR	Total Recordable Incident Rate
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
VPN	Virtual Private Network

0.0 SCOPE

This Project Technical Specification (Specification), including Appendices, comprise or constitute requirements to design, fabricate, ship, assemble, test, startup, commission, warrant and make ready for service a fully functional energy storage system complete with accessories as required by the Agreement. This Specification defines specific engineering, operating and performance requirements for the Project that is intended for installation on the Owner's electric system. The Project is to be designed to be in a restricted access setting and configured to meet applicable standards required of other Owner equipment with respect to safety, operations, maintenance and environmental impact.

1.0 CONFORMANCE TO SPECIFICATION

1.1 Applicable Documents

Except as modified herein, the Project, including the energy storage technology, power conversion system (PCS), and site energy controller (SEC) shall be designed, manufactured, and tested in compliance with the latest versions (including any issued revisions) of the applicable standards of American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), Occupational Safety and Health Administration (OSHA), American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME), National Fire Protection Association (NFPA), and Owner safety practices. See Appendix A for applicable standards and codes.

1.2 Safety

- The Project must be compliant with all applicable provisions of IEEE 1547-2018, Underwriters Laboratories (UL) 1642, UL 1741 Supplement B, UL 1973, UL 9540, UL 9540A and NFPA Codes including NFPA 855. The Project must be able to protect itself from internal failures and utility grid disturbances. As such, the Project must be self-protecting for alternating current (AC) or direct current (DC) component system failures. In addition, the Project must be able to protect itself from various types of external faults and other abnormal operating conditions on the grid.
- The Project must be designed in compliance with and ultimately meet all applicable federal, state, and local safety standards and regulations regarding construction and potential exposure to chemicals and regarding container or enclosure resistance to hazards such as ruptures and exposure to fire. Prepackaged and pre-engineered energy storage systems shall be UL 9540 listed per large scale fire testing performed at the cell, module, unit, or system level until it passes the criteria specified in UL 9540A. Contractor shall provide documentation of UL 9540A test results with the proposal.
- All Project systems and equipment must be grounded in accordance with the NEC and adhere to the guidelines in IEEE 80 and IEEE 142.
- For all Project equipment, Contractor shall provide information and training to first responders on all known or reasonably foreseeable safety issues related to the equipment, including appropriate responses on how to handle the Project in case of an emergency, such as fires, off-gassing or module ruptures.

- The Project must be designed to minimize the risk of injury to the workforce and public during installation, maintenance, and operation.
- Visual and audible fire alarms and fire alarm panel trouble alarms shall be included as necessary per all applicable fire and safety codes. If a fire alarm panel is existing at a site, the Project fire alarm panel will be required to tie into that site panel and therefore must be compatible.
- A physical Emergency Stop (E-Stop) button is required to be installed at all entrances and exits of the buildings or containers. The E-Stop button shall have the ability to open contactors/breakers to the inverter and batteries isolating the DC and AC potential, without affecting the fire protection, monitoring and other safety measures required by the applicable safety standards and regulations.
- The Contractor must submit a copy of its Company Safety Plan and a comprehensive site-specific safety plan (at least 30 days prior to the start of the Work) that the Contractor and all Subcontractors will understand and follow during execution of the Work. The site-specific safety plan shall incorporate, at a minimum, plans and policies that are at least as stringent as federal, state, and Owner safety regulations and policies. (i.e. include reference to Contractor Safety Program and all Owner Safety Plans/Policies).
- Designated safety personnel during construction of the Project shall have a minimum of five years of safety experience or an equivalent level of skill through a training certification or professional degree. Resumes will be provided to support this requirement.
- Contractor and all Subcontractors must submit historical safety data for review prior to start of the Work: previous three years of safety stats: Total Recordable Incident Rate (TRIR); Days Away, Restricted or Transferred (DART); Experience Modification Rate (EMR) on official letterhead; and OSHA inspection history and any OSHA citation history. Contractor shall use the following benchmarks for TRIR (less than or equal to 2.0, DART less than or equal to 1.0, EMR less than 1.0) and membership with ISN. Inspections and citations should be evaluated on case-by-case basis. If TRIR, DART, EMR are outside of recommended benchmarks, a risk mitigation plan is required.
- At minimum, Contractor’s Site-Specific Safety Plan shall include provisions with respect to:
  - Daily job planning
  - Activity Hazards Analysis
  - Analysis of Utility locations (proper mark-out for underground facilities)
  - Incident reporting procedures
  - Project safety statistics tracking and reporting
  - Personal Protective Equipment
  - Emergency Plans to include evacuations and inclement weather
  - Fire Management (i.e. Fire Safety)
  - Excavation plans
  - Sanitation (hand wash/temporary toilets)
  - Demolition activities (if applicable)

  - Procedures for a Regulatory Visit (should one occur)
  - Deficient Project Safety Performance (recovery plan)
  - Site Safety Orientation requirements
  - Security of work zones, material yards, etc.
  - Behavioral Based Safety Plan
  - HAZCOMM
  - OSHA

1.3 Environmental Requirements

- Contractor and its Subcontractors and vendors engaged in the performance of the Work shall comply with all Applicable Laws.
- Spill Prevention Control and Counter Measure Plan - Proper site containment when equipment has equal to or greater than 1,320 gallons of liquid.
  - Containment shall include Petro pipe and a lockable drain valve.
  - All containment basins shall include grating as required to access and maintain equipment located in the containment area.
- The Project shall be designed for proper operation without de-rating for the following conditions and limits:
  - Ambient temperature range as defined in Section 4.3.9.
  - Zero gas emissions during normal operating conditions.
  - Noise produced by any Project operation shall comply with the requirements set forth in Section 4.3.10 herein.
  - The Project must be designed to minimize risk of harm to the environment including land contamination or disturbance (footprint), water contamination or diversion, and air emissions, as required by permitting and best Industry Standards.
  - Contractor must provide sufficient information specific to their product and the Project to facilitate utility personnel training and communications with emergency response and environmental agencies. Safety Data Sheets shall be provided, as applicable.

1.4 Seismic

- The structural and nonstructural components of all buildings, Control Shelters/Rooms, free standing structures, structural equipment supports, and all associated foundations and anchorages shall be designed and constructed to withstand the effects of earthquake motions and seismic loading in accordance with the requirements of the most recent versions of the Oregon Structural Specialty Code and ASCE 7 (respectively) with supplements No. 1 and 2 with the following parameters:
  - Risk Category IV
  - Seismic Design Category D
  - Site Soil Class D, unless otherwise determined by the Geotechnical Engineer

  - Ip is 1.5

- All electrical equipment shall be designed to the 'High Seismic Qualification Level' in accordance with IEEE 693 Standard.
- For all anchors embedded into concrete that resist seismic loading, the cracked concrete provisions of American Concrete Institute (ACI) 318-11, Appendix D must be considered.
- Anchor design must be governed by ductile yielding of a steel element (anchor or attachment), unless the exceptions of ACI 318-11, Appendix D are met.
- Post-installed anchors installed into hardened concrete must be an International Building Code Compliant Anchor for Seismic Design Category D and shall be designed and installed in accordance with the cracked concrete provisions.

1.5 Specification Interpretation

- If the Contractor is in doubt as to the meaning of any part of this Specification, or if Contractor finds discrepancies in or omissions in this Specification, the Contractor must submit a request for a written interpretation or correction of the Specification. Any request for a written interpretation shall be made to the Owner Representative.
- Any interpretation or correction of the Specification will be given in writing by the Owner Representative.

2.0 GENERAL REQUIREMENTS

2.1 Workmanship

All Work must be done and completed in a thorough, workmanlike manner by personnel skilled in their various trades, notwithstanding any omission from drawings or this Specification. All parts of the Work shall be constructed accurately to standard gauge so that renewals and repairs may be made when necessary with the least possible expense.

2.2 Design and Material

All materials used in the Project shall be new and of the specified quality. All components and workmanship must be free from physical and electrical flaws and imperfections. The design shall not only be effective in engineering characteristics, but it must also comply with the finish requirements stated herein.

2.3 Document Submittals

The Contractor shall provide all documents and deliverables as set forth in M1-01-02 (Engineering Documents Drawings and Other Deliverables) and M1-01-02-01 (Documents and Deliverables Table). This shall include, but not be limited to, the example documents listed below.

The preliminary drawings submitted (30% review) shall be accompanied by design memoranda which shall provide, when applicable, all data, calculations, and information necessary for an engineering review and understanding of the proposed design. The 30% review level is defined as drawings and documents that define the design concept. Examples of documents to be submitted at the 30% level include but are not limited to:

- Site Plan Layout
- AC Single-line Drawing(s)
- DC Single–line Drawing(s)
- Grounding Plan
- PCS Layout and Details
- Energy Storage Layout and Details
- Architectural Drawings
- Foundation Plan
- Heating, Ventilation, and Air Conditioning (HVAC) Drawings and Details
- Fire System Drawings and Details
- Grading and Drainage Plan
- Storm Water Pollution Prevention Plan
- Equipment Specification List
- Control System Diagrams / Logic Diagrams
- Preliminary Data Tag List
- Communication System Block Diagrams with Proposed Communications Protocols
- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow, Arc-Flash and Short-Circuit Calculations
- Purchase Specs or Data Sheets for Long Lead Items
- Equipment Seismic Qualification Reports
- Enclosure/Building Structural Calculations

The Owner shall have the right to require the Contractor to make design alterations for conformance to the design requirements of the Statement of Work without additional costs to the Owner. The review of such alterations shall not be construed to mean that the drawings have been checked in detail, shall not be accepted as justification for an extension of time, and shall not relieve the Contractor from the responsibility for the correctness of the drawings and compliance to the Statement of Work. The Contractor shall make, at his own expense, any revisions needed to correct the drawings for any errors or omissions which may be found by the Owner.

The Contractor shall submit for review multiple packages of final drawings ready for construction (90% review). Calculations and drawings shall be submitted together. After review, the Contractor shall stamp the final drawings “Issued for Construction”, or IFC, to indicate that these drawings will be the official drawings used for construction activities. Drawings submitted at 90% review shall include, but are not limited to:

- Site Plan Layout
- AC Single-line Drawing
- AC Three-Line Drawings
- DC Single–line Drawing
- DC Three-Line
- Uninterruptible Power Supply (UPS) drawings for black start / islanding systems (if applicable)
- Drawings Grounding Plan and Details
- PCS Layout and Details
- Energy storage Layout and Details
- Building/Enclosure Drawings and Details:
    - Structural
    - Architectural
    - Plumbing
    - Mechanical
    - Electrical
    - Fire Detection
    - Fire Suppression, if required.
    - Gas Detection, Ventilation & explosion mitigation if required
- Grading and Drainage Plan and Details
- Foundation Drawings, Plans and Details
- Raceway Plan and Details
- Storm Water Pollution Prevention Plan, if required
- Equipment and Materials List / Bill of Materials listing major Equipment and Materials
- Control System Diagrams / Logic Diagrams
- Communication System Block Diagrams
- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow, Arc-Flash and Short-Circuit Calculations
    - Arc-Flash Labels
- Control Input/Output List

- Supervisory Control and Data Acquisition (SCADA) Points List
- Purchase Specs or Data Sheets for All Equipment
- Site Logistics
- Location and content of Labels and Signage
- Section 2.6 Study Reports
- Communication Network Documents
- Communication Network Block Diagrams
- Equipment Seismic Qualification Reports
- Structural Calculations
- Commissioning and Testing Documents
- Operations and Maintenance Documents
- First responder training program

A final set of signed “IFC” drawings for each sub-system shall be available on-site before construction of that sub-system may proceed. To the extent required by Applicable Laws, and/or the Authority Having Jurisdiction (AHJ) over Project permits, construction issue drawings shall be signed and stamped by an Oregon registered professional engineer involved in the Project. Electronic registered professional engineer stamps shall be provided for electronic issues.

- The following information shall be shown on each drawing submitted:
  - Contractor’s name.
  - Owner contract and release number.
  - Owner equipment number if indicated in the Agreement or Contractor’s equipment number if not indicated in the Agreement.
  - Description of drawings (Title).
  - Latest revision and date.
- Construction submittals shall be reviewed by Contractors’ registered engineer or architect (as applicable) and, to the extent required by Applicable Laws, and/or the AHJ over Project permits, shall bear review stamp from Contractor’s registered engineer or architect (as applicable), or the registered engineer/architect’s designee, where appropriate. Documentation provided by equipment manufacturers shall not require additional stamp by a registered engineer if those equipment manufacturer documents are included in a 30%, 90% or IFC submittal package. These reviewed submittals shall be submitted to the Owner at a minimum for the following items:
  - As-built drawing markups delivered after completion of Work.
  - Drilled pier construction work plan (if applicable).
  - Backfilling materials.
  - Structural concrete mix design and associated material certifications.
  - Complete reinforcing bar fabrication, details, and bar setting drawings.

- Anchor bolts.
- Structural steel shop fabrication drawings.
- CMU block including certification of compliance with appropriate design ASTM standards.
- Welding procedure specifications, qualifications, and QC plan.
- Disposal site for exported soil material.
- Masonry mortar mix.
- Grout mix and procedures.
- Roof deck erection drawings.
- Completed manufacturer application for roof guarantee along with shop drawings of the roofs showing all dimensions, penetrations and details. The roof guarantee shall contain all technical information including: Deck types, roof slopes, base sheet and/or insulation assemblies (with method of attachment and fastener type) and manufacturers membrane assembly proposed for installation. The roof guarantee should contain accurate and complete information including: Proper names, addresses, zip codes, and telephone numbers.
- Roof membrane guarantee, 20-year labor and materials membrane / system guarantee.
- Roofing material submittals, product data information and material certifications.
- Layout and attachment of insulation indicating fastener and adhesive patterns per the manufacturer’s installation requirements to meet Factory Mutual Global tested wind uplift resistance.
- Certification from roof manufacturer that board insulation materials are acceptable with roof membrane and included in roof manufacturer 20-year system guarantee.
- Copy of manufacturer’s warranty and installers warranty for control shelter.
- Doors, frames and hardware.
- Louvers
- Paints
- Sealant
- Cable cut sheets and testing results.
- Transformer testing results.
- Inverter testing results.
- Conductors and grounding rods.
- Exothermic welds and grounding connections.
- Conduit, tray, and conduit fittings.
- Mandrel

- All drawing / document reviews shall comply with the process set forth in M1-01-02 (Engineering Documents Drawings and Other Deliverables).

2.4 Record Drawings

The Contractor shall maintain a record drawing set on-site always with clear markings on the drawings indicating it as the record set. The record set shall be available for Owner review always during performance of the Work. The Contractor shall furnish record drawings to reflect any changes including red line drawings made during or after installation and commissioning of the Project. One set of marked-up paper print drawings all with a new revision number shall be forwarded within six weeks from the Substantial Completion Date. A transmittal letter shall accompany the mailing itemizing the revised drawings.

2.5 Project Specific – Operations and Maintenance Manual

No later than six weeks from the Substantial Completion Date, the Contractor shall furnish two complete identical set of detailed Operation and Maintenance Manuals in both print and digital (i.e. PDF) formats for the Project. These manuals shall be accompanied by a letter of transmittal and shall have a table of contents, contain all illustrations, assembly drawings, outline drawings, wiring diagrams, replacement parts list that includes part number identification, a list of recommended spare parts, and instructions necessary for storing, installing, operating and maintaining the Project. The illustrated parts shall be numbered for identification. Additionally, these books shall contain instructions and test procedures for integrating the Project into Owner control and monitoring computer networks. All information contained therein shall apply specifically to the Equipment and Materials furnished and shall not include instructions that are not applicable. All illustrations shall be incorporated within the print of the page to and drawings bound into the book form a durable and permanent reference book. Binding holes of all Table of Contents pages, illustrations shall be reinforced with nylon circlets to prevent this information from being torn out of the book.

The Owner will inform the Contractor six weeks after receipt of the Operation and Maintenance Manuals either that there are “No Comments”, “Furnish as Corrected” or “Correction Required”. If there are “No Comments”, the Contractor shall promptly furnish two additional sets identical to the submitted copy. If there are corrections needed, one set will be returned to the Contractor by the Owner. The corrections shall be promptly incorporated in the Operation and Maintenance Manuals and a total of four complete, identical sets of such revised Operation and Maintenance Manuals shall be furnished to the Owner in both print and digital formats.

One additional, identical Operation and Maintenance Manual shall be kept in control shelter.

2.6 Study Reports and Calculations

The Contractor shall submit all design study, calculations, dynamic modeling simulation, shake table testing, and field test reports to the Owner in a timely manner. All reports and calculations shall be signed by an Oregon registered professional engineer and shall list assumptions, study methods, results, significant findings and conclusions.

The Contractor shall prepare the following study reports and calculations as specified below:

- Seismic and Wind Loading Calculations: The Contractor shall provide seismic and wind loading calculations for all buildings, structures, nonstructural components, equipment and structural supports, and all associated foundations and anchorages as specified in Section 1.4.

- Seismic Qualification Report: Contractor shall prepare a report demonstrating the Project's compliance with the seismic standards specified in Section 1.4 for the following:
  - Battery racks IEEE-693-2005-Annex J
  - Batteries – IEEE 693-Annex J
  - Switchgear-IEEE 693-Annex M
  - Step-Up Transformer-IEEE 693-Annex D
  - Inverters (including rack mount)-IEEE 693- Annex L
  - Medium Voltage (MV)/High Voltage (HV) Breaker, IEEE 693- Annex C
  - MV/HV Disconnect Switch IEEE 693-Annex E
  - MV/HV Termination and Support Structure, IEEE 693-Annex N
  - Pad-mount Isolation Transformers (Anchorage Only), IEEE 693-Annex D
  - Electronic Devices, Panels, Switchboards, solid-state rectifiers-IEEE 693 Annex L
- Structural Calculations: The Contractor shall provide structural calculations for all structural supports and foundations, the building enclosing the batteries, and shelters, Control Shelters/Rooms, and equipment foundations and all nonstructural components in accordance with Oregon Structural Specialty Code requirements as specified in Section 1.4 of this document.
- Grounding System Study: The Contractor shall perform soil resistivity measurements and studies as necessary to determine the parameters for the Project's grounding system. Grounding studies shall identify step and touch potentials, as applicable, for each facility where new equipment is added as part of the Project scope. The Project grounding system shall be designed to function independently of the adjacent grounding system. The grounding system for the Project may be connected to the ground grid for the adjoining substation at the discretion of the Owner at Contractor's cost. If connected to the adjoining grounding system, the contractor shall perform a study to verify that step and touch potential are within tolerable limits. Connections to and routing of ground cables to connect the ground grid of the adjoining grounding system shall be provided by the Contractor. Grounding for all multi-component outdoor structures shall include two (2) or more independent ground connections. The Project grounding system shall also be designed in such a way as to reduce electromagnetic interference (EMI) coupled to the grounding system from power electronic converters, such as through single-point grounding systems. Designs and study shall adhere to IEEE 80, IEEE 81, IEEE 142, and the Project's geotechnical engineering report where applicable.
- Electrical Studies: The Contractor shall provide electrical studies as required to determine control response and settings, including load flow, short-circuit, cable ampacity, arc-flash analysis, and voltage drop using industry-standard engineering software agreed-upon by the Owner. For the purposes of the system electrical studies, the Contractor shall provide inputs data for an accurate power flow and dynamic simulation model of the Project compatible with the Owner's CYME database and software. Contractor shall perform dynamic simulations, utilizing CYME.
- Relay and Control Settings: The Contractor shall provide complete documentation of all protective relay and Project control settings for the Project's batteries, inverters, control

systems, and AC systems up to the POI. Such documentation shall include a protection and control criteria document (separate protection and control criteria documents are acceptable), all calculations and time current coordination curves used in the development of the settings.

- Depending upon the scope of the Project, additional studies such as transformer sizing, DCS/UPS sizing, harmonics and auxiliary power studies may be required. Refer to M1-04-01 for specific requirements of these studies.

2.7 Testing and Test Reports

- The Contractor shall, within 30 days prior to any on-site testing, submit a "Master Test Plan and Procedures" document indicating the order in which the tests will be conducted, and the test method being used along with required instrumentation for Owner approval.
- The Contractor shall furnish, at the Contractor's own expense, necessary facilities, personnel and test equipment for the required tests.
- The Contractor shall notify the Owner not less than two weeks in advance of the day when:
    - Manufacture, fabrication and integration starts for the batteries, inverters, controls and transformers of each major deployment.
    - The batteries, inverters, controls, transformers and other major components allocated for each major deployment are ready for testing and inspection prior to packaging for shipment.
- Should the Owner elect to waive the right of inspection or of witnessing tests and accept certified test reports instead, the Owner will notify Contractor no later than three business days ahead of the scheduled inspection or test.
- Witnessed factory tests shall be made in the presence of Owner personnel or authorized representative. The test procedures shall be subject to review and acceptance by the Owner prior to arrival at testing location, provided that non-acceptance of any part of the procedures is consistent with the Statement of Work. The Contractor shall bear all costs of such testing except for the compensation and expenses of Owner personnel. If scheduling such tests to accommodate the Owner causes schedule delays, then said delays will be accommodated on a day-by-day basis to the extent they negatively impact the critical path.
- One copy of the certified reports of all tests shall be furnished to the Owner in digital and print formats for review. The Owner will inform the Contractor within two weeks after the receipt of the certified test reports either that there are no exceptions noted or that the test results show noncompliance with the Specification. Contractor shall provide the test data for a representative sample of each of the major components.

2.8 Factory Acceptance Testing Requirements

The Contractor shall be responsible for compliance with all standard factory test procedures that check the quality and performance of the Equipment and Materials.

The Contractor shall perform those tests specified below and in other sections of this Specification. The Contractor shall propose additional tests to be conducted if required. Where appropriate, tests should conform to those contained in ANSI, NEMA, ASME, NEC, ASTM, NETA, IEEE and UL standards and guidelines. Where standards are not suitable or applicable, other common industry procedures and mutually acceptable methods shall be used.

If certain tests are performed by firms other than the Contractor, the Contractor shall furnish the test reports and certify that the necessary testing has been performed.

2.8.1 Factory Acceptance Testing of the Battery/Cells

The Contractor shall test and submit test data for the cells designated for use on this Project. At a minimum, the following tests shall be performed:

- Amp hour capacity
- UL 1642 Certificates (if applicable)
- As applicable, maximum noxious and toxic material release rates for same cell design but not necessarily a specific production lot.

The Contractor shall propose a test plan for all required cell tests. Required tests may be proposed as a percentage of the cells in production lots. Test data for production lots other than those being supplied for this Project are not acceptable.

2.8.2 Factory Acceptance Testing of the PCS and Control System

The Contractor shall develop and submit for Owner approval a Factory Acceptance Test (FAT) Plan. The FAT Plan shall be in general accordance with Appendix C of this Specification. The Contractor shall work cooperatively with the Owner to develop a formal FAT Plan based on the appendix.

At a minimum, tests shall be conducted to demonstrate that all controls, protective functions and instrumentation perform as designed and adhere to this Specification. Successful tests performed on analog simulators or a scaled-down version of the overall scope of supply will be deemed to meet the intent of this Section provided that Owner approves the design of the system under test. The tests shall demonstrate that the PCS is capable of synchronizing with and operating in conjunction with the utility connection. A report along with applicable graphs of each test and relevant data file(s) including a power quality report will be provided by the Contractor to the Owner upon completion of the FAT. This file should be captured at a minimum of 512 samples per cycle resolution.

Witness test shall demonstrate the following, at a minimum:

- Run at rated power for duration of specified system capabilities
- Normal and failure mode operating sequence and protective functions
- Verification of accuracy of measured input/output voltage and currents
- Verification of response to basic P and Q commands
- Verification of dynamic power factor (PF) control via SCADA system (e.g., Communications Protocol)
- Verification of power curtailment via SCADA system (e.g., Communications Protocol)

- Verification of islanding and black start capabilities
- Verification of power quality and compliance with IEEE power quality requirements through the use of power quality metering equipment with historization and harmonic analysis

2.9 Site Acceptance Test

The Site Acceptance Test shall be in accordance with Appendix F of this Specification, to be provided at a later date by Contractor as an exhibit to the Agreement. Owner will assist Contractor during the Site Acceptance Test process. In addition, the Contractor shall demonstrate that all aspects of the System integrate and coordinate as intended. At a minimum, the Contractor shall demonstrate that all control and management systems, including but not limited to, all levels of energy storage management system, PCS controls, overall site controls, and protective features operate as intended. Other balance-of-plant systems shall be tested in conjunction with the overall system tests (e.g. HVAC, fire alarm, thermal runaway mitigation system operational alarms, etc., lighting, security).

2.9.1 Actual Operating Experience

It may not be possible due to system constraints to test all facets of the Project function as part of the performance verification tests specified above. The actual operating experience of the Project through Final Completion shall be deemed an extension of the performance verification tests.

Actual operating experience will be documented through Owner-furnished sequence of event recorders, oscillographs, digital fault recorders and other system monitoring equipment capable of identifying system disturbances and associated Project performance. Additional information may be provided by monitoring equipment installed by the Owner at other locations. Operation may also be documented with the Contractor-furnished power quality meters, as determined by the Owner.

2.9.2 Other Compliance Tests

The Contractor is responsible for obtaining both before (or with all equipment de-energized) and after Project installation, measurements to ensure the Project complies with this Specification in the following areas. The Owner reserves the right to perform (or request others to perform), at Owner expense, identical compliance test measurements for the following:

- Broadband frequency signal strength and noise voltage.
- Harmonic voltages and currents adhering to IEEE 519.
- Audible noise measurements adhering to AHJ requirements.

2.10 Spare Parts

The Project specific Operations and Maintenance Manual provided by Contractor shall list the required spare parts to be furnished with the Project by Contractor. Each spare part shall be interchangeable with and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications. Enclosed storage space for spare parts required on site shall be provided by Contractor. If climate-controlled space is required, additional space shall be included in the Control Shelter or energy storage system enclosure(s).

2.11 Special Tools

The Contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the Project. Any accessories normally furnished with this system required for satisfactory operation of the Project, and not specified herein, shall also be furnished by the Contractor. All tools furnished shall be new and plainly marked for identification. One complete set of tools shall be furnished for the Site.

2.12 Cleaning and Painting

All waterproof enclosures shall be thoroughly cleaned of rust, welding scale, and grease, and shall be treated to affect a bond between the metal and paint which shall prevent the formation of rust under the paint. A priming coat shall be applied immediately after the bonding treatment. The final finish shall consist of two coats of paint of specified color and type. Contractor shall submit painting specifications and procedures for Owner approval.

Waterproofing is the combination of materials or systems that prevent water intrusion into structural elements of the buildings or its finished spaces.

2.13 Shipping Requirements

- The Contractor shall prepare Equipment and Materials for shipment in such a manner as to protect from damage in transit. Each item, box or bundle shall be plainly and individually identifiable for content according to item number, Owner contract number, Contractor’s identifying number, and complete shipping address. The Contractor shall pay attention to the proper packaging and bracing of the apparatus to assure its safe arrival.
- Systems, equipment, materials and components shall be transportable from the designates port at normal speeds over North American highways and railways and meet all United States Department of Transportation hazardous materials and other requirements. System components may be shipped separately as needed and assembled on-site. Battery shipments shall adhere to the requirements of Title 49 Code of Federal Regulations (CFR) Part 173.185.
- Energy storage media shipping containers will each be provided with shipping shock sensors of the appropriate G-rate sensitivity prior to loading at the manufacturer’s dock.
- Energy storage media shipping containers will each be provided with shipping tilt sensors prior to loading at the manufacturer’s dock.
- Shipping of storage media shall be via air-ride van or trailer.
- A complete itemized bill of lading, which clearly identifies and inventories each assembly, subassembly, carton, package, envelope, etc., shall be furnished and enclosed with each item or items at the time of shipment.

2.14 Installation

The Contractor shall be responsible for quality of construction to meet best Industry Standards and design requirements. Equipment shall be installed in accordance with their listing and the manufacturer's instructions.

2.14.1 Civil/Structural

The permanent Project shelters and required foundations, structures, anchoring (including the building or enclosure that will house the batteries), and other civil/structural work shall be designed by and under the supervision of a qualified registered professional engineer and registered architect, in each case in the state where the Project is located. All such work shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification and M1-02-01 (General Civil Requirements).

2.14.2 Geotechnical Testing

The Contractor shall perform geotechnical investigations and geotechnical report shall be in accordance with the requirements set forth in M1-02-01 (General Civil Requirements), including all information necessary to complete civil/structural and grounding design. Contractor to determine cable thermal ampacity based on geotechnical investigations.

2.14.3 Site Development

The Contractor shall perform all necessary studies and calculations for hydrology and drainage, erosion control, landscaping, NPDES (Stormwater Pollution Prevention Plan) and site grading to comply with local agency regulations. The Contractor shall be responsible for all surveys (e.g. topographic, Dig Alert, potholing) required to attain an accurate design.

Drainage structures and piping within the Project boundaries shall be grounded if constructed of materials capable of conducting electricity.

2.14.4 Excavation

The Contractor shall perform all excavation necessary for installation of all foundations and utilities. All excavation shall be in accordance with OSHA regulations and the geotechnical report performed or to be performed by Contractor. Excavation spoils shall be the Contractor's responsibility and may be used for backfill or embankment if suitable for this application as directed by the project geotechnical report/ engineer. Unsuitable or excess excavated material shall be disposed of properly. The Contractor shall verify that earth material exposed in excavations is consistent with those assumed for the Contractor's foundation designs.

2.14.5 Construction Surveying

The Contractor shall furnish all labor, equipment, material and services to perform all surveying and staking required for the completion of the Project in conformance with Contractor's design and the Statement of Work. Survey information shall be included in Project as-builts.

The Contractor shall retain qualified survey crews knowledgeable in proper and up-to-date survey techniques and shall use these qualified survey crews when conducting the survey. Such crews shall be under the supervision of a professional land surveyor licensed in the state where the Project is located.

2.14.6 Fills

Earth fill material adjacent to and below structures shall conform to the design requirements for the structure and the geotechnical report performed or to be performed by Contractor. Contractor-prepared specifications and drawings shall indicate the types of soil to use for fills and compaction requirements.

Fill shall be placed as uniformly as possible on all sides of structural units. Fill placed against green concrete or retaining walls shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly.

2.14.7 Fencing

Site perimeter fencing is required for the Project. Such fencing shall comply with the Owner fence standards as described in M1-01-07.

2.14.8 Lighting and Convenience Outlets

Lighting shall be provided for all indoor and outdoor areas of the project. The lighting system shall provide personnel with illumination for operation under normal conditions and means of egress under emergency conditions. Luminaries shall be LED type, mounted so they are easily accessible for maintenance and lamp replacement, to the maximum extent practical; for both interior and exterior. Emergency lighting shall be powered from self-contained batteries, with chargers, within a self-contained emergency lighting unit.

The power supply for the lighting system shall generally be from low voltage (LV) lighting panelboards. The emergency egress lighting shall consist of self-contained battery lanterns. Outdoor lighting shall be limited to providing fixtures mounted on building, container, or light standards. Light fixtures shall be Dark Sky compliant to help preserve the night sky from light pollution.

The lighting levels shall be designed in accordance with the Illuminating Engineering Society to provide proper illumination levels recommended. Minimum level in the energy storage system area shall be 30-foot candles (323 lux) at 30 inches (762 millimeters) above plane, when occupied, and adequate levels for illumination for video and security equipment when unoccupied; 3.0-foot candles (22 lux) at 30 inches (762 millimeters). Minimum level in the control room and maintenance area shall be 50-foot candles (538 lux) at 30 inches (762 millimeters) above floor plane.

Follow state and local lighting energy efficiency standards, as applicable. Electric power to light fixtures shall be switched with motion sensors in energy storage system rooms. When unoccupied, sensors shall reduce levels to minimum for security. Motion sensors with built-in override function shall be provided in areas where the light can be completely turned off, such as storerooms, switchgear rooms, and maintenance area. Wall mounted switches and sensors shall be provided at the latch side of the door entrance.

Electric power to outdoor light fixtures shall be switched with motion or heat detectors to keep lights off when not required. Convenience outlets and switches throughout shall be industrial grade rated for standard voltages and amperes per country standards. Convenience outlets located outdoors shall be provided with weatherproof snap-action covers. Outlets shall be spaced in the energy storage area such that there is a maximum 100 feet (30 meters) distance to a receptacle outlet, unless codes allow or require otherwise. As a minimum, an accessible receptacle outlet shall be reachable within 25 feet (7.6 meters) from each HVAC unit. Provide outdoor receptacles protected by ground fault interrupters, and interior receptacles in locations as required by codes. In finished areas, general-purpose power outlets shall be located on each wall and in no case shall they be located more than 10 linear feet (3.0 meters) apart.

2.14.9 Control Shelter (if control room not provided in building-based solution)

For container-based solutions, the Contractor shall design, engineer, and provide a shelter suitable for use to house the Project controls and all indoor components common to the Site. The shelter shall be designed to comply with the Oregon building code requirements. The Contractor shall provide the shelter required to accommodate the Project controls commensurate with the Project design life, including but not limited to seismic events, wind loads or other controlling criteria. The shelter shall be considered an occupied space and shall be designed in accordance with codes pertaining to occupied space.

If energy storage media is located within containers, the design shall be such that normal maintenance and operation can be performed without personnel entering the enclosure.

The Project shelter and containers shall be designed with the appropriate insulation to meet local building codes and ensure an energy efficient operation of the HVAC and/or ventilation system. Control shelter will be installed on a graded concrete pad and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite. Control shelter shall be designed without shipping splits. The control shelter shall be made from either steel (galvanneal), aluminum or stainless steel. The control shelter shall have doors to accommodate installation and replacement of equipment housed in the structure. The roof shall have a pitch design with a minimum slope of 0.25 inch per linear foot and shall be designed to support interior or exterior loads of 100 pounds per linear foot without compromising the roof load design.

The control shelter shall be equipped with DC cabinet, AC panels and disconnects (480/240/120), lights, switches, receptacles, controls rack, fire suppression, HVAC units, push buttons, HVAC controls, cable tray, wireway, grounding system and conduit.

Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

2.14.10 Project Building (if applicable to proposed system)

The Contractor shall design, engineer, and provide a building suitable for use to house all indoor components of the Project. The building shall be designed to comply with the Oregon State Building Code requirements. The Contractor shall provide the building required to accommodate the Project commensurate with the Project design life, including but not limited to seismic events, wind loads, or other controlling criteria as specified in Section 1.4.

The building shall be designed with the appropriate insulation to meet local building codes and ensure an energy efficient operation of the HVAC and/or ventilation system. Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

2.14.11 Structural Steel and Connections

All structural steel shall comply to the following applicable materials standards:

- Wide Flange Shapes - ASTM A992
- Angles and Channels - ASTM A36
- Plates - ASTM A572 Grade 50
- High Strength Structural Bolts - ASTM A325N Type 1, or A490
- Washers - Hardened steel, ASTM F436
- Nuts - Heavy hex, ASTM A563
- Welded stud anchors shall be headed arc-welded mild steel studs conforming to ASTM A108, Type B having minimum yield strength of 51,000 pounds per square inch (psi) and a minimum tensile strength of 65,000 psi.
- Anchor Bolts - ASTM F1554 Hex Head, Grade 36 or Grade 55
- Electrodes for Welding - Electrodes shall be E70XX 70ksi tensile strength, minimum.
- All structural steel shall be hot-dipped galvanized in accordance with ASTM 123 and all mill certifications shall be available. Structures shall be fabricated such that double dipping is not required.
- Bolted connections shall be ASTM A325 with hardened washer and heavy hex nuts installed as snug-tightened in accordance with the Research Council on Structural Connections Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- All welding shall comply with the requirements of AWS D1.1, Structural Welding Code - Steel. Welders and welding processes shall be qualified in accordance with AWS D1.1.

2.14.12 Foundations and Concrete Work

The Contractor shall furnish all labor, equipment, materials and services to layout, design and construct all foundation and concrete work required for the Project. The Contractor shall provide foundations for all equipment and structures, as appropriate, including but not limited to shelters, containers, buildings, transformers, switches, breakers and instrument transformers.

The design and construction of all foundations shall be in accordance with the requirements set forth in M1-02-01 (General Civil Requirements), ACI 318, and Oregon Structural Specialty Code. All concrete exposed to weather or in contact with soil shall be designed to be compatible with the life of the Project.

The appropriate manufacturer shall specify the quantity, size, and location of anchor bolts for enclosures and equipment per seismic qualification reports. Embedded steel items shall be hot dip galvanized. Anchor bolts and embedded steel items subject to corrosive action shall be fabricated from stainless steel.

Concrete shall be batched, mixed and delivered in accordance with the requirements of ACI 301. Reinforcing shall be detailed and fabricated in accordance with ACI 315. Details of concrete reinforcement not covered in ACI 315 shall be in accordance with the CRSI manual. Concrete placing methods shall conform to the requirements of ACI 301, 304, and 318.

The Contractor shall provide the services of an independent testing agency to perform tests on concrete material such as compressive strength, slump, concrete mix designs, during the course of the Work. Testing, evaluation and acceptance of concrete shall be done in accordance with the requirements of Chapters 16 and 17 of ACI 301. Any concrete that does not meet the requirements shall be replaced with no increase to the Purchase Price.

2.14.13 Mechanical

All exposed surfaces (inside or outside) of ferrous parts shall be thoroughly cleaned, primed, and painted or otherwise suitably protected to survive outdoor conditions for the design life of the Project.

The building housing the energy storage system and any other outdoor enclosures or shelters shall be waterproof and capable of surviving, intact, under the Site environmental conditions for the design life of the Project. Flat Roofs are not allowed – minimum roof slope shall be 0.25 inch per linear foot.

Components mounted inside of the building and any other enclosure shall be clearly identified with suitable permanent designations that also shall serve to identify the items on drawings provided.

- The Project shall include an HVAC, thermal management system, and/or ventilation system for the enclosure(s) housing the energy storage system(s) and control shelter which shall be seismically anchored. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.
- The Project shall be designed to maintain component temperatures within design limits for all modes of planned Project operation. The HVAC system shall be sized to maintain ambient temperature and humidity in the enclosure to within the limits specified by the battery manufacturer during all operating modes and ambient conditions.
- HVAC communications and control technology shall make use of the best Industry Standard components and be compatible with the Owner's existing environment for substation communications infrastructure.

2.15 Quality Assurance / Quality Control

2.15.1 Quality Control Program

- The Contractor shall establish, implement, and maintain a comprehensive QC Program, which shall be reviewed for approval by the Owner prior to implementation. This program shall include provision of a qualified, on-site Quality Assurance / Quality Control (QA/QC) support staff for the duration of the Project.
- The QC Program shall clearly establish a QA/QC Manager and/or staff with the responsibility and authority to inspect the Work, to enforce the quality requirements of the Statement of Work and the Agreement, and to verify the effectiveness of problem resolutions and corrective actions.
- The QC Program shall be capable of assuring that the design, construction, purchasing, manufacturing, shipping, storage, testing, inspection and examination of all equipment, materials, procedures, and services shall comply with the requirements of the Agreement and building code requirements. Reports generated under the QC program must be submitted to the Owner within three days of receipt.
- The Contractor shall provide all equipment, materials, and labor required to perform all Work in support of QA/QC. As a minimum, this applies to soil density, concrete, welding, and any laboratory tests. Any Subcontractors or third-party inspectors hired by Contractor to perform any Work in support of QA/QC shall be subject to the approval of the Owner.
- The Owner shall have the right to independently review and inspect all Work associated with the Project that occurs or will occur at the Site. This may include review and inspection by third parties and contractors of the Owner.
- The Owner shall have the right to independently review and inspect any Work or equipment associated with the Project that has been previously developed, constructed, or manufactured. For any work, equipment, or materials that are stored outside the Project location (e.g., off-site storage facility), the Contractor shall provide Owner will reasonable opportunities to inspect such items, including any affiliated documentation. This may include review and inspection by third parties and contractors of the Owner.

2.15.2 Quality Assurance Manual

The QC Program shall consist of one or more bound sets of documents comprising a single Quality Assurance Manual. The form and format of the Quality Assurance Manual is at the discretion of Contractor and its Subcontractors. Upon review and final approval by the Owner, it shall become the sole guide for Contractor and all its Subcontractors for quality performance of all Work on the Project. The content of the Quality Assurance Manual shall include written descriptions of QA/QC policies, procedures, methods, instructions, exhibits, or other quality assurance descriptions. An uncontrolled copy of Contractor's corporate QC manual shall be provided to the Owner Representative. The Owner shall always have access to all QA/QC documentation and shall be provided copies upon request.

The Contractor's Quality Assurance Manual shall include, at a minimum, control procedures or methods to assure the following:

- The establishment of on-site QA/QC staff.
- A plan for receipt inspection, in-progress inspection, examination, and testing of the equipment and material installed by Contractor.
- A description of the authority and responsibilities of the persons in charge of the quality assurance program.
- Current and accurate maintenance of design documents, drawings, specifications, quality assurance procedures, records, inspection procedures, and purchase control documents.
- Conformance of purchased materials, equipment and services to the requirements of the Agreement.
- Proper performance of receipt and in-process inspections as well as equipment examinations, testing, corrections as well as checkout procedures.
- The inclusion of adequate inspection and quality of all Contractor’s subcontracted work and shop fabricated components.
- Shop inspections are performed and documented at an adequate frequency rate.
- Assurance that the quality of all special processes such as welding, and any other nondestructive testing is properly inspected, verified, and documented.
- Assurance that the proper methods are employed for qualifying all personnel performing welding and non-destructive testing.
- Assurance that inspection hold points are identified and monitored in coordination with the Owner Representative.
- All deviations and non-conformance will be communicated to the Owner in writing within three days.

2.16 Required Training Courses

The training courses described below, with accompanying written text, shall be a live presentation at an Owner facility with the Owner having the right to video tape the training course. Such taped training will be used only for training of new personnel and will be subject to confidentiality agreements, and other protections of Contractor’s Intellectual Property. The training course shall cover all aspects of installing the Project, a pictorial breakdown of the energy storage subassemblies, procedures related to emergency response (ruptured modules, fire, etc.), and operation, maintenance and control of the Project.

2.16.1 General

The Contractor shall provide training for the Project as specified below. The Contractor shall determine the content and duration for each training session. The suggested class durations in this Specification are meant to illustrate the level of training expected. Performance evaluation testing of all trainees (i.e., a written test) is required for all classes except the orientation training.

2.16.2 Orientation Training

The Contractor shall provide two orientation training sessions. It is anticipated that each session will last half a day. These sessions shall be suitable for managers, supervisors, professional and technical personnel. Each session will be limited to a maximum of 20 people.

The orientation training sessions shall be scheduled before commencing Acceptance Testing. An outline for this orientation training shall be submitted to the Owner 90 days ahead of the actual date of training. Approval of this outline shall be obtained from the Owner. The Owner will provide comments and/or approval at least 30 days before the scheduled training date.

2.16.3 Operator Training

The Contractor shall provide the necessary training in proper operation of the Project and related equipment. This training shall be conducted after successful completion of the Acceptance Testing, but before system commissioning. It is anticipated that this session will last one (1) to two (2) days. This session will be limited to a maximum of 20 people. Emphasis shall be placed on hands-on operating experience interspersed with critical background as necessary, including switching procedures and emergency response training.

2.16.4 Maintenance and Diagnostic Training

The Contractor is responsible for providing necessary training on energy storage and inverter diagnostic software which includes a set of the necessary cables to diagnose these issues. This training shall be completed onsite using the Owner’s field personnel equipment. Documentation of the software and steps needed to communicate with various equipment will be supplied by the vendor.

2.16.5 Emergency Planning and Training

The Contractor is responsible for providing emergency planning and training so that operations personnel and emergency responders can effectively and safely address foreseeable hazards associated with on-site systems. Emergency planning and training shall include procedures for safe shutdown; alarm response procedures; emergency response procedures following fire, explosion, or release of toxic chemicals; and any other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders.

3.0 FUNCTIONAL REQUIREMENTS

3.1 General

The Project shall serve multiple purposes on the Owner’s system for bulk energy services, ancillary services, and distribution level services. Each service is described as a control mode. These modes will all be supported within the system capabilities and the system’s self-protection requirements. Most of the control modes are simply accomplished by the Owner sending active power (P) and reactive power (Q) setpoints via the SCADA interface while the system is in PQ mode. These control modes are described in this section for the Contractor to understand the expected operation of the system and potential impacts on maintenance, guarantees and system longevity. Only two services are accomplished through built-in applications within the Contractor's Site Controller. These two services are frequency/watt control (sometimes called frequency support or freq/watt) and Volt/VAr support (sometimes called voltage support).

Dispatch of the system will be limited to 2 full charge/discharge cycles per day and 365 full charge/discharge cycles per year.

All services that the Owner dispatches through P and Q commands will have ramp rates unique to that service; those ramp rates being controlled by the Owner. The P and Q setpoints will be sent to the system along the appropriate ramp curve, not as a step change. The Supplier will provide four data tags for the Owner to select the overall system maximum ramp-up and ramp-down rates (one data tag input for ramp up, one data tag input for ramp down and two data tags for feedback for each of the two ramp inputs). These four data tags will be shared with the Owner's SCADA system to be used by the Owner, subject to the Project's internal ramp limits for safety and system longevity. These two ramp rates will be used by the Owner as maximum ramp rates for charging and discharging. In dispatching the system, the Owner will send setpoints that ramp up or down and the Contractor is expected to respond to these commands no slower than the maximum rates established.

As well as ramp rates, all Customer PQ commands will be limited by the Contractor's site controller's Contractor-specified SOC limits and power limits to avoid damage to the Project.

Description of Various Ramp Rates and Their Hierarchy	
Project Internal Ramp Rates	Maximum ramp rates established by the Contractor and hard-coded into the system. These ramp rates are for ultimate safety and protection of the Project. They are not adjustable by the Owner.
Owner-Selectable Ramp Rates	Maximum ramp rates established by the owner. They are four data tags within the Project that can be written-to and read-from the Project's Project Site Energy Controller by the Owner. These ramp rates cannot exceed the Project Internal Ramp Rates.
P and Q Setpoint Ramps	These ramps are built into the P and Q setpoints sent by the Owner. If they should exceed the Owner-Selectable ramp rates, the Project will default to the Owner-Selectable ramp rates.

At any time during operation, if the system is responding to abnormal conditions as described in IEEE1547-2018 Clause 6, the system will respond in accordance with that standard without regard to any established ramp rates.

Termination of operating modes due to reaching the discharge limit shall take into account the ramp down energy required.

3.2 Control Modes

The following sections describe the control/operational modes and sources of commands for the Project. Contractor shall work with the Owner to ensure that the appropriate command and source hierarchy are enforced by the Project.

3.2.1 Offline

The Project shall open the breaker/contactor(s) on the DC bus, inverter AC output breaker/contactor(s), and de-energize non-critical power supplies. It should physically isolate the inverter output from the grid, not just provide a zero output, to prevent interaction with the grid (nominal auxiliary load contactors may continue to serve these loads). This mode includes both normal shutdown and system trips requiring reset. The entire system must be capable of remote reset. The control system shall initiate the offline mode under the following conditions and remain in the offline state until a reset signal, either local or remote, is initiated.

- Emergency trip operation
  - AC circuit breaker trips that isolates the Project from the grid such as direct transfer trip or other system protection
  - Smoke/fire alarm and suppression operation

3.2.2 Standby

The Project controller should close the inverter AC output contactor after synching, but neither charge nor discharge, and only draw necessary auxiliary load or power required to maintain a requested SOC (if requested). Under certain conditions, the system may spend long amounts of time in standby mode. The Project is expected to maintain a state of charge of 100% (or other SOC setpoint as provided from the Owner's controller) and be prepared to respond to a signal for P or Q dispatch within the specified time. The Project controller will maintain a requested SOC within +/-1%.

3.2.3 Contingency Reserve

The Project must respond from an idle state to a request for contingency reserve within two seconds of receiving the command. From that time, the facility will ramp up at a rate of at least 20MW per minute until the full rated active power output of the system is achieved. The full rated active power output shall be maintained according to the Customer's P setpoint. If the Project becomes depleted of charge prior to the completion of the service and the Customer's P setpoint is not reduced, the Project will ramp-down and go into standby mode. It will not recharge until the Customer sends a P command with a negative polarity.

3.2.4 Frequency Response

This dispatch is controlled by a central controller in the Owner's SCADA system. When this service is dispatched, it is a result of the Owner's system sensing a drop in frequency of a pre-defined magnitude. In this situation, the Owner's site controller will send a P setpoint of a particular value and maintain that value for three minutes. After three minutes the output will be ramped back to where the original P setpoint was. This active power setpoint is in addition to whatever P setpoint might already be in place. For example, if the project is operating with a setpoint of -10MW (charging at 10MW), when frequency response is initiated, the Owner may send a P setpoint +5MW, thus resulting in a net change of real power of +5MW. This would be maintained for 3 minutes and then ramped back to -10MW.

The Project must respond from a standby state to a request for frequency response within two seconds of receiving the command.

3.2.5 Active Power Regulation in Response to Area Control Error (ACE)

The Project shall charge or discharge in response to the Owner's P setpoint, received from the Owner's site controller.

The Project must be capable of performing regulation according to Area Control Error (ACE) signals. The control for this service will originate from the Owner's plant controller. The Project must be able to respond to these MW signals within four seconds or less. Response is defined as the time from the Project controller receiving a MW setpoint until that steady-state MW output is achieved.

The Project shall be capable of both positive (supplying) and negative (absorbing) active power setpoints, which may be of any magnitude up to 100% of the system's real power rating. Over time, these active power setpoints are intended to be energy neutral (no net gain or loss in energy). In the event battery SOC is at a level where the requested setpoint (either positive or negative) cannot be met, the Project controller shall respond only to active power setpoints for the polarity it can achieve. The Project will resume responding to MW setpoints of both polarities once the battery SOC has returned to an acceptable range.

Contractors must stipulate clearly how the thermal limitations of their system would affect this service.

3.2.6 Reactive Power Regulation

The Project will respond to reactive power setpoint requests from the Owner's plant controller within four seconds. Setpoints may be constant (fixed) or variable reactive power outputs in order to maintain voltage using closed-loop proportional integral control (an application residing within the Owner's site controller). The Project must be able to regulate reactive power to within +/- 1% for reactive power setpoints between 10% and 100% of the Project's reactive power nameplate rating.

The only limitation for providing this service must be the overall MVA rating of the Project, with active power setpoints having precedence over reactive power setpoints.

3.2.7 Manual/HMI

The Project shall be capable of being operated manually from a local operator HMI. All Project functionalities shall be available via this HMI including all control modes, operating parameters or setpoints and monitored information/status.

This operator HMI shall be capable of disabling other control modes from operating and signals being received from the Owner's other integrated systems in order to operate solely in local mode.

3.2.8 Frequency/Watt Service

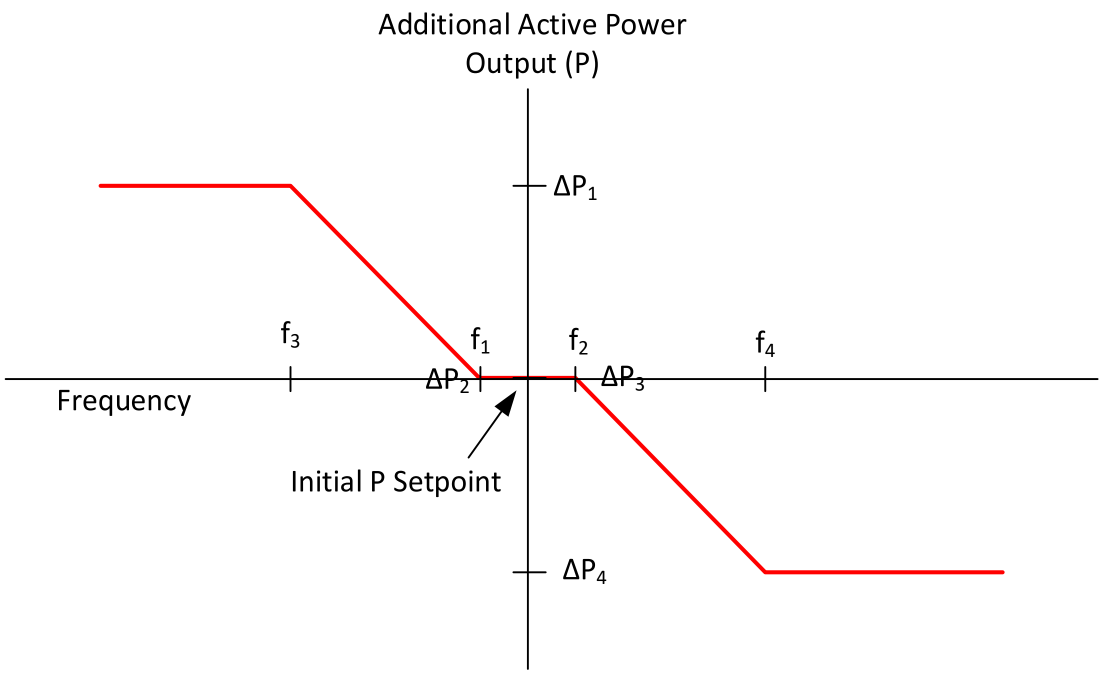
This control mode should be a feature of the Contractor's SEC. As a default, this mode should operate as described in IEEE 1547 Clause 10 – Interoperability. Alternatively, if the Contractor can achieve the same result with alternative means, that is acceptable.

Frequency support shall be an open loop response to frequency fluctuations from 60Hz as measured at the PCS terminals. The inverter real power response is proportional to the frequency offset from the frequency deadband and the defined freq/watt curve. The total system output is the sum of the active power resulting from the P setpoint and the delta power provided by frequency support.

If the frequency drops below the limit value defined by f2, the battery algebraically increases active power output (increases discharge power or reduces charge power) according to a slope defined by the Owner-configurable table. If the frequency exceeds the limit defined by f3, the battery decreases discharge or increases charge power according to a slope defined by the ΔP1/ f4.

Frequency support is enabled by the Owner's site controller sending a "1" to the "FreqActive" register.

Parameter	**Description**	**Units***	**Example**	**Range***
FreqActive	Activate frequency support mode	-	0	[0-1]
FreqLow (f_1)	Low frequency deadband setpoint	mHz	59.964	Fnom – 4Hz
FreqHigh	High frequency deadband setpoint	mHz	60.036	Fnom + 3Hz
FreqLowDelta	Frequency delta for low frequency	mHz	100	[0-2000]
FreqHighDelta	Frequency delta for high frequency	mHz	100	[0-2000]
PowerLowDelta	Power change for low frequency support	Watts	5000	≥0
PowerHighDelta	Power change for high frequency support	Watts	5000	≤0



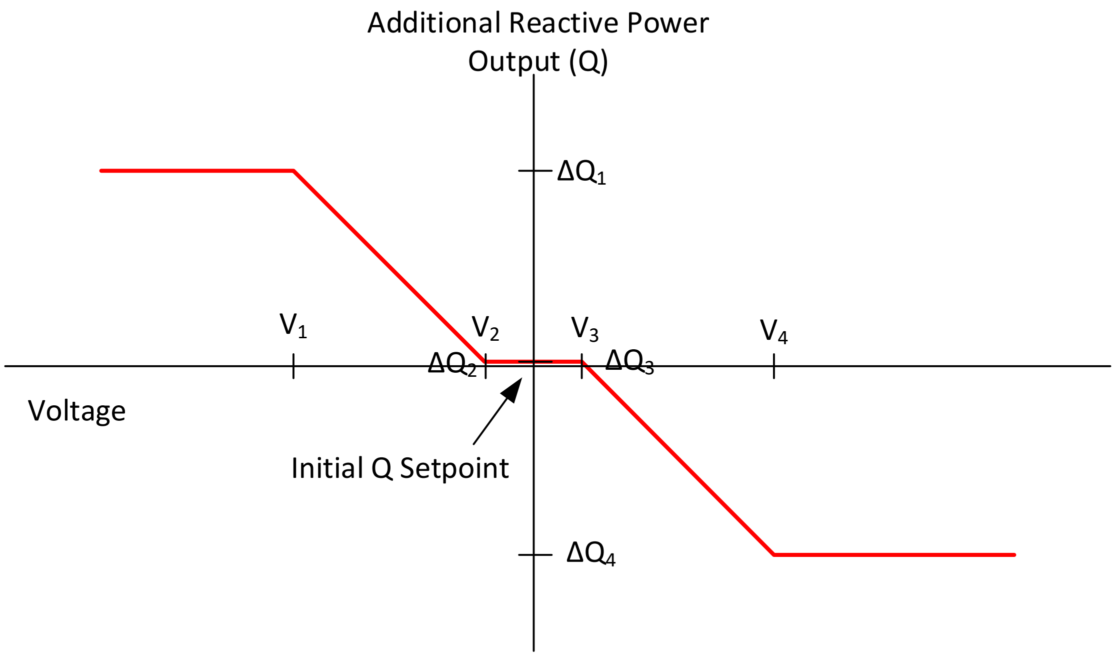
3.2.9 Voltage Support (Volt/VAr) Service

As a default, this mode should operate as described in IEEE 1547 Clause 10 – Interoperability. Alternatively, if the Contractor can achieve the same result with alternative means, that is acceptable.

Volt/VAr service shall operate as an open loop response to voltage deviations from nominal system voltage as measured at the inverter terminals. The inverter's reactive power response shall be proportional to the voltage offset from the nominal voltage as defined in a user-defined Volt/VAr table. Contractor shall make data tags available to Customer's SCADA system to populate this table. The total system reactive power output shall be the sum of any existing Q setpoint and the additional reactive power requested by the Volt/VAr service.

The Customer shall be able to configure the Volt/VAR slope through a parameter table such as that shown below:

Parameter	Description	Units	Default	Range
Volt/VAr Service Active	Enable Volt-Var mode	-	0	0-1
V1	Low voltage setpoint 1	0.1%	1000	0-2000
ΔQ1	MVARs at low voltage setpoint 1	0.1%	0	-1000 – 1000
V2	Low voltage setpoint 2	0.1%	1000	0-2000
ΔQ2	VARs at low voltage setpoint 2	0.1%	0	-1000 – 1000
V3	High voltage setpoint 3	0.1%	1000	0-2000
ΔQ3	VARs at high voltage setpoint 3	0.1%	0	-1000 – 1000
V4	High voltage setpoint 4	0.1%	1000	0-2000
ΔQ4	VARs at high voltage setpoint 4	0.1%	0	-1000 –



4.0 TECHNICAL REQUIREMENTS

4.1 General

The Project shall include the ESS, PCSs (inverter(s)), pad-mount transformers, cabling, shelters, metering, all associated control and communication interface systems, all switchgear and other interconnection equipment and all auxiliary loads necessary to support its operation to the point of interconnection with the utility.

All loads necessary to operate and protect the Project, such as controls, cooling systems, fans, pumps, and heaters, are considered auxiliary loads internal to the ESS.

The Point of Interconnection (POI) shall be defined per the Scope of Work and indicated in Appendix B which shall be submitted by Contractor at the time of bid submittal.

4.2 Storage Capacity

The Project shall be rated in terms of net delivered power and energy to the POI. All system loads and losses, including wiring losses, transformer losses, losses through the contactor/static switch, power conversion losses, auxiliary loads, and chemical/ionic losses are considered internal to the Project and ratings are net of these loads and losses as measured to the POI.

In such cases where auxiliary loads (such as cooling systems) are periodic in nature, ratings may be described for conditions in which these loads are active in the worst-case conditions.

The Contractor shall scale the reported SOC of the ESS so that 0-100% represents the maximum range of operational (usable) energy storage capacity available to the Owner regardless of the actual SOC of the system. A reported 0% SOC shall indicate that no further discharge of the system is permitted, and a reported 100% SOC shall indicate that no further charging of the system is permitted. This range shall permit the Owner to fully realize the rated energy storage capacity of the system (i.e. for a 1.0-megawatt hour [MWh] system, the Owner shall be able to discharge 1.0 MWh of energy when discharging from a reported 100% to a reported 0% SOC) as measured at the POI.

4.3 Ratings

Following are fundamental Project unit ratings. Note that power, energy, and ampacity ratings apply through the full operating temperature range, as defined for the Site unless otherwise noted.

4.3.1 AC Voltage

Nominal interconnection voltage is 12.47 kV [±5%] for Projects connected to Owner' primary system.

4.3.2 Round-trip Efficiency

The roundtrip AC-AC energy efficiency, measured at the POI, shall be provided and include parasitic and auxiliary losses under worst-case conditions prescribed in the FAT Plan.

The calculation is as follows:

$$\boldsymbol{\eta} = \frac{\boldsymbol{kWh_{out}}}{\boldsymbol{kWh_{in}}} \times \mathbf{100\%} = \frac{(\boldsymbol{rated\ discharge\ power}) \times (\boldsymbol{discharge\ time})}{(\boldsymbol{rated\ charge\ power}) \times (\boldsymbol{charge\ time}) + \boldsymbol{losses}} \times \mathbf{100\%}$$

In which the discharge time is from a fully charged to fully discharged energy storage, and charge time is from a fully discharged to fully charged energy storage. If the auxiliary power is provided by a separate connection from the energy storage, these measured values should be reflected in the losses term in the equation.

4.3.3 Parasitic Losses

The total ESS unit losses shall be determined for standby operation, including power electronics and any environmental controls such as HVACs.

4.3.4 Self-Discharge

Contractor shall provide self-discharge characteristics.

4.3.5 Basic Insulation Level

The ESS AC system equipment shall have a Basic Insulation Level (BIL) in accordance with the IEEE for each piece of equipment.

4.3.6 Inrush Capability

It may be advantageous to the Owner for the Project to have short time overload capabilities. This may occur for power system disturbances in which both real and reactive power is required for a short period of time to control both frequency and voltage excursions.

The Contractor shall provide a curve showing the inherent overload capability (if any) of the Project as a function of time. It is not a requirement of the Specification to design specific overload capability into the Project.

For projects that include islanding, the ESS shall have capability for 1.5 x rated MW and 1.5 x rated MVA for one minute. This inrush duty will be four times per hour on top of continuous, full load.

4.3.7 Auxiliary Voltage

Auxiliary voltage will be site specific.

4.3.8 Power and Energy

System ratings are defined in kVA (AC) or MVA (AC) and kWh (AC) or MWh (AC) as measured at the POI.

4.3.9 Design Ambient Temperature Range

System shall be designed for an ambient temperature range of 0°F (min) to 118°F (max).

4.3.10 Audible Noise

The maximum sound level generated from the Project and any associated equipment supplied by the Contractor under any output level within the Project operating range, shall be limited to levels specified by Applicable Laws, including any applicable local noise ordinance(s). The Contractor shall comply with all Applicable Laws that may apply to the Project installation as determined by the jurisdiction applicable to the site.

The audible noise level in the Project control room if separate from areas housing inverters, cooling equipment, etc. shall meet OSHA requirements for normally occupied areas.

The Contractor shall make audible noise measurements before and after commissioning of the Project for the purpose of verifying adherence and compliance with the local ministerial ordinance and requirements. The measurements shall be made at various locations using a Type 1 sound level meter that complies with the requirements of ANSI S1.4-1983 "American National Standard Specification for Sound Level Meters."

4.3.11 Broadband Interference

The Contractor shall take necessary precautionary measures to ensure that there will be no mis-operation, damage or danger to the Project due to broadband interference and effects. The

Contractor shall ensure that there are no discharge sources from the Project and related equipment that could cause interference with radio and television reception, wireless communication systems, or microwave communication systems per the 47 CFR Part 15. The Contractor shall propose any necessary mitigation to ensure that communication is not adversely affected.

The Contractor shall make measurements before (or with all equipment de-energized) and after commissioning of the Project for the purpose of verifying compliance with the broadband interference requirements.

All broadcast signals, radio noise, television interference and broadband interference measurements shall be made with instruments that comply with the latest revision of ANSI C63.2, “American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specification.” IEEE Standard 430, “IEEE Standard Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations” defines the measurement procedures that shall be used.

4.3.12 Interference and Harmonic Suppression

The PCS shall not produce EMI that will cause mis-operation of instrumentation, communication, or similar electronic equipment within the Project or on the Owner system. The PCS shall be designed in accordance with the applicable IEEE standards to suppress EMI effects.

The Project must meet the harmonic specifications of IEEE 1547 and IEEE 519 and comply with requirements outlined in the Energy Storage Integration Council (ESIC) technical specifications spreadsheet. Harmonic suppression may be included with the PCS or at the Project AC system level. However, the Contractor shall design the Project electrical system to preclude unacceptable harmonic levels in the Project auxiliary power system.

4.4 External AC Power Interface(s)

4.4.1 Termination

All terminations and locations of terminations shall be pre-approved by the Owner and specified in the appropriate submitted drawings. The Project shall comply with any applicable owner interconnection standard.

4.4.2 Isolation/Disconnect

An interconnection isolation disconnect device shall be placed directly on the line side of each metering section. The disconnect device shall be lockable and have a visible break or visible open. The device does not have to be rated for load break nor provide over-current protection. The Owner shall have full access and control over this device.

A LV source side isolation contactor shall be provided. The disconnect breaker shall be lockable and have a visible break. It shall be capable of breaking the full rated power of the system. The contactor will be operated by SEC and will also have provisions to be operated manually. The utility will have full access and control over this device.

4.4.3 Use for Auxiliary Power

The auxiliary power system shall include, but is not limited to, all step-down transformers, breakers, fuses, motor starters, relaying, uninterruptable power supplies, panels, enclosures, junction boxes, conduits, raceways, wiring and similar equipment, as required for the Project operation.

All uninterruptable power supplies must be provided with a Modbus Ethernet connection for monitoring.

The aux transformer will require a remote mounted 13-jaw electric meter socket to accommodate a Schneider Ion 8650 revenue meter. This meter must have a Modbus Ethernet connection to the Customer’s site controller.

4.4.4 Power Quality Metering and Telemetry

Contractor shall provide its own Current Transformers (CT) for protection and internal metering, and controls for Project operation. Contractor to provide local utility compliant metering and telemetry. Contractor to provide Potential Transformer (PT) connection points for synching and telemetry. Contractor to provide one revenue grade power quality meter installed on the line side of the main breaker to validate system performance. This meter must have a Modbus interface via Ethernet connection.

4.4.5 System Protection Requirements

Contractor shall adhere to rules and regulations described on the Owner’s Electric Distribution System Interconnection or Generation Interconnection Handbook if available. For the avoidance of doubt, the requirements of the applicable Interconnect Handbook shall apply to all aspects of the project and not just the system protection. If Owner Handbook is unavailable the contractor shall adhere to IEEE and Manufacturer device setting recommendation for protective system settings.

Protection and coordination for the “plant-side” system including batteries, DC combiner panels, inverters, AC combiner panels, transformers, auxiliary systems, and switchgear (where applicable) shall adhere to IEEE 242.

Protection relays for the interconnection shall be utility grade and shall meet the minimum requirements specified in IEEE C37.90 (latest edition) including requirements for EMI and surge withstand according to applicable standards for the intended location of the Project. A complete protective relaying system based on Industry Standards shall be a part of the AC system. The protective relaying and metering shall be integrated with the Project control system and a communications channel provided to the Owner’s SCADA system. However, integration into the Project control system shall not circumvent normal protective relaying functions.

All protective equipment and schemes shall be properly coordinated with the Owner protection engineering department. The Contractor shall use Schweitzer Engineering Laboratories (SEL) microprocessor-based protection equipment to the extent practical. When SEL microprocessor-based protection equipment is not practical, Owner shall approve of equipment Contractor proposes to be used. The interconnection relay shall be a SEL relay with Mirrored Bits capability (either an SEL 351 or SEL 751). The low side bus and cable shall be protected by multifunction feeder protection relays. Testing of protection equipment shall be conducted by International Electrical Testing Association (NETA) certified technicians. The NETA certification number of the tester shall be documented on all test reports.

4.5 Coordination of Controls

The Contractor shall provide a fiber optic communications pathway specifically for mirrored bits communications with the Owner's relaying at the interconnection distribution switch. This communications pathway will provide breaker status, permissions to island, black start and operate in parallel as appropriate.

4.6 Instrument and Control Wiring

In general, and where practicable, control and instrumentation wiring shall be designed and installed to minimize any and all electrical noise and transients. All cabling shall be new and continuous for each run; splices are not acceptable. All conductors shall be copper.

All cabling which may be exposed to mechanical damage shall be placed in conduit, wireway, overhead tray, or other enclosures suitable to the Owner. Wires shall have identifying labels or markings on both ends. The labels shall identify the cable tag, and opposite end destination. Each wire in the system must have an accompanied drawing and location reference.

Control and instrumentation wiring shall be separated from power and HV wiring by use of separate compartments or enclosures or by use of separate wireways and appropriate barrier strips within a common enclosure as required by the NEC.

Project and PCS control and instrumentation system wiring shall be bundled, laced and otherwise laid in an orderly manner. Where cable is in wire trays, waterfalls shall be used, as necessary. Wires shall be of sufficient length to preclude mechanical stress on terminals. Wiring around hinged panels or doors shall be extra flexible (Class K stranding or equivalent) and shall include loops to prevent mechanical stress or fatigue on the wires.

Cable insulation material shall be thermoset composition rated for 90˚C during normal operation. Insulation and jackets shall be flame retardant and self-extinguishing and shall be capable of passing the flame test of IEEE Standard 383 or IEEE 1202. Raceway and cable systems shall not block access to equipment by personnel.

Where appropriate, Fiber Optic Cable used for instrument and/or control shall be ruggedized indoor/outdoor breakout, riser rated, orange jacket, four fiber, 50/125um MM giga link 600 fibers, 2.5 mm, RoHS, standard strip.

Ethernet cable that is run in conduit underground must be rated for wet locations or direct bury. No Ethernet cables shall be actually direct-buried.

4.7 Modular Replacement

The Project PCS, control, batteries and current sensors shall be connected in a manner that enables field replacement. It is expected that most maintenance will be accomplished while maintaining partial service. The physical and electrical arrangement shall permit module replacement with the isolation breaker/contactor closed and the PCS disconnected. For CTs, this means that shorting test switches must be used.

Owner shall not be required to provide additional space or resources to accommodate the battery module replacement or supplementation. Contractor shall reserve the appropriate spacing and clearance per NESC into the design of the Project to accommodate battery module replacement and supplementation.

4.8 Physical Characteristics

The Project shall meet all applicable OSHA, NEC, IEEE, ANSI, and NFPA requirements for electrical and fire safety.

The Project shall be designed to minimize footprint and volume. The Project may also be designed to include subsurface components or modules, provided relevant operating and environmental factors normally addressed for submersible equipment are considered to assure full life-cycle performance requirements are met.

The Project components located outdoors shall be contained within weatherproof, tamper resistant, metal enclosures suitable for mounting outdoors on concrete pads with a minimum NEMA 3R rating. NEMA 3R: Types 3R, 3RX: Rain-tight, sleet-resistant. Indoor or outdoor use. Same protection as Type 1, but adds a degree of protection against ingress of falling dirt, rain, sleet and snow; also protects against damage due to external ice formation. Rust-resistant. The “X” designation indicates corrosion-resistance.

Any enclosures shall be dust tight to at least the NEMA 3R rating, except as designed to allow forced air exchange with the atmosphere.

Project Modules PCS, and controls shall be accessible and removable for replacement. The Project shall be designed to operate with minimal maintenance for at least five years.

A nameplate shall be provided including:

- Manufacturer Name
- Connection diagram
- ESS ratings; Power, energy, voltage, BIL
- Specimen data; serial number, date of manufacture
- The nameplate shall meet the requirements of IEEE C57.12.00

All necessary safety signs and warnings as described in ANSI Z535-2002 (entire series from Z535.1 through Z535.6), NEC, and NFPA 855 shall be included on the building, shelter or each enclosure. All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the building, shelter or each enclosure.

4.9 Cycle Life

The ESS must be designed to achieve a minimum lifetime of 20 years for continuous operation with minimum scheduled downtime for inspections and maintenance. End-of-life is defined as when the ESS reaches 80% of the nameplate rated capacity at the time of installation. If the ESS is subject to capacity degradation, the design must accommodate future augmentation as required to maintain nameplate rated capacity, taking into consideration the specified operating profile. See the ESIC technical spreadsheet in Appendix G for cycle life requirements to various depths of discharge over the anticipated ESS lifetime.

The Contractor shall provide a graph or set of graphs that displays the relationship between depth of discharge, discharge energy throughput, operating temperature, C-rate, resting state-of-charge, and other relevant parameters and the corresponding capacity degradation experienced by the ESS.

Cycle counting shall be accomplished by applying a filter for each of the specified depth of discharge levels or based on other methodology proposed by the Contractor and agreed to by Owner. Contractor shall propose a methodology for tracking all other parameters that effect ESS capacity.

The Project will be designed to provide the equivalent of at least two (2) cycles per day and a maximum of 365 cycles per year.

4.10 Battery Management System

As a subcomponent of the Project, a Battery Management System (BMS) shall be included to manage the operational health of the Project, provide cell-by-cell diagnostics information and assure its safe and optimal performance of the energy storage system as an interconnected asset to the Owner’s electrical system. The BMS shall be specifically built by the battery manufacturer for that battery system. If the battery manufacturer uses a third party BMS, the Contractor must provide detailed a description of how that BMS was custom designed for the application. Primary functions include but are not limited to:

- Monitoring:
  - State of Charge
  - State of Health
  - Voltage/Current
    - String
    - Bank (if applicable)
  - Temperature
    - Module Internal
    - Various Ambient
    - Highest cell temperature
    - Average cell temperature
  - Status

  - Contactor status
  - Energy Throughput
- Maximum charge/discharge current or power
- Active Cell Balancing (Passive voltage balancing is not acceptable)
  - Cell voltage
- Warning and alarms
- Internal protective measures
- Logs of operations
- Management of any software versions
- Cyber Security management of the device itself
- Provide data exchange to the SEC
- Contribute to functional safety of overall Project

4.11 Power Conversion System

The PCS shall be listed to UL 1741 Supplement B and shall comply with IEEE 1547-2018 for distribution-connected projects. PCS connected at the transmission level shall comply with IEEE 2800. The PCS must be capable of delivering any combination of active power and reactive power that results in the following equation being true: $\text{apparent power}_{rated}=\sqrt{\text{active power}^2+\text{reactive power}^2}$ and as defined by the inverter P-Q capability curve; provided that at the system level there may be restrictions on reactive power output if the setpoint is chosen to boost system voltage that is already higher than nominal or reduce system voltage that is already lower than nominal.

The PCS shall be a static device (non-rotational) using solid-state electronic switch arrays in a self-commutated circuit topology. Line-commutated systems or systems that require the presence of utility voltage or current to develop an AC output are not acceptable. Only commercially proven switch technology and circuit designs are acceptable.

The PCS, in conjunction with the Project control system and the BMS shall be capable of completely automatic unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect functions.

The control of the PCS shall be integrated with the overall Project control system. However, the PCS also shall include all necessary self-protective features and self-diagnostic features to protect itself from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. The self-protective features shall not allow the PCS to be operated in a manner that may be unsafe or damaging. Faults due to malfunctions within the PCS, including commutation failures, shall be cleared by the PCS protection device(s) or external protection devices. Such faults shall be acknowledged, cleared and reset remotely.

All PCS components shall be designed to withstand the stresses associated with steady state operation, transient operation and overload conditions as required by this Specification. The

Contractor shall demonstrate that all relevant aspects of overvoltage stresses have been considered.

The PCS system shall include provisions for disconnection on both the AC and DC terminal(s) for maintenance work. Conductor separation must adhere to the requirements of the Owner's Generator Interconnection Handbook, the Owner's Distribution Interconnection Handbook, or IEEE standards and best practices. These disconnecting devices shall be capable of being locked open for maintenance work. Any PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 volts within five minutes of de-energization per UL1741 requirements.

The PCS or battery system must have DC bus pre-charging functionality or other means of arc mitigation during switching of the DC disconnect devices.

Outdoor located PCS electronic compartments shall be NEMA 4 at a minimum and the overall enclosure rating shall be a minimum of NEMA 3R. PCS shall meet IEEE 519 and IEEE 1547 for harmonic content. Total harmonic distortion shall not exceed IEEE 519 requirements.

PCS cooling system shall not be susceptible to particle contamination and require minimal scheduled maintenance. The PCS shall be furnished with nameplates or stickers that are suitable for the environment. Nameplates shall be located to be visible with equipment installed and operating. Each nameplate shall indicate the following information:

- Nameplate ratings
- Component name
- Manufacturer's name
- Serial number
- Year built (or may be found in a reference document based on serial number)

4.12 Site Energy Controller

The Project shall include all necessary software applications and supporting hardware required to meet the specified functional requirements. Software algorithms, external data input capabilities, and user interfaces shall provide for user specified variable input or set point values, as well as external data value streams required by programs directing the Project operations.

The Project shall include the necessary communication and telemetry hardware, and support communications protocols, to effectively provide the required services. No single mode of failure shall result in loss of power to the control and data acquisition module. The control shall include provisions for an orderly and safe shutdown in the absence of utility power.

4.12.1 Operations and Control Functions

The SEC shall be the primary dispatching location for local monitoring and control command functions, and is responsible to perform the following by priority in this order:

- Protect itself (isolate for any internal fault)

- Remain within power constraints (transformer and Project ratings)
- Remain within frequency constraints
- Remain within voltage constraints
- Remain within operating temperature constraints
- Isolate in response to system anomalies
- Charge/discharge Real Power and Reactive Power in response to SEC programs or external commands
- Communicate status and diagnostic data

The SEC shall respond to commands issued remotely or locally, including but not limited to:

- Change Modes (e.g. charge, discharge)
- Startup/Shutdown
- Change Status (enable/disable)
- Reset Alarms
- System Reset/Restart

The SEC shall respond to the following modes of operation:

- Controller must be able to transition from one setpoint within a given mode of operation to another setpoint within the same mode without ceasing operation. Changing of output from an existing inverter setpoint to any other setpoint as a transition step (e.g. returning inverter to 0 output) before executing next command will be considered unacceptable.
- Controller must be able to accept and validate a given setpoint command prior to executing a given operation mode. For example, if the Owner sends a command for the BESS to discharge at 1.0 MW in constant real power output mode, the controller must be able to validate and accept the 1.0 MW setpoint prior to it initiating constant real power output mode. Setpoint validation will vary depending on the control mode command but may include limits associated with state of charge, facility ratings, ramp rates, system operating conditions, etc.
- For Projects that include either black start or islanding functions, the Controller must be able to switch from current source mode to voltage source mode and back via a single remote-control point (“Voltage Source Inverter Mode”), as well as a local point on the Human Machine Interface (HMI).
- Controller must be able to open and close inverter contactors via remote control points. Controller must also be able to open and close inverter breakers if those breakers are motor operated. Controller must be able to reset all applicable system alarms via a remote-control point.

- Controller must be able to conduct real and reactive power operations completely independently of one another until the apparent power limit of the asset is reached.
- Controller shall allow for the prioritization of either real power setpoints over reactive power setpoints or reactive power setpoints over real power setpoints once the apparent power limit of the asset is reached. Prioritization shall be indicated via remote commands from the Owner.
- Controller shall assign a positive sign convention to system real power output information when the system is discharging (real power).
- Controller shall assign negative sign convention to system real power output information when the system is charging (real power).
- Controller shall assign a positive sign convention to system information when the system is injecting reactive power (acting like a capacitor). This should be considered a leading PF.
- Controller shall assign a negative sign convention to system information when the system is absorbing reactive power (acting like an inductor). This shall be considered a lagging PF.
- Controller sign convention for real and reactive power commands shall match the desired convention assigned to system information reporting. In other words, positive real power commands refer to discharging, negative real power commands refer to charging, positive reactive power commands refer to injecting vars, and negative reactive power commands refer to absorbing vars.
- Specific to the Target State of Charge or Energy (SOC) operational mode, the Controller shall ensure the system reaches the commanded SOC setpoint and then not dispatch the system until after the SOC falls outside the commanded SOC deadband.

4.12.2 Loss of Communications

The Project shall remain functional in the absence or loss of communication from the Owner's site controller. The Project shall continue its current mode of operation for a set time period (variable setting, 15-minute default). On expiration of the time, the Project shall ramp to standby mode at a selectable ramp rate (25MW/minute default).

During an interruption to communications, the remote controller will make repeated attempts to re-establish communications at a set time interval (variable setting, default of five minutes). When communications have been re-established, the Project and remote controller shall automatically make any necessary updates or resets to resume performance. Once the system is again ready, it shall remain in standby mode until a new setpoint is sent by the Owner's site controller.

4.12.3 Monitoring, Data Logging, Alarms, and Status

Alarms

- Alarms shall be provided for all critical ESS parameters (see Appendix E for more details).
- Alarms shall be provided for all critical balance of plant system parameters (see Appendix E for more details).

- Owner shall have the ability to acknowledge and clear alarms remotely through the Owner's site controller.
- An alarm log with time stamps shall be provided.
- Details or help screens shall be provided for each alarm.
- An alarm matrix shall be provided to show the relationship and hierarchy of all alarms.

The SEC shall provide relevant status information, for feedback to the utility supervisory control system. The telemetry points should include:

- Operation Control
- Operation Status
- System Information
- AC/DC Status
- Status
- Device Status and Error Codes (Alarms)
- Data Logging:
    - Log of Operations for one year on-site. Life-of-project duration for off-site log.
    - Historical data and trending for one year on-site for a limited set of parameters as agreed with the Owner. Life-of-project duration for off-site data.

4.13 Network Communications

The Project and all its subcomponents required for operation shall be configured to be on its own sub-network, separate from any Owner communications network. All such work shall comply with M1-05-04 (Communication, SCADA, and Metering Facilities Facilities).

- Communication between the energy storage system and any Owner IP network shall be accomplished using a managed gateway between the Contractor-provided energy storage system and any Owner IP-based network (such as a Cooper SMP or SEL RTAC).
- DNP3 is the preferred communications protocol for external communications between Owner networks and the Contractor's energy storage systems. This must be accomplished without the use of an additional communications gateway device. If the Contractor's SEC cannot accommodate DNP3 protocol, then Modbus TCP/IP may be used. A secure, encrypted site to site IP virtual private network (VPN) tunnel may be established between the Owner and the Vendor to allow the Vendor remote access to the Project for monitoring and support purposes. The Owner firewall will deny IP traffic by default and allow authorized IP traffic only by exception. Vendor will provide a detailed list of devices and protocols that require access for remote support. The contractor will provide and maintain a list of Contractor's employees who need this VPN access. These employees will be assigned Owner's employee credentials and network credentials for remote VPN access. These employees will be required to complete various annual cybersecurity and regulatory training to maintain this access.

- Any additional Contractor or Vendor external communications to the energy storage system are prohibited. This includes analog lines, cellular modems, wired or wireless communications circuits, internet connections, cloud, or any other connection methods. If the Contractor requires alternate external communications, these must be submitted to the Owner for review. If the Owner grants approval, it is the sole responsibility of the Contractor to provide, install, secure, and maintain. The Contractor shall pay all installation costs and reoccurring charges for approved communications. For cybersecurity purposes, the Owner will not interconnect any Vendor network that has Internet access with any Owner routed IP network or networked device.
- The Project's HMI for control shall be able to be controlled by the Owner electric control centers using a TCP/IP routable protocol specified by the Owner.

Contractor shall provide its proposed network and communications block diagram to include identifying all cable and protocol types (DNP3, Modbus, IEC61850, CAN serial modbus, etc.).

The solution shall use wired connections for communications. If the Contractor wishes to include wireless communications in the proposal, these must be submitted to the Owner for review. The Contractor shall provide a list of any proposed wireless communications devices, security methods and encryption standards, the associated protocols, and a list of endpoint devices that would be connected.

Contractor provided communications equipment shall be suitable for the intended purpose and the environment where it is installed. Contractor shall use hardened devices that support extended temperature and humidity where required. For key system communications, the equipment should have built in high availability or redundancy capabilities, or separate redundant devices should be used.

Any Contractor-provided LAN switch implemented as a part of the Project shall have a switch port configured as a SPAN port, to which an Owner network anomaly detection appliance may be attached to span the traffic to identify and alert on apparent cybersecurity issues.

The proposed solution shall provide communications for any required security and fire alarm systems, including fire and first responders, in compliance with all Applicable Laws and Owner standards. The solution shall be capable of communicating with Owner-selected Remote Terminal Unit (RTU) via currently supported protocols and cabling types, as assisted by an Owner Interface.

The Project's Owner-facing network and firewall equipment shall be interoperable with Owner Networks LAN switches, routing, and firewalls, to include static routing, MPLS, OSPF, and 802.1q VLAN trunking.

4.14 Information Security

In addition to any requirements set forth below, all Project-related physical, cyber, information, and other security shall conform to M1-01-07 (Security and Compliance).

4.14.1 Contractor

Contractor shall design the Project to be hardened against willful attack or human negligence using Cybersecurity industry best practices and incorporating technical controls as applicable to the Project as outlined in the NISTIR 7628 Framework. The reference for these controls can be found through the NIST government publications for the Framework NISTIR 7628 – Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements. A summary of these controls is listed in Appendix G.

4.14.2 Application Partitioning

The Contractor shall design the Project to support integration with Role-based Access Controls, as assisted by an Owner Interface. For example, functions necessary to administer databases, network components, workstations, or servers, and typically requires privileged user access. The separation of user functionality from information system management functionality is either physical or logical.

4.14.3 Audit Logging and Reporting Mechanisms

The Contractor shall design the Project to provide logging capabilities. Preferably the logging mechanism is in a standard format like Syslog that can easily integrate with the Owner Security Integration and Event Management system.

4.14.4 Authentication and Authorization Controls

- The Contractor shall design the Project to provide the following authorization controls:
  - Log account access events, such as failed login, login, logout, session timeout.
  - Display an approved system use notification message or banner before granting access to the system that provides privacy and security notices consistent with all Applicable Laws, Executive Orders, directives, policies, regulations, standards, and guidance.
  - Prevent non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures.

4.14.5 Authenticator Feedback

The Contractor shall design the Project to obscure feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. For example, do not display a separate error message for an invalid username versus an invalid password.

4.14.6 Baseline Configuration and Configuration Settings

The Contractor shall provide a checklist of security configuration requirements / system hardening requirements for all IT assets deployed as part of the Project, as assisted by an Owner Interface.

The Contractor shall provide an asset baseline configuration for all applicable assets. For network-connected assets, the baseline configuration shall list all open/listening logical ports (both TCP and UDP), the executable that opened that port, and the underlying justification for that port being open. For all assets capable of installing software, the baseline configuration shall list all intentionally installed software and the version of that software, and all applied security patches.

All unused logical ports should be closed/disabled (per equipment capability).

4.14.7 Boundary Protection System

The Contractor shall segment trust zones using a barrier technical control such as a firewall. The barrier technical control shall be configured to deny inbound and outbound network communications traffic by default and allow inbound and outbound network communications traffic by exception.

4.14.8 Cryptographic Key Establishment and Management

The Contractor shall provide certificates that support at least SHA-2, SHA-1 certificates are not permitted. Wildcard certificates like *.example.com are not permissible and certificates must be for specific (list) of sub-domains. All PKI certificates must support SHA-256 or higher. The Contractor will provide cryptographic keys from a Certificate Authority approved by the Owner.

4.14.9 Device Identification and Authentication

The Contractor shall provide an asset inventory containing all programmable electronic devices in the Project. The asset inventory will include the following fields: Device Name, Network Name, IP Address, MAC Address, Building Location, Rack Location, Firmware version / software version, Device Description.

4.14.10 Information Input Validation

The Contractor shall provide a solution that validates user input and network input for malicious content and unstructured data within the Project. For example, user interfaces should not be susceptible to untrusted user inputs.

4.14.11 Information System Backup

The Contractor shall provide the Project with a solution that is scheduled to conduct periodic backups of user and system-level information and protect the confidentiality, integrity, and availability of the backups.

4.14.12 Information system Monitoring

The Contractor shall allow the Owner to monitor network traffic leveraging SPAN ports on switches and routers provided as part of the Project.

4.14.13 Least Functionality

The Contractor shall configure information systems to provide only essential capabilities, open ports, protocols, and services as part of the Project.

4.14.14 Malicious Code Protection

The Contractor shall provide malicious code Endpoint protection software on all assets that support it in the Project and provide a method for updating the software. The Contractor shall configure the Endpoint protection software to perform periodic scans of the information systems and real-time scans of files that are downloaded, opened or executed. The malicious code protection software will block malicious code, quarantine malicious code and send alerts to administrators of the system. Enforced Whitelisting of system software and operation may be considered an alternative to Endpoint protection.

4.14.15 Password-Based Authentication

The information system shall offer provisions for a password-based authentication. These features should include, but are not limited to, the following:

- Enforce password complexity to include case sensitivity, a minimum of eight characters, mix of upper-case letters, lower-case letters, numbers, and special characters.
- Stores and transmits only encrypted representations of passwords.
- Enforces password minimum and maximum lifetime restrictions of specific defined numbers for lifetime minimum, lifetime maximum.
- Prohibits password reuse for 10 generations.
- Allows the use of a temporary password for system logons with an immediate change to a permanent password.
- Employs automated tools to determine if password authenticators are sufficiently strong as related to above criteria of password authentication requirements.

4.14.16 Protection of Information at Rest

As part of the Project, the Contractor shall implement Information Systems that:

- Protects the confidentiality and integrity of information at rest.
- Implements cryptographic mechanisms to prevent unauthorized disclosure and modification of information on information system components.
- Securely stores off-line storage.

4.14.17 Session Authenticity

As part of the Project, the Contractor shall implement Information Systems that:

- Invalidates session identifiers upon user logout or other session termination.
- Generates a unique session identifier for each session with randomness and recognizes only session identifiers that are system-generated.
- Only allows the use of certificate authorities for verification of the establishment of protected sessions.

4.14.18 Transmission Confidentiality and Integrity

As part of the Project, the Contractor shall implement cryptographic mechanisms to prevent unauthorized disclosure of information during data transmission (e.g. VPN Tunnel).

4.14.19 Unique Identification and Authentication

As part of the Project, the Contractor shall provide the means to uniquely identify and authenticate organizational users (or processes acting on behalf of organizational users) such as Multifactor authentication. Shared user accounts shall not be permitted.

4.14.20 3rd Party Assessment

Contractor shall contract information/cyber security scans and penetration tests by an Owner-approved third-party security company, prior to Substantial Completion.

The Contractor will provide the Owner with a copy of the original report from the 3rd party security company. The Owner reserves the right to perform its own internal security testing in addition to the Contractor's testing.

Contractor shall develop a cybersecurity plan that addresses and mitigates the critical vulnerabilities inherent in both the hardware and software that comprise the control and data acquisition systems. The cybersecurity plan will include regular qualified software patches and service packs to Windows and Linux based operating systems, the underlying software and device firmware. The patches will be applied at least every 30 days with an expedited method for highly critical vulnerabilities (Common Vulnerability Scoring System Score of 19). Security related patches should continue to be applied for the duration of the system's useful life.

4.14.21 Portable Media and Laptops

As part of the Project, the Contractor shall disable all mass storage device capabilities for Windows and Linux based servers and workstations (USB drives, SD Cards, CD-ROMs, External Portable HDDs and Floppy disk drives).

Any portable device (or variant) such as process control service laptops will be regularly managed by policy to ensure it is inspected and found to be free from malicious code. Using latest version Endpoint protection with regular updates no older than 30 days. Portable devices will be restricted from connecting to a secondary network while connected to the Process Control network. The Owner may request logs and audit access to review system scans, patching and management tools to ensure compliance. Under no circumstances will the

Contractor allow its employees to access any part of the Project with their personal laptop or tablet.

4.14.22 Unused Network Ports

As part of the Project, the Contractor shall disable all unused network ports on switches, routers and firewalls.

4.15 Containment

4.15.1 Lightning Protection

Contractor shall provide a UL Master Label lightning protection system for all buildings, shelters and other structures per the requirements of NFPA 780 and UL 96A. Provide evaluation and risk assessment of remaining Owner and Contractor furnished equipment and enclosures to confirm that remaining equipment is self-protected under NFPA 780 paragraph 7.2.2.

4.15.2 Cooling Systems

The Site temperatures and the effect of temperature on component life shall be considered in developing the thermal design for all components, including the batteries and PCS. There may be several separate heat removal systems to accommodate the particular needs of Project components and subsystems (e.g. PCS, transformers). The heat removal and/or cooling system may include vapor-compression cooling system or other conventional environmental conditioning equipment. Final rejection of all waste heat from the Project shall be to the ambient air.

The cooling system shall be sized for end-of-life battery heat loss information. Total battery heat dissipation shall account for all installed batteries including any provisions for battery augmentation throughout the project life.

Air handling systems shall include filters to prevent dust intrusion into the Project. Exterior wall make-up air inlet louver shall be sized to avoid water penetration. HVAC system(s) efficiency and control requirements must comply with applicable local and national codes. HVAC system(s) for energy storage cooling shall include three or more stages. Sufficient redundancy shall be considered in the design such that no single component failure will shut down the system.

HVAC and ventilation systems shall be seismic braced/anchored. All design shall be in accordance with local and national seismic design requirements.

Evaporator coil coating shall be required if outside air is drawn from the exterior. Indirect waste from the HVAC system(s) shall be disposed per local and national plumbing codes. HVAC/ventilation design shall comply with all Applicable Laws. HVAC/Ventilation shall require interlock to the shelters fires alert system for shutdown. If explosion prevention or deflagration venting is required by the applicable safety codes and standards as a result of large-scale fire testing, activation of mechanical ventilation system activation shall require interlock to the shelter’s flammable gas detection system.

4.15.3 Fire Protection

The Contractor shall provide fire protection system for the complete energy storage system including modification of existing site fire protection system to meet all applicable codes including the 2020 Edition of NFPA 855 “Standard for the Installation of Stationary Energy Storage Systems” and the latest approved revision of the applicable local fire protection codes.

Contractor shall comply with NFPA coordination, design, installation, commissioning, testing, training and startup requirements. This shall include all other requirements as outlined in this specification. Fire Protection system design shall include, but not be limited to, the following:

- Emergency vehicle access and fire hydrants per applicable local and national codes;
- Failure Modes and Effects Analysis or other approved Hazard Mitigation Analysis (HMA) in accordance with the applicable local fire protection codes and safety standards to defend and gain alignment for the system design with all key stakeholders before the design is finalized (e.g. risk mitigation for thermal runaway prevention);
- Enclosure design in accordance with NFPA requirements for location, separation, materials of construction, ventilation, smoke or flammable conditions detection, fire suppression, communications/alarms, explosion control, training, commissioning, permitting, and documentation as required by UL 9540 listed design and applicable local codes. Unless otherwise approved by Owner and the local fire code official, design shall include:
    - Smoke detection system in accordance with NFPA 72.
    - Off-gas detection.
    - Fire control and suppression with automatic sprinkler system per NFPA 13 or other approved automatic fire control and suppression systems or equivalent. based on reports issued as a result of large-scale fire testing.
    - Permanent source of water for fire protection. If water source is not available on site, water storage tank and all other necessary equipment shall be provided internal to the enclosure.
    - Explosion prevention system designed and installed per NFPA 69 or deflagration venting installed per NFPA 68.
- The fire alarm control panel shall provide supervised addressable relays for HVAC controls. The HVAC Engineer shall design and specify startup and testing services to support the interface with the Fire Protection System and ensure that the HVAC is controlled as designed. Alarms shall clearly annunciate location of detected condition within building or by individual enclosure.
- Startup and testing of the Fire Protection System will be provided by the fire protection contractor in accordance with NFPA requirements.
- Fire suppression chemicals shall be selected based on their effectiveness and also based on their long-term availability. Some common fire suppression chemicals such as Novec and FM200 are being phased out and these chemicals shall not be used.

Contractor will provide an Emergency Operations Plan that includes emergency procedures to be followed in case of potentially dangerous conditions, in addition to response conditions similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment.

If lithium-ion batteries are proposed as the storage medium, the Contractor shall provide an optional price for a lithium-ion battery fault detector utilizing an off-gas sensing system that will detect off-gassing at the cell level. This system shall be integrated into the Contractor's control system and/or site controller.

4.16 Station DC System and Uninterruptible Power Supply

The Project shall be equipped with a Station DC system and/or a UPS to power essential functions in the event of a total failure of auxiliary supply systems(s) if required for orderly shutdown. The provided DC system/UPS shall comply with the applicable standards. The UPS must have a minimum of four hours of back-up power for power essential functions (including but not limited to EMS control power and communications rack power). All UPSs must have Modbus Ethernet connections for monitoring by the Owner's SCADA system. Protective relays must have a minimum of 8 hours of backup power.

4.17 Energy Storage System Design

The Contractor shall design, furnish and install an Energy Storage System (ESS) that meets all the requirements of the Agreement, including this Specification.

4.17.1 Cells and Modules (if applicable)

The energy storage shall consist of cells of proven technology designed for the type of service described herein. For the purposes of this Specification, proven technology shall be defined as cells that have been in successful commercial service in similar type applications for a period of time sufficient to establish a service life and maintenance history. Only cells that are commercially available or for which suitable (not necessarily identical) replacement cells (or modules or strings) can be supplied on short notice throughout the Project life will be allowed. Cells shall be listed to UL 1642 and manufacturer must provide UL certificate prior to shipment to Project Site.

The cells may be supplied as separate, individual units or as a group of cells combined into modules. Modules shall be listed to UL 1973, and UL 9540 and manufacturer must provide UL certificate prior to shipment to Site.

Cell construction and accessories (as applicable) shall be sealed to prevent electrolyte seepage. Post seals shall not transmit stresses between the cover or container and the posts. Cell terminals and interconnects shall have adequate current carrying capacity and shall be designed to withstand short-circuit forces and current generated by the energy storage. Safety features shall be designed into each cell in accordance with UL 1642, UL 1973, and UL 9540.

DC Contactors will disconnect the string from the circuit during high temperature conditions but will reconnect once the cell temperatures reach an acceptable range and other conditions are met allowing reconnection. Labeling of the cell (or modules) shall include manufacturer's name, cell type, nameplate rating and date of manufacture, in fully legible characters or QR code. Contractor shall provide a list showing all the modules by their unique identification number along with their corresponding physical location within the project site. The unique identification numbers shall correspond to their identification within the Project so to provide easy location of all cells or modules.

The energy storage subsystem and its individual cells shall be designed to withstand seismic events as described herein. The batteries may consist of one or more parallel strings of cells.

DC wiring shall be sized per NEC Article 310 or based on UL standards and be appropriately braced for available fault currents. Protection shall include a DC breaker, fuse or other current-limiting device on the energy storage bus. This protection shall be coordinated with the PCS capabilities and energy storage string protection and shall consider transients and the Inductance/Resistance (L/R) ratio at the relevant areas of the DC system. The Project shall operate no higher than 1,500 Volts DC.

The Contractor shall provide information on the impact that weak or failed cells have on the life and performance of the entire string. The Contractor shall specify critical parameters, such as temperature variation limits between cells of a string. The Contractor shall provide a means of monitoring critical parameters to ensure the limits are being met.

Cells, wiring, and all DC electrical components shall be insulated for 2,000 Volts DC. The Contractor shall have overall responsibility for the safety of the electrical design and installation of the Project. The Project shall include a monitoring/alarm system and/or prescribed maintenance procedures to detect abnormal cell conditions and other conditions that may impair the ability of the Project to meet performance criteria.

The energy storage monitoring system shall be capable of balancing the voltages across cells automatically and independently without any input from the operator or the SEC. Cell monitoring system shall be specified so as to alert the proper personnel in a timely manner that an abnormal cell condition exists or may exist. Abnormal cell conditions shall include over- and under-cell voltage. Temperature is not expected to be monitored at the individual cell level.

The monitoring/alarm system will record data and notify the Owner on the number and general location of failed modules, to expedite maintenance and cell replacement. This data shall be stored in non-volatile memory. Such monitoring/alarm systems shall be integrated into the overall control system.

The Project shall include racks or shall consist of stackable modules of batteries. Aisle spaces shall be set to permit access for equipment needed for easy removal and replacement of failed modules. The lengths and widths of aisles shall conform to all applicable codes, facilitate access by maintenance personnel and be approved by Owner. As applicable, the racks shall provide sufficient clearance between tiers to facilitate required modules maintenance, including modules testing and inspection, and replacement.

Rack-mounted modules shall have all connections located on the front of the enclosure or module. Modules shall not be required to be removed from the racks during regular maintenance. All racks and metallic conductive members of stackable modules shall be solidly grounded. Racks shall be seismically designed based on the requirements of Section 1.4 and shall include means to restrain cell movement during seismic events. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.18 Medium Voltage Switchgear

Metal-enclosed switchgear shall be designed, constructed and tested per IEEE C37.20.3. Metal-clad switchgear shall be designed, constructed and tested per IEEE C37.20.2. Design test results shall be provided to the Owner prior to shipment to the Site.

4.18.1 Field Tests

Contractor shall:

- High-potential test each breaker in accordance with IEEE C37.20.2, Table 1 and part 6.5. Apply test voltage to each pole of the breaker for one minute.
- Test and record contact resistance on each phase from bus to load terminal through a closed breaker.
- Record operation counter reading.
- Perform vacuum integrity test.

The MV switchgear lineup shall be rated to continuously carry nominal Project generation. The lineup shall contain power metering and voltage transformers, fused switches and circuit breakers as necessary to collect and interconnect full plant generation.

Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and a 120/240 Volt Control Power Transformer. The Control Power Transformer shall be fused and able to disconnect. The Control Power Transformer shall be sized to supply the expected continuous load, with approximately 20 percent margin for future load growth. The transformers shall be air-cooled, dry type, with a 150 °C rise. Alternatively, site DC backup power may be used.

Switchgear shall be provided with a metering section containing provisions for utility meters. Consistent with the Owner’s Electric Distribution System Interconnection Handbook, the metering section includes cable pull sections, bus bars for metering CT/PT insertion; disconnect switches, a metering panel, a meter socket(s), and accommodations for test switches/test blocks. A set of visible disconnect switches, or rack-able breaker, shall be placed directly on the line side of each metering section as well as a set of disconnect switches for the metering PTs (accessible by Owner personnel only) per the Owner’s service requirements. In addition, a set of disconnect switches shall be placed on the load side of the meter or at the point of generator output. Disconnect switches and rack-out breakers must accommodate locking devices to allow the Owner to lock-out services or net-generation points when necessary.

Protective relaying, metering, and control parameters shall be in accordance with the Owner Electric Distribution System Interconnection Handbook and reviewed and approved by Owner prior to construction. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.19 Inverter-Connected 3 Phase, Liquid-Filled or Dry-Type Pad-Mount Transformer

Transformer LV windings shall be per inverter manufacturer's recommendations. Percent impedance voltage shall be according to the inverter manufacturer's recommendation. Transformers shall be rated for continuous operation of the inverters.

Transformers shall be configured as grounded-wye on the side toward the POI. The winding configuration on the side toward the PCS is the Contractor's choice.

Liquid filled transformers shall be designed, constructed and tested in conformance with IEEE C57.12.00. Liquid filled transformers shall contain a UL-listed and Factory Mutual Global Approved less-flammable dielectric coolant meeting the requirements of NEC Section 450-23 and the requirements of the National Electrical Safety Code, Section 15. Transformer shall be suitable for indoor or outdoor use as applicable meeting the requirements of NFPA 855. Routine test results shall be provided to the Owner prior to shipment to the Site. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

For transformers connected to the PCS, the Contractor must provide calculations to demonstrate that the appropriate H-factor or K-factor has been selected. A sample calculation is shown below:

h	Ih	$(Ih)^2$	h^2	$(Ih)^2h^2$
1	1	1	1	1
3	0.1000	0.0100	9	0.0900
5	0.1500	0.0225	25	0.5625
7	0.1000	0.0100	49	0.4900
9	0.1000	0.0100	81	0.8100
11	0.1400	0.0196	121	2.3716
13	0.2000	0.0400	169	6.7600
15	0.0200	0.0004	225	0.0900
17	0.0500	0.0025	289	0.7225
19	0.0075	0.0001	361	0.0203
21	0.0050	0.0000	441	0.0110
SUM		1.1151		12.9279 K FACTOR

4.19.1 Field Testing

- Verify nameplate data.
- Coordinate and perform instrument transformer tests on CTs with transformer assembly.
- Verify correct polarity of CTs.
- Winding Tests:
  - Transformer Turns Ratio (TTR) at all no-load taps.
  - Megger winding to ground.

  - Megger winding to winding.
  - Set HV taps at positions determined by Engineer.
- Check and measure equipment ground; ground shall not be more than one ohm.
- Check insulating fluid for clear or pale amber color and report any variance to the Owner. Other colors may indicate contamination from decomposition of insulation, foreign material, carbon, or other substances.
- Test oil samples from each transformer with standard AC test in accordance with ASTM D1816. Notify the Owner if breakdown voltage is less than 30 kV.
- Check liquid level in tanks, and in bushings of the liquid-filled type, and check nitrogen content in inert gas sealed oil preservation systems.
- Check that all valves are open between the transformer tank and cooling equipment.
- Check operation of cooling equipment and cooling controls before energizing transformer.
- Check calibration of pressure relief device, top oil temperature relay, and hot spot temperature relay.
- Pressure test the sudden pressure relay in accordance with the manufacturer's instructions to verify proper operation of device and electrical contacts.
- Alarm Sensor Testing: Induce the device to operate with proper input medium (heat, cooling, pressure, vacuum, voltage, current, etc.) and verify operation of the device at the correct input medium level by monitoring the output contacts with an ohmmeter.
- Annunciator Testing: Check each unit of annunciators by closing or opening the trouble contact and observing operation of control board.
- Check all annunciator lamps, bell cutoff, and reset operation.
- Test all gauges including level, temperature, and pressure gauges.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.
- Transformer compartments shall have provisions for padlocking.
- High-voltage compartment shall contain terminations for dead-break elbows, and provisions for entrance of multi-conductor high-voltage, insulated, shielded, power cable. Provide terminations with stress relief devices.
- Transformer shall be equipped with a load-break switch that is oil immersed in transformer tank. The handle shall be located on the exterior tank wall. The switch shall be operable without exposure to any live circuits.

Include accessories as follows:

- Dial-type thermometer with contacts for high-temperature warning and alarm levels
- Magnetic liquid level gauge with alarm contact for low level.
- Pressure/vacuum gauge with alarm contacts.

4.20 Dry Type Transformers

Dry type transformers shall be designed, constructed and tested in conformance with IEEE C57.12.01. Dry type transformers shall be ventilated dry-type cast coil, Class AA suitable for indoor or outdoor use as applicable. All designs shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.20.1 Field Testing

- Verify nameplate data.
- Winding tests:
  - Transformer Turns Ratio (TTR) at all taps.
  - Megger winding to winding.
  - Megger winding to ground.
- Check equipment ground to assure continuity of connections. Notify the Owner if ground is more than one ohm.
- Check electrical neutral of the transformer. This connection shall be a copper wire connection to the station ground grid.
- Check for proper operation of the winding temperature gauge and cooling fans.
- Set HV taps at positions determined by Engineer.
- Check connections for tightness; clean out dust and other foreign material.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.

4.21 Raceways

4.21.1 Conduit

- Contractor shall install all conduit, bends, accessories, fittings, junction boxes, mounting hardware, etc., to produce the complete system.
- Conduit shall be sized and installed in accordance with the NEC.

- In general areas, Electrical Metallic Tubing can be used for all feeders hidden from view above ceilings and in walls. Electrical Metallic Tubing fittings shall all be compression-type fittings. Set-screw fittings shall not be utilized.
- Flexible Metal Conduit or Liquid-tight Flexible Metal Conduit shall be used for connections to motors, transformers, machinery, lighting, and for other equipment subject to vibration.
- Rigid Metal Conduit or Intermediate Metal Conduit shall be used as allowed in the NEC.
- Plastic conduit, elbows, couplers and other fittings for underground application shall be Schedule 40 PVC, UL or ETL Listed. Fabrication, testing, and installation shall be per NEMA TC-2. Direct buried conductors will not be allowed. Each underground conduit package shall include at least one spare conduit for communications circuits.
- Reinforced Thermosetting Resin Conduit (Fiberglass RTRC) conduit, elbows, couplers and other fittings shall be UL or ETL Listed. Fabrication, testing, and installation shall be per NEMA TC-14. Direct buried conductors will not be allowed. Each underground conduit package shall include at least one spare conduit for communications circuits.
- Threaded or compression fittings shall be used with all raceway types. Set-screw fittings are not permitted.
- All conduits shall be sealed by Owner approved duct seal or foam.
- Any conduits intended to contain fiber optic cables will only use large radius factory sweeps, not 90-degree elbows.
- Conduits containing CT or PT conductors for Owner’s revenue metering may not use condulets.

4.21.2 Tray

- Tray shall be fabricated, tested, and installed per NEMA VE1, NEMA VE2, and the NEC.
- Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063 and all fabricated parts shall be made from Aluminum Association Alloy 5052, in accordance with ASTM B221 and ANSI H35.1.
- Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.
- Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All hot-dip galvanized after fabrication cable trays and components must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc to mitigate damage to cables and/or injury to installers.
- Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors, then hardware shall be Type 316 stainless in accordance with ASTM F593 and F-594.
- Any exterior tray shall include a cover.

- All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.22 Medium Voltage Cable

- Aluminum or Cooper cable shall be listed to UL 1072 and adhere to NEC requirements.
- Cable furnished shall be suitable for installation in underground ducts and conduits, trays, underground structures, and in outdoor applications of direct underground burial or for use in suitable supported aerial applications. Cable shall be rated for wet and dry locations.
- Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90°C, 140°C for emergency operation condition, and 350°C for short circuit conditions.
- Cable shall be tested at the factory and reports delivered to the Owner prior to shipment. Once test results are provided to the Owner, it will have five business days to review testing reports. Contractor shall not ship cables until the Owner approves the test reports or the review period expires.

4.22.1 Field Tests

- Field high potential test in accordance with NEMA WC 74 (ICEA S-93-639), Table F-1, DC Test Voltages After Installation and NETA ATS, Table 100.6, Medium-Voltage Cables Acceptance Test Values, as follows:

		DC TEST VOLTAGE (KV)	
Rated Voltage (kV, Phase-Phase)	Conductor Size AWG or kcmil	100% Insulation	133% Insulation
2,001 – 5,000	8 – 1,000	28	28
2,001 – 5,000	1,001 – 3,000	28	36
5,001 – 8,000	6 – 1,000	36	44
5,001 – 8,000	1,001 – 3,000	36	44
8,001 – 15,000	2 – 1,000	56	64
8,001 – 15,000	1,001 – 3,000	56	64
15,001 – 25,000	1 – 3,000	80	96
25,001 – 28,000	1 – 3,000	84	100
28,001 – 35,000	1/0 – 3,000	100	124
35,001 – 46,000	4/0 – 3,000	132	172
46,001 – 69,000	4/0 – 3,000	N/A	195

- The initially applied DC voltage shall be not greater than 3.0 times the rated AC voltage of the cable.
- The duration of DC voltage test shall be 15 minutes.
- Do not test cables with an AC test set. Disconnect from all equipment during testing. Testing cable on the reel will not be acceptable. Perform tests after installation, but before final connection to equipment. Make high potential tests between each conductor and shield, or between conductor and armor with shield or armor grounded.

4.23 2.0 kV Cable

- Aluminum or Copper cable shall be listed to UL 44 and adhere to NEC requirements.
- Cable shall be rated for use in conduit, underground ducts, and cable tray.
- Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90˚C.
- Field Tests
    - Megger insulation resistance testing is required prior to energization.

4.23.1 Field Tests

- All field tests shall be performed by a certified third-party testing company.
- In addition to the tests specified previously, the following tests shall be conducted:
    - LV breakers 100A and greater shall be trip tested.

4.24 Substations

All Project substation design and construction shall comply with M1-05-03 (Substation Design and Construction Specification) and M1-04-02 (General Transformer Specification).

4.25 Communication Facilities

All Project communications facilities shall comply with M1-05-04 (Communication, SCADA, and Metering Facilities).

5.0 APPENDIX A - APPLICABLE STANDARDS AND CODES

No.	Standards	Code
1	ANSI/IEEE C2	National Electric Safety Code
2	IEEE 519	IEEE Recommended Practices and Requirements for harmonic Control in Electrical Power Systems
3	IEEE 1547-2018	IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
4	IEEE 1547.1	Standard Conformance Test Procedure for Equipment Interconnecting Distributed Resources with Electric Power Systems
5	IEEE 1547.2	Interconnecting Distributed Resources with Electric Power Systems
6	IEEE 1547.3	Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
7	ANSI Z535	Product Safety Signs and Labels
8	ANSI C57/IEEE	Transformer Standards, whenever applicable
9	ANSI C37/IEEE	Surge withstand capabilities, whenever applicable
10	UL 1642/IEC 62133	Applicable sections related to battery cell safety, where applicable
11	UL 1741	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
12	NFPA 704	Standard System for the Identification of the Hazards of Materials for Emergency Response
13	UL 1642	Standard for Lithium Batteries
14	UL 1778	Underwriters Laboratories' Standard for Uninterruptible Power Systems for up to 600 Volts AC
15	UL 1973	Standards for Batteries for Use in Light Electric Rail Applications and Stationary Applications
16	UL 9540/9540A	Standard for Energy Storage Systems and Equipment / Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems
17	Electric Tariff Rule 21	Generating Facility Interconnections
18	NISTIR 7628	Guidelines for Smart Grid Cyber Security
19	NEC	National Electric Code
20	NESC	National Electric Safety Code
21	ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
22	CAA	Clean Air Act and Amendments
23	CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
24	EPA	Environmental Protection Agency regulations
25	FAA	Federal Aviation Administration regulations
26	FERC	Federal Energy Regulatory Commission regulations
27	FPA	Federal Power Act
28	RCRA	Resource Conservation and Recovery Act

No.	Standards	Code
29	SDWA	Safe Drinking Water Act
30	SWDA	Solid Waste Disposal Act
31	TSCA	Toxic Substances Control Act
32	ADA	Americans with Disabilities Act
33	MBTA	Migratory Bird Treaty Act
34	CWA	Clean Water Act
35	ANSI	American National Standards Institute
36	IEEE	Institute of Electrical and Electronics Engineers
37	NEMA	National Electrical Manufacturers Association
38	ASTM	American Society for Testing and Materials
39	ASME	American Society of Mechanical Engineers
40	IEEE 1881	Standard Glossary of Stationary Battery Terminology
41	IEEE 519	Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
42	IEEE 142	Recommended Practice for Grounding of Industrial and Commercial Power Systems
43	IEEE 242	Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
44	IEEE 2030.3	Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications
45	EPRI 3002009313	Energy Storage Integration Council Energy Storage Test Manual 2016
46	IEEE 1881	Standard Glossary of Stationary Battery Terminology
47	Owner S-76	Below Grade Substation Standards
48	MESA	Open Standards for Energy Storage
49	NFPA 855	Standard for the Installation of Stationary Energy Storage Systems
50	OSSC	2014 Oregon Structural Specialty Code
51	International Building Code	2012 International Building Code
52	ACI-318	American Concrete Institute 318-11
53	AWS	American Welding Society D1.1 Structural Welding Code - Steel
54	OFC	2019 Oregon Fire Code
55	IEEE 2800	IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems

6.0 APPENDIX B - CONCEPTUAL ONE-LINE DIAGRAM

To be submitted by Contractor at the time of bid submittal.

7.0 APPENDIX C - ENERGY STORAGE SYSTEM FACTORY ACCEPTANCE TESTING PROCEDURE

To be submitted by Contractor as an exhibit to the Agreement at the time of contract execution.

8.0 APPENDIX D - STATE MATRIX

		Standby	Run	Current Source Enable	Sync Request	Black Start Enable	Inverter Ready	Inverter Running	Island Ready	Synch Ready
1	Standby	1	0	0	0	0	1	0	0	0
2	Island	1	1	0	0	0	1	1	1	0
3	Synch request	1	1	0	1	0	1	1	1	1
4	Black Start	1	1	0	0	1	0	0	0	0

9.0 APPENDIX E - SCADA INTERFACE

The following is information of the data objects being used by the Owner for the purpose of controlling and monitoring storage systems via a communications gateway. Contractor will appropriately deploy or provide an interface which utilizes either DNP3 or Modbus TCP/IP protocol. This interface shall be a port that is integral to the Contractor's SEC or Ethernet switch. Achieving the correct communications protocol by use of a separate communications gateway is not allowed. Additionally, Contractor will implement and make available multiple points lists, including integration of the Owner's Points List as specified below.

Note the alarms list for each system has not been listed, as systems provide a multitude of alarms. In all cases, the complete set of all possible alarms must be conveyed via alarm word points at each level, System and Subsystems (Inverters and Energy Storage Banks Blocks, Modules or Cells). Each bit of a given word must be mapped to a single alarm (fault or warning). Multiple alarms words can be utilized at every level if the number of alarms exceed the number of bits available in a single alarm word.

It should be also noted that any other device capable of generating alarms within the energy storage system should have its alarms passed to the Owner's gateway via the same, single interface described in this section. Any resettable alarms, for any device capable of generating alarms, must be able to be reset via the same, single interface.

Contractor will provide a draft communications and tag name spreadsheet at the 30% design review. The spreadsheet will include an IP address for every addressable device in the project as well as all the Project tag names. Accommodation will be made for Owner addressable devices on the network and Owner's required tags. When the spreadsheet reaches the 90% review level, new tag names shall only be added to the bottom of the list.

Contractor's tag list shall comply with IEEE 1547-2018 Clause 10 – Interoperability.

10.0 APPENDIX F - SITE ACCEPTANCE TEST

To be submitted by Contractor as an exhibit to the Agreement at the time of contract execution.

11.0 APPENDIX G - APPROVED VENDORS AND SERVICE SUPPLIERS

This section provides a list of approved Suppliers for plant materials, equipment, and services. The Contractor may not deviate from this list prior to contract award but may do so after contract award only with prior written Owner approval.

In some categories, a Supplier has been identified as “Preferred” with an (*) in order to maintain the same Suppliers of equipment as PGE has utilized the Supplier for its generating fleet and has had favorable experiences.

The basis for the plant design should generally be the “Preferred” Suppliers in areas where common operating procedures, routine maintenance or spare parts can be affected.

In other areas, the Owner shall be notified and shall have the option to select an identified equipment “Preferred” Supplier via a Change Order if the “Preferred” Supplier is not the Contractor’s evaluated equipment bidder. The Owner would not expect to see a request for change order however unless there are significant cost differences from the “Preferred” Supplier.

Final major equipment supplier list is to be approved by Owner. If Contractor is considering the selection of a material, equipment supplier, or subcontractor that is not listed herein, Contractor shall request approval from Owner prior to executing any contract for the procurement of such material or with such equipment supplier or subcontractor.

- BESS Suppliers, Batteries (Cells)
  - BYD
  - CATL
  - LG Chem
  - Samsung
  - Panasonic
  - Tesla
- BESS Suppliers, Inverters
  - Power Electronics
  - SMA
  - Sungrow
  - Tesla
  - TMEIC
  - EPC
- Generator Circuit Breaker
  - *ABB
  - GE Grid Solutions

- Mitsubishi
- Siemens
- HVB

- Generator Step-up Transformer (substation main power transformer)
  - ABB, Varennes, Canada shop
  - ABB, St. Louis, Missouri shop
  - ABB, Bad Honnef, Germany shop
  - ABB, South Boston, Virginia shop
  - HICO, ChangWon, South Korea shop
  - Hyundai, Montgomery, Alabama shop
  - Hyundai, Ulsan, South Korea shop
  - Smit, Nijimegen, The Netherlands shop
  - SPX Waukesha, Waukesha, Wisconsin shop
  - EFACEC, Arroteia, Portugal shop
  - Siemens, Guanajuato, Mexico shop
  - GE Prolec, Monterrey, Mexico shop
  - Shihlin, Taipei, Taiwan shop
- Ground Reference Transformers
  - ABB
  - Cooper Power Systems
  - GE
  - Virginia Transformer
- GSU Pad-mount Transformers
  - ABB
  - General Electric
  - Cooper Power Systems
  - Siemens
  - WEG
- Instrument Transformers
  - ABB
  - Trench Ltd
  - GE/Alstom
- Load Center Unit Substations

  - ABB
  - Eaton
  - General Electric
  - Powell Manufacturing
  - Schneider Electric / Square D
  - Siemens Power T&D
- LV Motor Control Centers
  - *Eaton
  - ABB
  - Allen Bradley
  - General Electric
  - Powell Manufacturing
  - Schneider Electric / Square D
  - Siemens Power T&D
- Medium Voltage Switchgear, Starters and Controllers
  - Powercon
  - Siemens Power T&D
  - ABB
  - Eaton
  - General Electric
  - Powell Manufacturing
  - Schneider Electric / Square D
- Protective Relays and Revenue Meters
  - Schweitzer Engineering Laboratories (SEL)
- Relay Panels
  - Electrical Power Products (EP2)
- Revenue Meters
  - SEL
  - Schneider Ion 8650
- SF6 Circuit Breakers (High Voltage and Medium Voltage)
  - Siemens
  - ABB
  - Mitsubishi

- GE/Alstom
- Hitachi/HVB (Georgia)
- Single Mode Fiber Cable & Attachment Hardware
  - AFL
  - OFS
  - Preformed Line Products
  - Anixter
- Substation Capacitors
  - Cooper Power Systems
  - General Electric
- Substation Control Enclosure
  - Trachte
  - AZZ
  - Systems control
- Substation Disconnect Switches (115-230KV)
  - Pascor
  - Cleaveland Price
- Substation Distribution Metering
  - Novatech Bitronics M871 (SCADA distribution feeder metering)
  - Novatech Bitronics M650 (SCADA distribution transformer metering)
- Substation Human/Machine Interface
  - Schneider Electric
- Substation Remote Terminal Unit
  - Eaton Cooper Power System
- Substation SCADA Ethernet Switches and Port Servers
  - Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports
  - Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports
  - Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports
  - Siemens RuggedCom RS416 – Serial port server, Rack mount, 16 ports
- Substation SCADA Gateway
  - Eaton Cooper SMP SG4250
- Substation SCADA Input/Output Devices
  - Eaton Cooper Power Systems

- Transformer Bushings
  - PCORE
  - ABB
- Uninterruptible Power Supply System (UPS)
  - *Vertiv Chloride (formerly Emerson Network Power)
  - Ametek Solidstate Controls
  - CEG
  - Gutor/Schneider
- 48 VDC Battery & Charger
  - East Penn Manufacturing
  - C&D Technologies
  - Eltek/Valere
- 125 VDC Chargers
  - *SENS
  - *Vertiv Chloride (formerly Emerson Network Power)
  - Ametek Solid State Controls
  - Cyberex
  - Hindle Power
- 125 VDC Batteries
  - *GNB
  - BAE
  - Hoppecke
  - C&D Technologies

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

Table of Contents

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Certification	3rd party structural design certificate	Third-party Registered Professional Engineer's Certificate confirming the suitability of all 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	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	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 electrical scope of Work, 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 PCS/Inverter skid MV/LV transformers • Instrument transformers (i.e. CTs, VTs) • 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 • Switchroom batteries and chargers		X			Prior to delivery to Site	
Certification	Performance test report	Report summarizing test as specified. Upon satisfactory completion or upon failure of the Performance Test, theContractor 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 Circle Test Report and Certificate	Upon satisfactory completion or upon failure of the Power Circle 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	
Design	Civil works	30% Design including the following: • Buildings and structures		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Roads • Site drainage • Earthwork and compaction • HV/MV substation foundation/footings • Site landscaping • Site restoration/reclamation						
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			
Design	Site electrical single-line system	30% Design including the following: • Energy storage system SLD, showing connection to PCS, step-up or isolation MV/LV transformers, all junction boxes, ground reference transformers (if applicable) and battery banks or blocks; protection SLD to be incorporated or provided separately • Earthing drawings		X		X	3 months after Agreement execution	
Design	Site electrical single-line system	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Site electrical single-line 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	Site electrical single-line system	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Site electrical single-line 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: • MV Protection Schematics • MV CB Control Schematics • LV Air CB Schematics • UPS Schematic • DC Circuit Schematic • Distribution Board schedules • Cable schedules (HV, MV, LV and Comms) • As-built MV Switchroom GA drawings, including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.			X			
Design	Fire Protection System documentations and drawings	Including as a minimum: • Fire Risk Evaluation/Fire Protection Design Basis Document		X		X	3 months after Agreement execution	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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 • 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	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		
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	Battery and PCS block design drawings	30% Design: Includes the general arrangement drawings of the following: • Battery blocks, including racks and modules as appropriate • Inverter Blocks • PCS		X			3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Permanent and temporary buildings						
Design	Battery and PCS block design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Battery and PCS block design drawings	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	Battery and PCS block design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Battery and PCS block design drawings	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	Substation	30% Design including the following (as applicable): • Substation general arrangement drawing • Main power transformer(s) • Protection equipment and switchgear specifications • LV systemsincluding battery and UPS capacities/back-up time • Revenue and power quality meter specifications • 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 • Submittals as required in Appendix M1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.		X		X		
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)		X		X		

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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 • 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): • Battery and PCS layouts • Landowner boundaries • Public roads • Access roads • Cable routes • Laydown areas • Substation • Transmission line • Borrow pits • 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 • Foundations/footings • Drainage and erosion control features • Spares, parts, tools and permanent storage • Temporary utilities, and		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• Fencing, gate, signage and label details						
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	Project controls drawings and documentation	30% Design: Operating description document, controls architecture block diagram, control devices specifications details		X		X	3 months after Agreement execution	
Design	Project controls drawings and documentation	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Project controls drawings and documentation	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	Project controls drawings and documentation	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Project controls drawings and documentation	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	Project auxiliary systems specfications and design drawings	30% Design: Includes specifications and design drawings of all elements of the electrical system including, but not limited to the following: • Switchgear connections, including connection diagram, in addition to individual equipment specifications and compliance certification. • Transformer specifications, including kVA rating, nominal voltage rating, insulating medium, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, corrosion protection, load and no-load loss guarantees, manufacturer and standards compliance. Design drawings, including enclosure. Transformer type test certificate and a fitness for purpose statement (considering Environmental Conditions, corrosion, cyclic loading, harmonics, peak voltages and fire risk). • Auxiliary power systems and associated equipment specifications, including battery and UPS capacities/back-up time • Revenue and power quality meter specifications		X		X	3 months after Agreement execution	
Design	Project auxiliary systems specfications and design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Project auxiliary systems specfications and design drawings	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	Project auxiliary systems specfications and design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Project auxiliary systems specfications and design drawings	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	Spare parts, tools, and permanent storage	30% Design including the following:				X		

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• List of components and consumables that do not satisfy the Design Life for Work including additional information						
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		
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 Per M4-01-01, Section 2.5		X		X	Per M4-01-01, Section 2.5	
Manuals	O&M Manuals	Complete and final O&M Manuals, including but not limited to (as applicable): • Overview of the Plant Works • 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			X		Per M4-01-01, Section 2.5	
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			X			

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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 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						
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. • Details of the equipment to be used • Any deviations • The methodology for dealing with those deviations • Details of the site calibration procedure		X		X	6 months after Agreement execution	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	
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		X		X	45 days following NTP	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	**Deliverable:**	**Description:**	**Level**			**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
			A	**B**	**C**			
		• 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						
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 • Major milestones • Milestone payments, if applicable • Startup and commissioning activities • Testing activities		X		X	8 weeks after NTP	
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	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	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 works 3rd party structural design report	Third-party Registered Professional Engineer's Report confirming the suitability of:		X			6 weeks prior to start of relevant work	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• The permanent buildings • Any other structures as required to be certified under the local building and/or structural codes						
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: • HV/MV substation foundations/footings; • 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 • Isolation transformer k-factor (or h-factor) calculation • DC/UPS sizing • Grounding calculation • Harmonics 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	Energy generation summary	Report summarising loss parameters and energy estimates for the Solar Project	X				Agreement close	
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 • 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.		X		X	3 months after Agreement execution	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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, protection systems and switchgear, transformers and switchgear, MV cables, fiber optic cables, metering, LV equipment, 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 • All partial safety factors • Decision trees • Reinforcement specifications and testing, and • Conclusions		X		X	3 months after Agreement execution	
Report	Geotechnical investigation report	Comprehensive geotechnical investigation, including and as applicable: • MV/HV Substation • Access Roads • Underground Cabling • 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 incorporating protection (or provided separately) • Earthing general arrangement (GA) drawings and schematic diagrams • Substation GA drawings, including overall GA drawing, MV switchroom GA drawings (including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.) • 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.		X		X	6 months after Agreement execution	
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	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 • 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		X	X	X	monthly and weekly	
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	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			X	X	Within 5 days after test completion	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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						
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	
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	Grid connection documentation	All required information to assist Owner in its application for Grid Connection.	X	X		X	Duration of Agreement	
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	X			X	Agreement close	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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						
Specifications	Inverter specifications	The following documents shall be submitted by the Contractor. • Datasheet • Track records • Type test certificates to Applicable Standards and test reports • Accelerated test certificates • Warranty terms	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	Permanent on-site buildings	Functional description and preliminary design specifications including: • Layout • Elevation drawings • Structural • Architectural • Fire rating • Hold down	X			X	Agreement close	
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: • Switchgear • Monitored equipment • Statcom equipment, and • Power Quality Metering			X			
Specifications	Substation specifications	Functional description and preliminary design specifications including:	X			X	Agreement close	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
		• 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)						
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	

APPENDIX M1

ATTACHMENT 01

EXHIBIT 05

PROJECT MANAGEMENT AND CONTROLS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	11Dec17	Issued for Implementation	DNV-GL	DS	CPA	Craig Armstrong
1	14Apr23	Update from 2021 Version	PGE		CPA	Craig Armstrong

TABLE OF CONTENTS

1.0 PROJECT CONTROLS

1.1 GENERAL

The Contractor shall provide a project management plan, detailed project schedule, milestone or progress payment schedule, progress reports, and other information necessary for the completion of the facility on time and within budget. The scope of this shall include all work in all phases of the project for which the Contractor is responsible.

1.2 KICK OFF MEETING

As a first step, Contractor shall organize a kick-off meeting with Owner and subcontractors, with the following objectives:

1. Learn about the Project, update timeline, and short-term and medium term priorities and discuss other key points and expectations
2. Introduce the team that will be working on the project and their roles and responsibilities
3. Establish document control method (see Section 1.3)
4. Identify time and frequency of conference call
5. Identify main point(s) of contact and discuss communication protocols and timeframes for response
6. Discuss any risks to the project and potential mitigation measures
7. Discuss escalation procedures
8. Discuss contract administration

Contractor shall have project managers and any other representative in attendance during the kick-off meeting.

1.3 DOCUMENT CONTROL

Contractor and Owner shall discuss and agree upon a document control plan. The document control plan shall address how documents are transmitted, named, reviewed, tracked, and edited in compliance with the requirements in Appendix M1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables. A data room shall be set up that Contractor and Owner can effectively use.

1.4 PROJECT MANAGEMENT PLAN

Contractor shall develop a project management plan for the management and execution of all phases of the Work within 30 days of contract execution, and shall address as a minimum:

1. Construction project manager and key team members (including curricula vitae)
2. Project organization diagram
3. Communication plan

4. Permits, licenses, certifications and agreements required
5. Procurement and sub-contracting plan
6. Project schedule and payment milestones
7. Resource loading plan
8. Environment, health and safety plan (initial draft or outline)
9. Quality Management System plan
10. Management of Owner and other external interfaces
11. Change control plan – including change order process
12. Escalation matrix – how and when to escalate issue for resolution

Contractor shall identify project manager(s), project scheduler, cost controller, risk matrix manager, and documentation manager for the Project.

1.5 SCHEDULE

The Contractor shall furnish a detailed, minimum level 3[1], Project Schedule, referred to as "Schedule", for its scope of work utilizing the Critical Path Method (CPM) 8 weeks after Notice to Proceed (NTP). The Schedule shall include, but not be limited to, the following:

1. Engineering activities
2. Procurement activities
3. Material and equipment deliveries
4. Construction activities
5. Tie-ins to existing plant systems
6. Equipment factory tests
7. Interfaces with Owner and other external interfaces
8. Major milestones
9. Milestone payments, if applicable
10. Startup and commissioning activities
11. Testing activities

Along with the detailed level 3 schedule, the Contractor shall furnish a Schedule Basis Memorandum. The Schedule Basis Memorandum shall include, but not be limited to, the following:

1. Project description

2. Project scope

    a. Provide work breakdown structure (WBS)

3. Schedule methodology

[1] As defined by AACE International (Association for the Advancement of Cost Engineering)

a. Key milestones and interface milestones

b. Schedule duration basis (i.e. time estimates)

c. Schedule assumptions (e.g. workweek, resources and equipment availability)

d. Project schedule settings (i.e. activity type, duration type, default scheduling options)

e. Summary of activities on the critical path

f. Execution strategy summary for engineering, procurement, construction, installation, testing and commissioning

4. Risk and opportunity analysis

   a. Summarize key risks that could delay the schedule

   b. Summarize strategies to mitigate key risk

5. Major constraints

   a. Key dates and constraints

6. Scheduling team

   a. Names and roles

The Schedule shall be resource loaded and be of sufficient detail to assure adequate planning and execution of the work, such that, in the judgment of Owner, it provides an adequate basis for monitoring and evaluating the progress of the work. This plan shall include and highlight all non-contractor interface points with the Owner, vendors or other external entities that could impact the Contractor's Schedule and execution plan. Owner will assume overall schedule integration to assure linkage of those non-contractor interfaces within the Schedule. After the Notice to Proceed, the Contractor shall update their project Schedule monthly as part of the monthly progress reporting. The Contractor shall also prepare, during construction, a rolling three-week Gantt chart schedule, updated weekly, for review at each progress and coordination meeting.

The Contractor shall use Oracle/Primavera P6 scheduling software, or Owner approved alternate software, that is based on network logic and will display the schedule critical path. Schedule performance shall be measured against a fixed project baseline schedule approved by the Owner. Initial schedule submittal and monthly updates shall be in PDF format along with the native file from the scheduling software.

A written schedule analysis shall be prepared as part of the monthly progress reporting. The analysis shall include Schedule status, variance, and constraints, including actual versus planned progress as indicated by the initial baseline Schedule (and any updates thereof), with reference to the major milestones and Schedule. All Schedules shall be configured to calculate data as follows:

1. Retained logic
2. Total float calculations based upon finished data
3. Contiguous scheduling
4. Start-to-start lags calculated from actual start dates
5. Percent completion and remaining completion not linked

All updates shall comply with the following requirements unless specifically altered in writing from Owner:

1. Contractor's construction schedule shall be carried out to support the overall project Schedule and key milestones identified in the Engineering, Procurement and Construction Contract
2. It shall be the Contractor's responsibility to maintain the progress of its Work in accordance with the Schedule
3. The Contractor, at its option and at no cost to Owner, shall develop additional schedule procedures it deems necessary to control and manage its work

All Schedules required by this specification are subject to Owner review and acceptance. Owner shall reject any Schedule or report that fails to show timely completion of the Work or any contract milestone date, or otherwise indicates unrealistic performance.

1.6 PROJECT STATUS REPORTING

The Contractor shall prepare and provide, at a minimum, a monthly and weekly progress report to the Owner. The monthly report content requirements are listed below. A weekly report template will be provided by the Owner and will include daily weather records and reporting major activities during the past week and those planned for the next three weeks. Weekly major activity reporting shall cover equipment delivery dates and status. An alternate template may be used upon Owner approval. The monthly report shall be issued to the Owner by the 10th day of the month following the month being reported, commencing upon notice to proceed. The weekly report shall be issued to the Owner by 4:00 pm, local time, every Friday, commencing upon notice to proceed.

The monthly report shall include, as a minimum, for that month:

1. Safety statistics, issues, and events
2. Summary of events including equipment delivery dates and status
3. Major activities accomplished during past month and those planned for the coming month
4. Project schedule update
5. Milestone payment schedule status

6. Earned Value Quantities Report (EVQR)
7. Contract progress S-curves
8. Contract overall man-hours S-curves
9. Contract overall staffing histograms
10. Contract overall craft histograms
11. Key quantity S-curves
12. Risks, delays, and quality concerns

The Contractor shall also prepare and submit to the Owner the Semi-Annual Construction Report as required by the applicable Site Certificate or state or local governmental siting process during the construction and commissioning phases only. Contractor shall prepare other permit required reports, as applicable.

1.6.1 EARNED VALUE QUANTITIES REPORT (EVQR)

This is a tabular report where contract quantities are reported showing quantities completed on monthly basis. This is the report that shows actual % complete, productivity, earned value, etc. on a monthly basis. Contractor is required to finalize the format and submit with contract quantity data within 4 weeks of award of contract/notice to proceed.

1.6.2 CONTRACT PROGRESS S-CURVES

This is a graph showing the cumulative and period plan, actual, and forecast progress on a weekly basis. The plan progress curves should be derived from the resource loaded Schedule and is to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual progress as derived from the EVQR should be plotted on the same graph against the plan. The Schedule is to be updated with the actual progress on a monthly basis. The forecast progress curve should be derived from the Schedule thus updated accordingly.

1.6.3 CONTRACT OVERALL MAN-HOURS S-CURVES

This is a graph showing the cumulative and period plan, actual, and forecast craft hours on a weekly basis. The plan craft hours curves should be derived from the craft hour loaded Schedule and are to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual craft hours spent as derived from the EVQR should be plotted on the same graph against the plan. The Schedule is to be updated with the actual craft hours on a monthly basis. The forecast craft hours curve should be derived from the Schedule thus updated.

1.6.4 CONTRACT OVERALL STAFFING HISTOGRAMS

This is a bar graph showing the overall weekly staffing (e.g. craft, home office team, management, etc.) planned, actually employed, and forecast (if different from plan). This should be derived from the resource loaded Schedule.

1.6.5 CONTRACT OVERALL CRAFT HISTOGRAMS

This is a bar graph showing the overall weekly craft manpower planned, actually employed, and forecast (if different from plan) broken down into various crafts. This should be derived from the craft hour loaded Schedule. A composite bar graph is acceptable for 1.4.4 and 1.4.5.

1.6.6 KEY QUANTITY S-CURVES

This is a graph showing the cumulative quantities plan, actual installed, and forecast to be installed on a weekly basis. Key quantities should be selected for this graph. Some of the key quantities (will differ from contract to contract) are excavation, back filling, concrete poured, structural steel, underground piping, aboveground piping, cable trays, cables, equipment to be installed, instruments, electrical terminations, etc. The plan curves should be derived from the quantity loaded Schedule and is to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual progress as derived from the EVQR report should be plotted on the same graph against the plan. The Schedule is to be updated with the actual progress on a monthly basis. The forecast progress curve should be derived from the Schedule thus updated. Since this process as mentioned above is required to continue on a monthly basis, Contractor is requested to plan the scheduling process in a way that the monthly updating of the Schedule with actual progress is managed well within the Contractor's capability.

1.6.7 CONTRACT DELIVERABLES LOG

This is a log of the required deliverables from the Contract. The deliverables log will be created by the Owner within 30 days of the notice to proceed, then tracked and updated by the Contractor on a monthly (or more frequent) basis.

1.7 ON-SITE STATUS & COORDINATION MEETINGS

During construction, startup and commissioning, the Contractor will hold a weekly on-site meeting that includes their key field personnel and the Owner project team. The purpose of these meetings is to review the weekly status report and to discuss current status, the three-week rolling schedule, coordination issues, and any significant concerns or problems that require action.

Commencing a month after project notice to proceed, Contractor will hold a monthly meeting that includes their key personnel and the Owner project team. The purpose of these meetings is to review the monthly progress report and to discuss current status, the Schedule, coordination issues, health and safety issues, and any significant concerns or problems that require action.

Additional project meetings to facilitate construction and communication may be required as well. Contractor shall hold a meeting prior to tower erection with Owner.

1.8 RISK ASSESSMENT

The Contractor shall furnish a Risk Assessment Analysis for their scope of work identifying major risks, probability of occurrence, possible impact, and actions that can be taken to mitigate any adverse effects. A Risk Matrix template is available from the Owner. The assessment shall be completed within 30 days of contract execution and updated monthly or more often as conditions or events warrant and submitted to the Owner. Specific risk items that were/are active during the previous month or next three months shall be included in the monthly report.

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	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong

Table of Contents

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

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	15Oct21	Issued for Implementation	DNV-GL	DS	CPA	Craig Armstrong
1	14Apr23	Update from 2021 Version	PGE		CPA	Craig Armstrong

APPENDIX M1

ATTACHMENT 02

EXHIBIT 01

GENERAL CIVIL REQUIREMENTS

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

TABLE OF CONTENTS

1.0 GEOTECHNICAL INVESTIGATION

1.1 GENERAL

The Project shall have a site-specific design level geotechnical investigation completed to evaluate subsurface conditions and provide recommendations for design and construction of all foundation systems supporting project infrastructure including but not limited to electrical collection system, electrical transmission line, substation, operation and maintenance facilities, and project civil infrastructure including roads and drainage facilities. Refer to M4-01-01 (Energy Storage Technical Documents) (the “BESS Spec”) for additional requirements applicable to energy storage projects.

The geotechnical investigation shall also include an appropriate document review of the regional geological information, including review of geological and geotechnical hazards.

1.2 DOCUMENT REVIEW

A document review shall be conducted consisting of available geotechnical and geologic documentation, which at a minimum includes the following:

1. Historical and current aerial imagery
2. Regional geologic maps
3. Soil survey reports
4. Groundwater hydrology data and maps
5. Landslide hazard maps (as applicable)
6. Karst hazard (sinkhole) maps (as applicable)
7. Mine subsidence maps (as applicable)
8. Seismic hazard maps
9. Field photographs
10. Other geologic/geotechnical hazard maps (as applicable)
11. Other applicable geotechnical and geologic mapping

1.3 GEOLOGIC/GEOTECHNICAL HAZARDS

All geologic/geotechnical hazards that may affect the project shall be included in the geotechnical study and report, with recommendations for mitigation as applicable. Geologic/geotechnical hazards shall include, at a minimum:

1. Seismic hazard and seismic effects (ground shaking, soil liquefaction, cyclic softening, earthquake induced landslide, surface fault rupture, seismic settlement, etc.)
2. Landslide and slope instability
3. Flooding and debris flow
4. Land subsidence/mining
5. Expansive soils

6. Collapsible soils
7. Corrosive soils
8. Excessive settlement
9. Karst/sinkhole hazards
10. Frost heave
11. Any other geological/geotechnical hazards that may affect the project

1.4 GEOTECHNICAL EXPLORATION

The scope of the geotechnical investigation shall be consistent with the corresponding industry standards of practice and the recommendations shall be adequate for use in design and construction of the Project. The number and depth of soil borings, as well as field testing required to confirm design assumptions and requirements, shall comply with the BESS Spec. Sufficient rock core samples shall be obtained from each boring including coring from the point at which competent rock is encountered and until the appropriate boring depth is achieved (at a minimum).

1.5 GROUNDWATER CONSIDERATIONS

Effects of groundwater shall be accounted for in the foundation design and considered in construction of the project. Monitoring of groundwater levels shall be taken over a sufficient period to capture seasonal fluctuation in groundwater levels. The geotechnical engineer shall determine the design groundwater level, 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.

1.6 GEOTECHNICAL LABORATORY TESTING

Laboratory testing shall be conducted on samples from soil borings gathered during the subsurface exploration program to determine engineering properties for design of the proposed foundations. Laboratory testing on samples collected during the exploration program shall be sufficient to characterize all soil types and layers that may have an impact on the foundation design.

The following tests shall be included, as appropriate, in the soil laboratory testing program to support foundation design and electrical design activities:

1. Moisture content per ASTM D2216 and unit weight per ASTM D7263 (all relatively undisturbed samples).
2. Atterberg Limits per ASTM D4318.
3. Grain size analysis per ASTM D422.
4. Soil shear strength per ASTM 3080 (unconfined, triaxial, direct shear, vane shear, etc.).
5. Consolidation/settlement characteristics per ASTM D2435.
6. Compaction characteristics per ASTM D698 (maximum unit weight, optimum moisture content, etc.).

7. Hydrocollapse (as appropriate).
8. Corrosion characteristics per ASTM D4972 and USEPA methods (Sulfate, chloride, pH, resistivity, etc.).
9. Minimum resistivity.
10. Soil Thermal resistivity including dry-out curves including 0% moisture per ASTM D5334. Quantity of test sites shall depend on site plans and geology.
11. Soil Electrical resistivity using the “Wenner Four Probe Method” 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 ft. Quantity of test sites shall depend on site plans and geology.
12. Unconfined compressive strength per ASTM D2166.
13. Unconsolidated-undrained triaxial compression per ASTM D2850.
14. Other laboratory testing as appropriate.

1.7 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

Geotechnical engineering recommendations shall be provided in the geotechnical report for the following for incorporation into design of the project:

1. Foundation design parameters (including factors of safety and uplift resistance)
2. Design groundwater level and recommendations for construction dewatering
3. Earthwork recommendations, subgrade preparation, compaction requirements, final grading, and testing requirements
4. Mitigation measures for unsuitable soils (expansive soils, collapsible soils, etc.)
5. Seismic parameters in accordance with local codes and standards
6. Mitigation measures for soil corrosion of concrete and buried metal
7. Recommendations for mix design of concrete in contact with on-site soils
8. General recommendations for civil work and facilities
9. Recommendations for site drainage (slopes)
10. Recommendations for foundations supporting site buildings
11. Recommendations for substation foundations
12. Recommendations for transmission line foundations, as applicable
13. Recommendations for gravel and paved roads
14. Frost heave loading (adfreeze), if applicable
15. Trenching and backfill recommendations
16. Recommendations for earth-retaining structures (e.g., retaining walls), as required
17. Any other pertinent geotechnical recommendations for the project as identified by the Geotechnical Engineer of Record

2.0 CIVIL WORKS

The design shall suit the requirements for construction access for long loads, heavy equipment and cranes, as well as ongoing access for operation and maintenance facilities. Design and construction of civil works shall comply with agreements between Owner and local authorities, as well as between Owner and OEM Supplier, and be designed per the project requirements and OEM Supplier's project site requirements.

Site entrance, access roads, site drainage, ancillary structures, and general project layout shall follow the recommendations in the hydrology study to control storm water runoff and prevent flooding of roads, equipment inundation and erosion of soils. A hydrology study based on the storm events noted in Section 2.7 below flood inundation event shall be performed to describe the hydrology of the Site and any impacts that the hydrology may play in the design of the site layout. Drainage shall be provided by Contractor and designed to prevent flooding, inundation of equipment and erosion. Additional requirements are outlined in the BESS Spec.

All roads and tracks shall be designed in accordance with the geotechnical engineer's recommendations appropriate to the site, climatic conditions and their period of use. Treatment of cut and fill slopes and installation of drainage shall be in accordance with applicable state and local standards and regulations. All fences, gates, cattleguards, and entrances shall be in accordance with applicable standards and permits, and shall be of a standard type and similar in all aspects with the type commonly used in the local area unless otherwise specified. All fencing and gates shall comply with the requirements set forth in M1-01-07 (Security and Compliance).

Requirements for formwork, reinforcement, concrete works and batching plant, materials strength, shall be in accordance with applicable state and local codes, standards and guidelines, and shall comply with the BESS Spec.

Restoration shall be in accordance with the Permits and planning and environmental constraints on the Project. All crossings shall be in accordance with utility and county agreements.

2.1 CONCRETE WORKS AND BATCHING PLANT

Contractor shall provide a detailed method statement for quality control and concrete batching and transport.

Concrete shall be transported, placed, compacted and cured in accordance with Applicable Standards.

Concrete mix design, cement, aggregate, admixtures, and trial batch test result shall be provided for owner approval prior to concrete placement. A successful break test showing the minimum specified compressive strength(s) shall be provided prior to concrete placement.

If an on-site portable batch plant is used, the following shall apply:

1. Contractor shall provide and maintain on-Site storage of cement, aggregates and all other materials required for concrete production.
2. Contractor shall provide and maintain a concrete batching plant(s) with all equipment, facilities, approvals and permits that are required for the associated batching plant(s).
3. Contractor shall remove from plant from site within 30 days of final concrete pour utilizing plant.

If an off-site batch plant is utilized, the following shall apply:

1. Travel times to the primary and backup batch plants shall be provided for owner approval
2. A transportation plan for off-site concrete batch plants shall include an allowance for potential traffic impact on transportation time, for owner approval

A backup shall be provided for critical items including the batching plant (on site or alternate location), concrete delivery and placement equipment (conveyor belt or pump).

Prior to pouring, Contractor shall install all grounding elements and cable ducts (tapes, electrodes, etc.). Exothermic (Cadweld, etc.) welding of grounding elements to reinforcing steel shall not be permitted.

A concrete placement plan shall be prepared in accordance with a Contractor-provided mass concrete placement plan. Unformed concrete finish on the surface of the concrete shall be screeded and finished neatly to be uniform and non-slip when wet.

Adequate precautions shall be implemented in finishing to prevent plastic shrinkage cracking. Methods to be used for plastic shrinkage cracking shall be provided to Owner prior to placement of concrete.

A hot and/or cold weather concreting plan shall be prepared in accordance with ACI 305R and ACI 306R, as applicable to anticipated project site temperatures.

2.2 CONCRETE AND GROUT STRENGTH

As a minimum, concrete and grout shall have a minimum 28 day compressive strength of 4000 psi, or greater as specified by the foundation designer.

Concrete constituents shall meet the requirements listed in Table 1, below:

Table 1 Concrete Material Standards

Material	Requirement
Water	Clean, Potable, free from acid/alkali, oil, petroleum products, organic material or other deleterious substances
Portland Cement	ASTM C150, Type I, II, or V or ASTM C1157, Type GU, MS, or HS
Coarse Aggregate	Gravel, crushed gravel or crushed stone, in accordance with ASTM C33
Fine Aggregate	Washed natural or manufactured sand, in accordance with ASTM C33
Concrete Curing Compound	ASTM C309 and C1315
Admixtures:	
Air Entrainment	ASTM C260
Water-reducing	ASTM C494 Type A
Retarding	ASTM C494 Type B
High Range, water reducing	ASTM C494 Type F
High range water-reducing and retarding	ASTM C494 Type G
Fly Ash	If allowed by engineer of record, fly ash may be used to replace up to 20% of cementitious material content by weight in accordance with ASTM C618 Class F; Class C fly ash shall not be used without Owner approval.

Grout materials shall be non-shrink cementitious (ASTM C1107) or epoxy material.

The concrete or and grout strength shall be defined by the characteristic compressive strength at age 28 days.

Sampling and testing of concrete shall be in accordance with ACI 318, ASTM C172, ASTM C31, ASTM C39, ASTM C172, ASTM C231, ASTM C143 and ASTM C1064.

Sampling and testing of grout material shall be in accordance with ASTM C579.

Sampling and testing concrete is be carried out by an accredited materials testing laboratory.

Maximum water/cement ratio: 0.45

Defective concrete shall be repaired by chipping out unsatisfactory material and placing new concrete.

2.3 OFF-SITE ROAD IMPROVEMENTS

Contractor shall establish any off-site road or public highway improvements that are required to:

1. Comply with agreements between Owner and the local Authorities
2. Permit full access for the project
3. Permit delivery of all plant and equipment required for the project, and
4. Permit delivery and supply of all other plant items, construction materials and equipment required to complete the Power Plant.

Contractor, with respect to the Work, shall be responsible for obtaining any relevant encroachment permits or other permits or authorizations and reaching any relevant agreements required with Government Authorities and third parties.

Contractor shall maintain off-site roads in as good or better than original condition throughout construction.

2.4 SITE ENTRANCE AND ACCESS ROADS

Contractor, with respect to the Work, shall be responsible for obtaining any relevant permits or authorizations and reaching any relevant agreements required with Government Authorities and third parties in relation to access:

1. Except where explicitly agreed as being within Owner's scope
2. Except in the case of approvals or agreements with landowners which shall be obtained through Owner

Contractor shall be responsible for establishing the extent to which improvements are required to any existing and new site entrance and access roads to facilitate the Project.

Contractor shall be responsible for establishing the site entrance and access roads to facilitate the Work including, but not limited to:

1. Delivery and installation of Project equipment and components in accordance with the equipment manufacturer's requirements.
2. Crane and heavy equipment access for the installation of Project components.

3. Two-way traffic for construction access
4. All-weather emergency vehicle access to work areas and site locations

Access road geometry shall conform to the following criteria, the Project component requirements, and permit requirements:

1. Road width shall be a minimum of 16 feet
2. Road cross-fall gradient shall be between 1 and 3 percent
3. Maximum road longitudinal gradient shall be 8 percent
4. Turn radii shall be as specified by the Project equipment supplier
5. Maximum vertical crest and dip on roads as specified by the Project equipment supplier.

Access roads shall be clear of overhead obstructions.

The Site entrance and access roads shall furthermore be designed to facilitate access including crane or heavy equipment access, for the ongoing operation and maintenance of the Power Plant, including turnarounds throughout the Site.

Contractor shall repair the Site roads and access roads to the design requirements at the end of the construction, but site access for crane access and delivery of large components cannot be diminished.

Particular attention shall be given to cutting, storing and reinstating topsoil and vegetation in order to encourage regeneration of vegetation.

Treatment of cut and fill slopes and installation of drainage shall be in accordance with applicable state and local standards and regulations.

All roads and tracks shall be designed in accordance with the geotechnical engineer's recommendations appropriate to the Site, Climatic Conditions and their period of use including, but not limited to:

1. Subgrade strength
2. Hydrology
3. Flooding
4. Frost
5. Snow
6. Bearing strength

Proof rolling shall be performed on all access roads in presence of qualified, competent, practicing geotechnical engineer or qualified representative.

2.5 UNDERGROUND CABLE RUNS

Underground cable runs, including SCADA communication cables and earth conductors, shall be located at an appropriate depth to meet Applicable Standards, Owner’s requirements as set forth in the Agreement and this document, and industry best practices.

Where appropriate, cables or cable conduits shall be laid during access road construction in order to avoid disturbing reinstated ground. Cables shall be suitably protected in conduit where they cross roads.

Possible surface reduction from future road maintenance shall be considered when selecting the cable burial depth at road crossings.

To prevent damage, all direct buried cables shall be laid on a bed of not less than 2 inches of sand or friable soil free of sharp stone and covered by not less than 2 inches of the same material.

Cables shall be installed in accordance with Applicable Standards including requirements for mechanical protection, warning and locating tape, and depths of burial.

All trenches are to be backfilled and compacted on completion and original levels restored to a minimum level of compaction and tested as specified by the Geotechnical Engineer. No surplus soil piles or stockpiles are to be left on the Site.

Cables shall be installed via trenching; blasting and plowing are not permitted excavation methods.

Native material excavated from the trench shall be used for the bedding/cover material as much as practicable, subject to the requirements listed above, local ordinances, and the need to ensure thermal stability. 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. In areas where topsoil is present, the topsoil shall be preserved during excavation and replaced following installation of the backfill.

Reseeding shall be undertaken by Contractor once trenches are backfilled and topsoil replaced.

Variations in underground cable installation depths, due to road/creek crossings and the typically rigid structure of direct burial machines, shall be considered in the cable sizing calculations and the selection of cable depth derating factors.

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

Direct buried cables leaving a trench to pass through ground surface shall be protected by a PVC conduit bend and concrete haunch, or other rigid frame acceptable to Owner.

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

Suitable cable marker posts shall be installed to indicate the route and depth of all underground power cables at each change of direction and on each side of each corresponding road or rail crossing, fence crossing, pipeline, utility crossings, property lines, wetlands, and streams.

1. The markers shall include cable voltage details and telephone numbers of both the asset Owner and the appropriate dig-safe agency.
2. Landowners shall also be provided with these phone numbers and the as-built cable route details and drawings.

Electronic cable marking tape shall be installed along the length of all buried power cable.

An appropriate cable locating device shall be provided to enable the location of underground cables, splices, and electronic markers. GPS-located marker balls are preferred for this purpose.

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..

2.6 FENCES, GATES, ENTRANCES, CATTLEGUARDS

All fences and entrances shall be in accordance with Applicable Standards and Applicable Permits.

All fences, gates, entrances, and cattleguards shall be of a standard type and similar in all aspects with the type commonly used in the local area unless otherwise specified.

Contractor shall determine and comply with the requirements of all Government Authorities.

All fencing and gates shall comply with the requirements set forth in M1-01-07 (Security and Compliance).

2.7 DRAINAGE

Drainage shall be provided by Contractor and shall prevent erosion, consistent with:

1. Federal, state and local laws and regulations
2. The design assumptions and criteria of the foundations, and other elements of the Civil Infrastructure
3. The absolute requirement to maintain adequate soil cover over the equipment foundation
4. Pollutant discharge and other environmental permitting restrictions on construction and the finished Project
5. Consideration of the safety of personnel and wildlife through the construction work

Batters and steep slopes that are disturbed in the course of the Project shall have a suitable means of stabilization applied.

Erosion control measures shall be installed in accordance with federal, state and local standards and regulations.

Appropriate means of energy dissipation shall be incorporated into the site drainage.

Additionally, Contractor shall provide drainage that shall accommodate:

1. A 20-year 24-hour return period flood event for the road and drainage infrastructure, and
2. A 100-year 24-hour return period flood with sufficient freeboard for the Project infrastructure, substation and permanent buildings.

Drainage infrastructures shall include culverts or low-water crossings 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.

The natural drainage patterns of the 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.

Access road and crane pad drainage shall be integrated and prevent water flow on the roads. All roads and pads shall have a minimum side slope of 1% to promote drainage.

Water pooling under the inverter and step-up transformer pads (if required) shall be prevented. To comply with this requirement, Contractor shall consider raising the ground level prior to installing the transformer kiosks.

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

A hydrology study shall be performed to describe the hydrology of the Site and any impacts that the hydrology may play in the design of the site layout. Drainage shall be provided by Contractor and designed to prevent flooding and erosion, consistent with:

1. Federal, state and local standards, laws and regulations
2. Recommendations from the hydrology study
3. Pollutant discharge and other environmental permitting restrictions on construction and the finished Project
4. Consideration of the safety of personnel and wildlife through the construction work

2.8 DISPOSAL OF EXCESS MATERIAL

Surplus soil and excavated materials may be disposed of on-Site to the extent this is consistent with Applicable Permits and planning and environmental constraints on the Project.

Other wastes including chemical waste shall be removed from the Site and disposed in an appropriately registered facility in accordance with federal, state and local laws and regulations. If immediate removal is impractical the wastes are to be temporarily stored in accordance with the Laws and applicable standards.

All permits and authorizations required for the temporary storage of waste on site shall be obtained by Contractor.

No litter, unsuitable materials, or construction related waste is to be left on the Site. Contractor shall remove all waste, including that of which is generated within temporary facilities.

2.9 RECLAMATION

Contractor shall reclaim all areas which have been disturbed during the Work by replanting and indigenous seeding, including conformance with the requirements of any Permits, the SWPPP, and any Project Agreements. All Work areas shall be restored to their pre-construction condition, at a minimum.

(1) 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 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 Site were in on the date the Contractor commenced work at the Site, ordinary wear and tear excepted.

(2) All drains and ditches shall be cleaned at completion of the construction Work, including removal of soil and debris from culverts, and leave the Site in

a neat and presentable condition wherever construction operations have disturbed the conditions existing at the time of starting the Work.

(3) 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.

(4) Notwithstanding the following paragraph (a), 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 erection/installation activities have been completed.

(5) Re-dress all road surfaces within the 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.

(6) 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.

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

(8) Spread surplus fill on-site in areas and depths approved by Owner.

(9) Spread recovered aggregate from laydown yard within approved disturbance limits at Owner-approved locations including but not limited to on access roads, and/or the operations and maintenance building yard.

(10) 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 Site.

The seed mix and plant species are to be approved by Owner prior to re-seeding.

Reclamation shall be in accordance with the Permits and planning and environmental constraints on the Project.

APPENDIX M1

ATTACHMENT 04

EXHIBIT 01

GENERAL ELECTRICAL STUDY REQUIREMENTS

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

TABLE OF CONTENTS

1.0 SCOPE

1.1 GENERAL

This specification covers the technical requirements for electrical system studies. The Contractor shall provide electrical system studies for the entire project, including arc flash hazard, load flow, short circuit, relay coordination, insulation coordination, DC/UPS sizing and grounding calculations.

The electrical system studies shall be prepared by the Contractor's qualified engineers or by an approved consultant. The coordination study and analysis shall be signed and sealed by a registered Professional Engineer. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study.

1.2 STANDARDS AND DOCUMENTS

Calculation and documentation shall be performed in accordance with the applicable standards in M4-01-01 (Energy Storage Technical Specifications).

2.0 SOFTWARE AND MODELING REQUIREMENTS

Electrical system studies (3.1 – 3.3) 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. Examples of BES components are collector circuits, substation, and switchyard equipment. The Easypower/Aspen model shall include a complete system one line diagram with the following minimum requirements:

1. Utility source information including calculated maximum and N-1 three-phase and single line-to-ground short-circuit current values and X/R ratios.
2. Bus nodes with ampacity and voltage ratings, and available short circuit current.
3. 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.
4. Cable and iso-phase bus size, type, impedance, and cable lengths within 10 feet of actual (through the 480 V level).
5. Circuit breaker or protective device make and model, frame ampacity, trip plug rating, and protective settings.
6. Motor circuit protectors make and model, ampacity, and protective settings.

7. Motor loads including horsepower, voltage, full load amps, and locked rotor amps.

8. Variable speed drives and protective settings.

9. Generators, including all nameplate information.

10. Neutral grounding resistor/transformer size and ratings.

11. 480 V panelboards including all branch circuit information.

12. Protective relay make, model, and protective settings.

13. DC/UPS chargers, inverter, batteries, disconnects, and panelboards.

14. 120/208 V panelboards including all branch circuit information.

15. 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.

16. WECC PSCAD transient model

3.0 DESIGN CALCULATIONS

3.1 ELECTRICAL STUDIES

3.1.1 Load Flow

Prepare a load flow study in Easypower to determine the steady state loading profile of the project electrical system.

Review the load flow study results and provide a listing of electrical equipment that shows overload, based on National Electrical Code loading requirements

Present the data conclusions of the load flow study in a table format. Include the following:

1. Bus identification
2. Bus nameplate ampacity
3. Operating voltage
4. Load Current

3.1.2 Reactive Power

Prepare a reactive power study to determine the reactive power capability of the project including additional reactive power compensation equipment to meet interconnection requirements as necessary to supplement site generation equipment reactive power capability, if applicable. Study shall include determination of voltage step due to capacitor switching to confirm compliance with power quality requirements including flicker. The study shall identify reactive compensation required to meet the project requirements, including the interconnection agreement requirements for power factor and voltage regulation, and including any capacitor bank and/or reactor requirements. This study shall include combinations of (a) active power (no load to full load at ten percent (10%) increments); and (b) voltage (0.95 to 1.05 pu) at the point of interconnection, or more stringent as necessary to meet project requirements, including the 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.

3.1.3 Thermal Ampacity

Prepare a thermal ampacity study to determine the underground MV and LV cables are adequately sized for the worst-case load current. Study shall include modeling of all trench and bore configurations including supporting assumptions of soil rho, native or non-native backfill, temperature, and compaction.
This study shall include all medium-voltage cable and low-voltage cable (from the turbine to the pad-mounted transformer). The final report shall include a table showing cable ampacity and percent loading per cable section corresponding to the Project one-line diagram. Cable ampacity shall not cause the operating temperature of cable insulation to exceed 105C or temperature limits as specified in this study, whichever is less. All external heat sources shall be considered, including parallel circuits. Thermal design shall account for actual field soil samples, maximum ambient temperature as defined by historical weather data, and backfill requirements (native or engineered).

3.1.4 Electrical Losses

Prepare an electrical losses study to determine the total power losses and annual energy losses from generation unit to point of interconnection. This study shall be sufficient to demonstrate that the, as defined in the Contractor scope of work, is not being exceeded, and shall be based upon project-specific cabling and transformer specifications, Project site-specific soil conditions, project site-specific operating data, and other similar considerations. A pre-construction annual energy loss study and an as-built energy loss study, respectively, shall be submitted. The energy loss calculation shall include supporting assumptions and breakdown of subsystem loss contribution. The loss study shall be based on IFC drawings and be revised following construction to include any material changes to the EBoP in as-built drawings.

3.1.5 SHORT-CIRCUIT

Prepare a short-circuit study for electrical equipment provided for the project.

The Contractor shall request from the Owner the available fault ratings of the source utility connection. The Owner shall provide the fault ratings no later than 28 days upon receiving the request from the Contractor.

Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices. Short circuit analysis shall be run at a collection system pre-fault voltage of nominal voltage of 105%. In addition, the report shall consider all short circuit scenarios when the bus ties are closed and when the bus ties are open. This study shall include maximum and minimum fault current results for three-phase, single phase-to-ground, phase-to-phase, and double phase-to-ground faults at each of the collection system circuits, the project substation, and the interconnection line.

Collection power cables and grounding conductors shall be sized to appropriately withstand maximum fault currents for the duration that is specified in the interconnection agreement or other requirements as provided in the scope of work contract, whichever is greater.

The short circuit study shall be utilized in Contractor’s electrical designs to support a coordination study and equipment specifications.

Fault current results in this study will also include direction fault current data which may be used in the coordination study.

Analyze the short-circuit calculations, and highlight equipment determined to be underrated regarding fault duty as specified. Propose approaches to effectively protect the underrated equipment.

Present the data conclusions of the short-circuit study in a table format. Include the following:

1. Device identification
2. Operating voltage
3. Device rating
4. Calculated short-circuit current (symmetrical and asymmetrical)

3.1.6 MOTOR STARTING STUDY (if required)

Prepare a static motor starting study for electrical equipment provided for the project. The motor starting study shall evaluate the capability of the auxiliary power system to start the largest motor load on the MV and LV systems at normal operating voltage (100%) as well as the minimum operating voltage (95%) with transformers at nominal tap.

Cases shall also be run for startup (back fed from system no generator online) and normal (generator online).

The report should confirm that the motor terminal voltage does not dip below the minimum starting motor terminal voltage of 80%.

Present the data conclusions of the Motor Starting study in a table format. Include the following:

1. Device identification
2. Operating voltage
3. Motor terminal voltage during starting

3.2 COORDINATION STUDY

The Contractor shall provide a selective coordination study using either Easypower or Aspen OneLiner (Easypower to be populated with Aspen OneLiner results) with an organized time-current analysis of each protective device in the project. The coordination study scope shall include protective devices including the entirety of the project substation, collection system, generators, and switchyard as applicable. This study shall provide detailed calculations, one-line and three-line diagrams, fuse curves, coordination curves, protected equipment data, and relay set points. 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 shall be shared with relevant stakeholders (e.g., OEM) 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 coordination study shall consider maximum and minimum fault current results as determined by the short circuit study.

Contractor shall communicate with the interconnecting switchyard/substation owner to coordinate remote-end line relay settings between the interconnecting switchyard/substation and the project substation.

Prepare the coordination curves to determine the required settings of protective devices to ensure selective coordination. Graphically illustrate on log-log paper that adequate time separation exists between series devices, including the utility company upstream device. Plot the specific time-current characteristics of each protective device in such a manner that upstream devices are clearly depicted on one sheet.

After developing the coordination curves, highlight areas lacking protective coordination. Present a technical evaluation with a discussion of the logical compromises for best coordination.

The following information shall also be provided on the time coordination curves:

1. Device identification
2. Voltage and current ratio for curves
3. 3-phase and 1-phase ANSI damage points for each transformer
4. Transformer inrush points
5. No-damage, melting, and clearing curves for fuses
6. Cable damage curves
7. Maximum short-circuit cutoff point
8. Minimum short-circuit cutoff point

Develop a table to summarize the settings for the protective devices. Include the following in the table:

1. Device identification
2. Relay CT ratios, tap, time dial, and instantaneous pickup
3. Circuit breaker sensor rating, and all protective elements as specified in the protection and control drawings
4. Fuse rating and type

3.3 ARC FLASH HAZARD STUDY

An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and personal protective equipment that people within the arc flash boundary shall use. These results shall be provided for all reasonably operated enclosures and corresponding buses at major substation equipment, collection system, transformers (including pad-mounted), switchgear (as applicable), operations and maintenance building, and other major components, as applicable.

The Contractor shall perform an Arch Flash Hazard Study in Easypower as identified and in accordance with IEEE 1584. The following modeling requirements shall apply:

- In addition to IEEE 1584 recommended scenarios, scenarios shall include maintenance mode selection of switchgear protective relays.

- As identified in NPFA 70E Article 130 the Arc Flash Boundary shall be the distance at which the incident energy equals 5 J/cm2 (1.2 cal/cm2).

Develop a report to summarize the arc flash hazard information at electrical equipment rated 120 volts or greater. The report shall provide the following information for each piece of electrical equipment:

1. Available incident energy and the corresponding working distance

2. Minimum required level of PPE to meet incident energy calculations

3. Highest Hazard/Risk Category (HRC) for the equipment

4. Nominal system voltage

5. Arc flash boundary

6. Electrode configuration used to determine arc flash results

3.4 INSULATION COORDINATION

The Contractor shall provide an insulation coordination study to ensure the insulation coordination requirements of IEEE C62.22 have been satisfied within the project's electrical design, including proper application of surge arresters to safeguard electric power equipment within the collection system circuits, substation, and interconnection line against hazards of abnormally high voltage surges of various origins. 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.

3.5 TRANSFORMER SIZING

Transformer sizing calculations, including medium-voltage and main power transformers, shall be provided prior to procurement of any power transformer.

3.6 DC/UPS SIZING

A DC and UPS sizing calculation shall be provided to verify that the DC and UPS systems are adequately sized for the project. The Contractor shall provide the initial calculation prior to procurement of the equipment. The supplier of the equipment shall also submit a battery sizing calculation to validate the project specific battery. This 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.

The calculation shall include:

1. A UPS Load List (indicating a load factor and diversity factor)

2. A DC Load Cycle

3. A battery sizing calculation per IEEE 485 (including 10% design margin and 125% aging factor)

4. Battery Charger sizing calculation

3.7 GROUNDING CALCULATION

Grounding calculations shall confirm that the grounding systems be provided at the substation and each generation location to assure that a person in the vicinity of grounded facilities is not exposed to the danger of critical electric shock. The grounding calculations shall be performed in CDEGS software and provided to Owner for review. The calculations must establish:

1. Touch and step potentials are within tolerable safe limits in accordance with IEEE 80.

2. Ground grid resistance is low enough to limit the ground potential rise (GPR).

In addition to IEEE 80 recommended practices, the following requirements shall be followed:

1. Most conservative body weight shall be assumed (50 kg).

2. A minimum of 3000 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.

3. As-built crushed rock depth shall be recorded and updated in the calculation.

CDEGS software shall conform to the following:

1. Software Version: Contractor shall verify acceptable version with Owner.

2. Multi-layer soil model in RESAP

3. Grounding Plan in SESCAD

4. Step and Touch Potentials in MALZ

5. 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.

3.8 HARMONICS STUDY (if required)

A harmonics study shall confirm that the generation plant harmonics output does not exceed limits required by generator interconnection requirements and IEEE 519. This study shall provide recommendations for the use of harmonic filters, equipment, and methods as necessary to meet these requirements. A pre-construction harmonic analysis report (performed at 90 percent design) and an as-built harmonic analysis report, respectively, shall be submitted.

3.9 SUBSYNCHRONOUS RESONANCE STUDY (IF REQUIRED)

A subsynchronous resonance study shall confirm no subsynchronous resonance issues or mitigation is required. EMTP software shall be used (Owner to approve software version).

3.10 EFFECTIVELY GROUNDED STUDY

An effectively grounded study shall confirm that the project is considered effectively grounded, as defined in IEEE C62.92.1.

3.11 AUXILIARY POWER STUDY

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

3.12 BUS STRUCTURAL ANALYSIS STUDY

A substation bus structural analysis study shall confirm that the 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 are acceptable.

3.13 SUBSTATION BUS DESIGN STUDY

A substation bus design study shall perform an analysis 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.

3.14 SUBSTATION LIGHTNING STUDY

This study shall provide 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.

3.15 SUBSTATION LIGHTING STUDY

This study shall provide lighting illumination calculations for the project substation to determine the illumination levels within the new substation that will be achieved with added luminaries.

3.16 FIELD EFFECT STUDY

Provide Field Effect study for transmission line. Calculations shall be made for measurement heights of 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.

4.0 <u>NERC COMPLIANCE</u>

The project shall be designed to comply with all applicable NERC requirements, including provision of the studies set forth in M1-01-07. Studies shall be completed prior to synchronizing. Contractor shall provide models for studies as listed in subsections c, d, e, f, and g prior to synchronizing, but these models will be verified during project commissioning.

5.0 <u>REPORTS AND DELIVERABLES</u>

5.1 APPROVAL REPORTS AND SOFTWARE FILES

The Contractor study preparer shall analyze the electrical system studies, prepare, and submit an approval report for each study that is required. Each report shall include executive summary, assumptions, methodology, analysis, and conclusion sections. Analysis sections shall summarize the results of each study and reports any deficiencies found with suggested corrections that should be made. Each report shall be submitted with the native software files and any referenced files for the Owners use in reviewing.

The Contractor shall provide Owner completed study reports for approval prior to proceeding with study results in accordance with Appendix M1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

One month prior to construction completion, the Contractor shall provide the Owner two hard copies and two electronic copies of the completed electrical system as-built studies, including native software files, in accordance with Appendix M1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables. The Owner shall be given 14 days to review the as-built electrical system studies and software files and provide review comments to the Contractor.

5.2 FINAL REPORTS AND SOFTWARE FILES

Upon receipt of the Owner's review comments, the Contractor shall incorporate comments into a final electrical system study report.

For the coordination study, after commissioning is complete, the Contractor shall verify the study protective device settings corresponding to the device settings in the field and resolve any conflicts.

The Contractor shall provide the Owner two hard copies and two electronic copies of the final electrical system studies in accordance with Appendix M1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables. The Contractor shall also provide the Owner with a copy of the native data files for their use. Native data files for generation facilities shall include:

1. Detailed Load Flow / Dynamic (RMS) Model: PSLF or PSS/e model of the entire facility
2. Detailed Transient Stability Model: PSCAD model of the entire facility
3. Aggregate Load Flow / Dynamic (RMS) Model: PSLF model from NERC testing would satisfy this requirement

Appendix M1

Attachment 04

Exhibit 02

General Transformer Specification

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

TABLE OF CONTENTS

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 03

SUBSTATION DESIGN AND CONSTRUCTION SPECIFICATIONS

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

M1-05-03-Substation Design and Construction Specifications

SPECIFICATION INDEX

SECTION 5 - METALS

SECTION 6 - ELECTRICAL

1 SECTION 1 - GENERAL

1. SECTION 1000 SUMMARY OF WORK

1.1.1 General

1.1.2 Description of Project

The XXXX Project consists of constructing XXXX

1.1.3 Work Performed by Contractor

The Contractor's scope will include all below grade and above work required to complete construction including but not limited to the following tasks.

Incidental work and materials required to provide a complete and functional substation shall be the responsibility of the Contractor.

All work shall be in accordance with this specification, applicable contract exhibits, Owner-approved design specifications, and the drawings.

1.1.4 Work Performed by PGE

1.1.5 PGE Provided Materials

MATERIAL	PLANNED DELIVERY

The Contractor will be responsible for receiving and storing the equipment if the substation location has not been deemed to be ready by the Owner. If the Contractor is unable to receive the materials when they are delivered, the Contractor is responsible for any additional storage or shipping.

1.1.6 Contractor Provided Materials

Contractor is responsible for providing material quantities required for construction, except for those identified in section 1.4. Quantities will not be adjusted for actual quantities installed.

1.1.7 Work Sequence

Contractor shall propose a detailed work schedule for PGE's approval.

1.1.8 Attachments

- Engineering and Construction Standards
  - MP-6C-ALL-002 – Generic Baseline for New Gas Breakers
  - MP-6C-VAC-001 – Generic Baseline for Vacuum Breakers
  - MP-6G-ALL-004 – Circuit Breaker Checkout Procedure
  - MP-11G-ALL-004 – Transformer Testing
  - MP-12G-ALL-003 REV 1 – Doble 3100 Timer Operating Instructions
  - MP-15G-INST-TESTS-REV 3 – Testing Instrument Transformers
  - S-116-25 – Potential Fuse Box

- S-130-50 – Animal Deterrents
- S-131-40 – Bolted Pad Connections
- S-140-06 – Metal Building Grounding
- S-140-09 – Capacitor Bank Grounding
- S-140-12 – Outdoor Enclosure and Cabinet Grounding
- S-140-15 – Fence and Gate Grounding
- S-140-16 – Barb Wire Grounding
- S-140-21 – Ground Grid and Structures
- S-140-24 – Instrument Transformer Grounding
- S-140-27 – Switch Handle and Operator Grounding
- S-140-31 – Power Transformer Grounding
- S-144-10 – Control Wiring
- S-144-10 Addendum – Control Wiring
- S-140-30 – Underground 15kV Power Cable
- STND-1300 Substation Raceway Systems
- STND-1400 Substation Lighting

- Evaluation Questions
- West Union Geotech report
- Testing Checklist for Contractor (TCC)
- Switchgear 1&2 Vendor Drawings
- C&P IFC 4-3-15
- Physical IFC 4-2-15
- Civil IFC 4-9-2015

2. SECTION 1020 QUALITY CONTROL

1.1.9 GENERAL

A. The Contractor shall ensure that subcontractors are approved by the Owner and satisfy the Owner required qualification/approval process prior to work being performed by the proposed Subcontractor.

1.1.10 QUALITY ASSURANCE

B. Contractor shall monitor quality control over suppliers, manufacturers, products, services, site conditions and workmanship to produce work which meets quality requirements as set forth in applicable contract specifications. Locations of existing structures, utilities and other site conditions indicated on the drawings are approximate, and shall be the Contractor's responsibility to verify the true and correct locations so as to avoid interferences, damages or disturbances. Deviations from information indicated on the drawings shall be brought to the immediate attention of the Owner. New construction shall accommodate existing conditions.

Prior to any excavation the Contractor shall call for primary power cable locates by a PGE Special Tester. To schedule a PGE Special Tester call **PGE's Power Quality Hotline at 503-572-0395.**

C. Contractor shall comply with manufacturer's instructions including performing each step in sequence. Should instructions conflict with contract documents, request clarification from Owner before proceeding. All fabrication and installation shall comply with the drawings and specifications. Should information provided on the drawings conflict with that in the specifications, request clarification from the Owner before proceeding.

D. Contractor shall comply with specified standards as minimum quality for the work. The exception is where standards, by code or by requirements of construction permits, indicate higher standards or workmanship that is more precise is required.

1.1.11 TOLERANCES

E. Contractor shall comply with manufacturer's tolerances. Should manufacturer's tolerances conflict with contract documents, request clarification from Owner on which tolerances should be used before proceeding.

1.1.12 INSPECTING, TESTING AND LABORATORY SERVICES

F. Contractor will employ the services of an independent firm to perform testing and inspection services. The independent firm will perform inspections, tests and other services specified in individual specification sections or as required by the Owner.

G. Reports will be submitted by the independent firm to the Owner indicating observations and results of tests and indicating compliance or non-compliance with the specifications.

H. Contractor shall cooperate with the independent firm and furnish samples of material, design mix, and provide equipment, tools, storage, safe access and assistance by incidental labor as requested.

I. Testing or inspecting does not relieve Contractor of responsibility to perform work in compliance with contract requirements.

J. The same independent firm, on instruction by the Owner, shall perform retesting required because of non-conformance to specified requirements by the Owner. Payment for retesting will be charged to the Contractor by deducting inspecting or testing charges from the Contract price.

1.1.13 MANUFACTURER'S FIELD SERVICES AND REPORTS

K. If the Owner, scope of work, or material specification requires the manufacturer to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, or startup of equipment, the Contractor shall arrange and coordinate such activities.

L. The Contractor will supply the Owner with certified originals or copies of all equipment or material test completed by manufacturers and/or specified by Owner specifications and/or scope of work.

1.1.14 CONTRACTOR HOLD POINTS

Contact PGE at the following times during construction for a PGE site review of work to the drawings and specifications:

- After compaction and backfill.
- After completion of grading.
- After completion of drilling holes for pier foundations and prior to placement of rebar cage.
- For all other foundations, after rebar is installed and before pouring concrete.
- Special inspections for rebar and concrete placement.
- Prior to installing any major equipment on concrete slab foundations to check for flatness.
- Before covering conduits & grounding connections.
- After completion of all sub-grade conduit & grounding installations and before placement of geo-textile fabric and final aggregate surfacing.
- After completion of all steel structure erection and disconnect switch and switch operator placement. Verify disconnect switch operation before punching set screws.
- After completion of the placement of all 115kV & 15kV equipment and bus work and bus jumpers to equipment
- After bolted electrical connections and enclosure assembles are made. PGE to verify torqueing requirements.
- During the pulling of control cables to and from major equipment into control enclosures.
- During control cable terminations.
- After major equipment testing.

3. SECTION 1030 TEMPORARY CONSTRUCTION FACILITIES

1.1.15 GENERAL

1.1.16 TEMPORARY UTILITIES

Owner will provide the following utilities to the Contractor at no cost. Contractor is responsible for connection, maintenance and removal of all temporary utilities. Owner does not guarantee continuity of service. Contractor shall minimize disruption to Owner during connection and removal activities.

All utilities not listed that are required shall be provided by Contractor

- Owner will only provide electrical utility for Contractor. Contractor shall coordinate and provide a month notice to Owner for electrical utility requirements.
- Contractor shall provide a three phase, 400VAC, 50kW generator for GIS gas cart and supply all fuel necessary to operate the generator.

1.1.17 TEMPORARY CONTROLS

A. Barriers: Contractor shall provide barriers or barricades as required to prevent unauthorized entry to construction areas and protect existing facilities and adjacent properties from damage from construction operations.

B. Fence:

- Contractor shall provide temporary fencing as shown on the drawings or as required to maintain security.
- Any temporary fence installed that functions as the substation perimeter fence shall be installed in accordance with PGE's fence and fence grounding standards. With approval from PGE the temporary perimeter fence posts may be directly embedded into the soil without concrete.

C. Traffic Control: Contractor shall provide traffic control measures including signing, flagging and other traffic control measures as required to maintain safe access into and through the construction area and any other traffic control measures that may be required by local agencies.

1.1.18 TEMPORARY FACILITIES

M. Field Office: Contractor shall provide a weather tight construction office complete with lighting, heating and cooling equipment. Office shall include space for Owner's Inspector or other personnel.

N. Temporary restrooms shall be available and shall be outfitted for conditions (i.e., space heated in the winter, if necessary).

4. SECTION 1040 CONTRACT CLOSEOUT

1.1.19 GENERAL

1.1.20 SUMMARY

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:

1. Inspection procedures
2. Project record document submittal
3. Submittal of warranties
4. Final cleaning
5. Refer to M1-02-01 (General Civil Specs) for detailed reclamation requirements

1.1.21 SUBSTANTIAL COMPLETION

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.
   a) Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
   b) If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.
2. Advise the Owner of pending insurance changeover requirements.

3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
4. Obtain and submit releases enabling the Owner unrestricted use of the work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Submit final record information.
6. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.
7. Discontinue and remove temporary facilities, construction tools, and similar elements from the site.
8. Complete final cleanup requirements.
9. Touch up and otherwise repair and restore marred and exposed finishes.
10. The Contractor will submit their internal QA process which will indicate any outstanding construction issues.

B. Inspection Procedures: On receipt of a request for inspection, the Owner will either proceed with inspection or advise the Contractor of unfilled requirements. The Owner will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction work that must be completed or corrected before the certificate will be issued.
1. The Owner will repeat inspection when requested and when assured that the work is substantially complete.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 Final Acceptance

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. Create a list of exceptions in the request.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the Owner's final inspection list of items to be completed or corrected, endorsed and dated by the Owner. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Owner.
4. Submit consent of surety to final payment.
5. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Re-inspection Procedure: The Owner will re-inspect the Work upon receipt of notice that the work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Owner.

1. Upon completion of re-inspection, the Owner will prepare a certificate of final acceptance. If the work is incomplete, the Owner will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
2. If necessary, re-inspection will be repeated.

1.5 Record Document Submittals

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire- resistant location. Provide access to record documents for the Owner's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of black line prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record later.
1. Mark three record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the work.
2. Mark new information that is important to the Owner but was not shown on the Contract or Shop Drawings.
3. Note related change-order numbers where applicable.
4. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.

C. Record Specifications: Maintain one complete copy of the Project Specifications, including addenda. Include with the Project Specifications one copy of other written construction documents, such as Change Orders and modifications issued in printed form during construction.
1. Mark these documents to show substantial variations in actual work performed in comparison with the text of the Specifications and modifications.
2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
3. Note related record drawing information and Product Data.
4. Upon completion of the work, submit record Specifications to the Owner for the Owner's records.

D. Record Product Data: Maintain one copy of each Product Data submittal. Note related Change Orders and markup of record drawings and Specifications.
1. Mark these documents to show significant variations in actual work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the work that cannot otherwise be readily discerned later by direct

observation.

3. Upon completion of markups, submit a complete set of record Product Data to the Owner for the Owner's records.

E. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals concerning actual performance of the work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to the Owner for the Owner's records.

5. SECTION 1050 CONTRACT ADMINISTRATION PROCESS

1.1.22 GENERAL

1.1.23 PLANS AND SPECIFICATIONS

The Contract Documents govern the Work to be done, set forth the relative responsibilities of the Owner and Contractor, and establishes the method by which changes in the Contract are made.

Some details of the Work may be found in only one location in the Contract Documents. Therefore, the Contractor must review all portions of the Contract Documents in order to know the full scope of Work. Including, but not limited to PGE Standard Construction and Design Documents.

All civil works for the Project Substation shall comply with the applicable specifications in M1-02-01-General_Civil_Specs.

1.1.24 PRECEDENCE OF CONTRACT DOCUMENTS/CONFLICTS

Obvious conflicts in the Contract Documents, or obvious omissions, are ones that should have been discovered before submission of a Bid to the Owner by a reasonable person in the Contractor’s position if all the Documents had been reviewed. In such a situation, the Contractor has a duty to inquire of the Owner before submitting its Bid about the correct interpretation of the Contract. This permits the Owner to clarify by Addendum what is intended by the Contract. That is particularly true for errors in figures, drawings or Specifications.

If the Contractor fails to bring an obvious conflict or error to the Owner’s attention before it submits a Bid, it has waived its right to additional compensation when the Owner resolves it.

Anything shown on the Plans and not mentioned in the Specifications or Standards, or mentioned in the Specifications and Standards and not shown on the Plans, shall be of like effect as if shown or mentioned in both. This does not constitute a conflict, discrepancy or error between the two.

In cases of apparent discrepancies or conflicts between the Plans, the Specifications and the Standards, the Contractor shall first determine if the matter can be resolved pursuant to the rule stated above. If not, the apparent conflict shall be resolved by designating the portion of the Contract Documents that takes precedence over the others. Therefore, when preparing its Bid, or when beginning any portion of the Work, the Contractor shall use the following order of precedence to resolve any apparent conflict:

- Permits from Outside Agencies required by law
- Change Orders
- Addenda
- Technical Specifications
- Plans
- Information furnished by written notes and/or schedules on drawings
- Large Scale Drawings over small scale drawings
- Information provided by lines on drawings
- General Conditions of the Contract

Contractor shall bring any real or perceived discrepancy concerning dimensions, quantities or location between the Drawings, details, Specifications or Standards to the attention of the Owner's Representative before beginning that portion of the Work.

In the event of any inconsistency in the Drawings, Specifications and Standards unless otherwise ordered in writing by the Owner's Representative, the Contractor shall provide the better quality of, or the greater quantity of Work or materials. This provision shall apply only to inconsistencies in express requirements of the Drawings, Specifications and Standards and not the interpretations by the Owner or Architect.

1.1.25 SHOP DRAWINGS AND SUBMITTALS

For purposes of this subsection the following definitions apply:

- All drawings and submittals shall comply with the applicable specifications in M1-01-02-Eng_Docs_Dwgs_and_other_Deliverables and results of the studies as specified in M1-04-01-General_Electrical_Study_Requirements.
- "Shop Drawings" are drawings, diagrams, schedules and other data specifically prepared for the Work by the Contractor, a Subcontractor at any tier, manufacturer, supplier or distributor to illustrate some portion of the Work.
- "Product Data" are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.
- "Samples" are physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.
- "Submittals" are documents required by the Contract to be submitted to the Owner for review. However, they are not part of the terms and conditions of the Contract. They may include shop drawings, product data, samples, or a schedule of construction events.

Shop Drawings, Product Data, Samples and other Submittals are not part of the Contract. Their purpose is to demonstrate, for those portions of the Work for which Submittals are required, the way the Contractor proposes to conform to the requirements of the Contract and the design concept expressed in the Contract.

The Contractor shall review, approve and submit to the Owner all Shop Drawings, Product Data, Samples and other Submittals required by the Contract regardless of whether the document originated with the Contractor or with some other Subcontractor or supplier. They shall be submitted at the time required by the Contract, or, if no time is specified, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate Contractors. Submittals made by the Contractor that are not required by the Contract may be returned without action or may not be returned at all.

Informational Submittals that do not require the Owner to take responsive action may be so identified in the Contract.

The Contractor shall submit electronically a copy of any Submittal required by the Contract or when requested by the Owner's Representative. In addition, the Contract may also require the Contractor to provide information about the products and materials it proposes to incorporate into the Work and to provide samples of such products and materials for inspection or testing. The Contractor shall be responsible for all Submittals presented to the Owner for review, no matter what their point of origin may have been.

The Contractor shall not perform a portion of the Work that requires the Owner to review a Submittal until the respective Submittal has been reviewed by the Owner as outlined below. Such work shall be performed in accordance with Submittals that conform to the Contract Documents.

When tendering a Submittal to the Owner for review, the Contractor represents that it has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained with such Submittals with the requirements of the Work and of the Contract. The Contractor shall expressly note where any submittal differs from or varies from the requirements of the Contract, notwithstanding any belief on the part of the Contractor that the variance is obvious.

The Owner's review of any Submittal does not relieve the Contractor from its responsibility to follow the requirements of the Contract. The Owner is not responsible for ensuring that Submittals are correct. Failure of the Owner to discover that a submittal varies from the requirements of the Contract Documents does not relieve the Contractor of its responsibilities to conform to the Contract nor provide a basis for a Change Order. Nevertheless, the Owner's Representative shall review any Submittals provided in order to make a general determination about whether they appear to meet Contract requirements or the intended design of the Project. The Contractor remains responsible for following the Contract, including, but not limited to:

- Confirming and correlating all dimensions.
- Fabricating and construction techniques.
- Coordinating the work with that of all other trades and Subcontractors.
- Satisfactorily performing the Work in strict accordance with the Contract Documents.

- The means and methods of construction.
- Conforming to all the requirements of the Contract.

The Owner's Representative shall have fourteen (14) days to review any Submittals. Submittals returned to the Contractor as "REVISE AND RESUBMIT" OR "REJECTED" and subsequently resubmitted shall have fourteen (14) days for each additional review. The Owner's Representative will review the Submittals and return them electronically to the Contractor stamped with one of the following notations:

- "NO EXCEPTIONS TAKEN": If the Submittal is marked, "NO EXCEPTIONS TAKEN," this means that the Contractor immediately can begin the work encompassed by the Submittal.
- "MAKE CORRECTIONS NOTED": If the Submittal is marked "MAKE CORRECTIONS NOTED" the Contractor is required to make any revisions suggested by the Owner's Representative and, upon correction, may immediately begin the work indicated by the Submittal or may incorporate the material or equipment covered by the Submittal into the Work.
- "REVISE AND RESUBMIT": If the Submittal is marked "REVISE AND RESUBMIT," the Contractor is required to revise the Submittal and resubmit it to the Owner's Representative. No work shown on the Submittal, or which is dependent upon review of the Submittal or material or equipment covered by the Submittal, may be incorporated into the Work until the Contractor has made the necessary revisions, resubmitted the Submittal and received the Submittal back marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."
- "REJECTED": If the Submittal is marked "REJECTED" it means that the Owner's Representative has found the Submittal, material or product data to be unacceptable and not in conformance with the Contract. Generally speaking, rejection of a Submittal simply indicates the Owner's Representative's belief that the defects in the Submittal are so great that it cannot be revised in order to make it conform to the Contract, as indicated in paragraph I (3) above. The Contractor may not begin work indicated by the Submittal, nor incorporate material or equipment, nor proceed with Work dependent upon review of the Submittal, into the Work based on any Submittal, product data or material that has been marked "REJECTED."

The following rules about Contract Time shall apply to Submittals. Contract Time will not be extended if:

- The Contractor's delay resulted from the Owner's use of the full amount of allotted time under the Contract to review the Contractor's Submittal;
- The Contractor's delay resulted from its own failure to provide a submittal in a timely manner;
- The Contractor's delay resulted from a submittal that properly was marked "Revise and Resubmit," "Rejected;" or
- The Contractor did not understand what it was required to submit and failed to inquire about it in a timely manner.

The Contractor shall keep a current schedule of submittals available for the Owner's Representative to review.

1.1.26 EXTRA WORK AND CONTRACTOR CHANGE ORDERS

Owner and Contractor mutually agree that changes in Plans, quantities, or details of the Work are inherent in the nature of construction and may be necessary or desirable. Therefore, without impairing the Contract, the Owner reserves the right to require changes determined necessary or desirable to complete the proposed construction within the general scope of the Work provided for in the Contract or to order Extra Work if that is required. Performance of changed or Extra Work shall be in accordance with requirements of the Contract.

When the Owner’s Contract Administrator is contemplating changed or Extra Work, a Notice of the proposed changed or Extra Work together with a solicitation for a quotation for the performance of the changed or Extra Work shall be issued to the Contractor, in writing, by the Owner’s Contract Administrator.

During construction, any change that the Contractor performs that varies from the approved Contract requires a change order submitted and approved by PGE prior to commencing work. A Contractor change order will require review by multiple PGE individuals and PGE will be allowed fourteen (14) days before the change order is approved or denied. A contractor’s failure to notify PGE in advance of the change being performed will be denied for payment and time extensions.

During construction, the Contractors site Project Manager and the PGE Site Inspector will need to maintain regular discussions with the PGE engineering team. It is expected that changes that occur are addressed far enough ahead to not impact the overall project schedule. On-site weekly meetings discussing upcoming work should address possible change issues far in advance before a change order is submitted.

Contractor will be responsible to submit with the change orders all supporting e- mails and documentations supporting the change order request. Copies of all invoices from material suppliers are to be included with the change order to support costs outlined in a change order.

When preparing its Change Order, or when beginning any portion of the Work, the Contractor shall use the following order of precedence to resolve any Extra Work and Change Order requests:

For Change Orders for a Maximum of $5,000 Value:

- PGE Site Inspector can give verbal approval for the Contractor to proceed based on a follow-up written Change Order submittal by the Contractor.
- Contractor submits a Change Order request via SharePoint and also to the PGE Contract Administrator and CC’s the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order request cost. The Change Order submittal shall be no greater than 15 days from the change.

For Change Orders over $5,000 but No Change to Project Scope or Schedule:

- Contractor discusses the requirement for the Change Order with the PGE Site Inspector but does not proceed.

- Contractor submits a Request for Information (RFI) to PGE via the SharePoint site or requests technical support from PGE Engineering immediately or within 5 business days of Change Requirement.
- PGE will respond to the RFI or technical request to the Contractor within 5 business days after the RFI or technical request.
- Contractor submits the Change Order to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order costs. The Change Order submittal shall be no greater than 15 days from the original Contractor RFI or technical request from PGE. Greater than 15 days shall be allowed with a PGE approval per Change Order.
- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE Engineering discuss the Change Order.
- PGE Contract Administrator approves/denies the Change Order with PGE PM and PGE Engineering support.

For Change Orders to Revise the Project Scope - Regardless of Cost:

- Contractor discusses the requirement for the Scope Change/Change Order with the PGE Site Inspector but does not proceed on the work.
- Contractor requests information from PGE Engineering through an RFI submittal within 5 business days.
- PGE will respond to the RFI or technical request to the Contractor within 5 business days after the RFI or technical request.
- Contractor submits the Change Order to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order costs. The Change Order submittal shall be no greater than 15 days from the original Contractor RFI or technical request from PGE. Greater than 15 days shall be allowed with a PGE approval per Change Order.
- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE Engineering discuss the Scope Change.
- PGE Contract Administrator approves/denies the Change Order after PGE PM and PGE Engineering approval.

For Change Orders to Revise the Overall Project Schedule - Regardless of Cost:

- Contractor discusses the requirement for the Schedule Change with the PGE Site Inspector.
- Contractor discusses the schedule change with the PGE PM and the PGE Contract Administrator.
- PGE will respond to a schedule change request within 5 business days after the request.
- Contractor submits a Change Order for the Schedule change to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change. The Change Order shall be submitted no greater than 15 days from the original schedule discussions with PGE.
- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE

Engineering discuss the Schedule Change.

- PGE Contract Administrator approves/denies the Schedule Change on the Change Order after PGE PM and PGE Engineering approval.

1.1.27 DIFFERING SITE CONDITIONS

The Contractor shall promptly, and before the conditions are disturbed, give written Notice to the Owner's Representative of:

- Pre-existing subsurface or latent physical conditions at the site which differ materially from those indicated in this Contract, or;
- Pre-existing unknown physical conditions at the site, of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inherent in the work of the character provided for in the Contract.

After receipt of the Notice, the Owner's Representative will investigate the conditions encountered by the Contractor promptly. If the Representative finds that the conditions are materially different and cause a material increase or decrease in the Contractor's cost of, or the time required for, performing any part of the Work under this Contract, whether or not changed as a result of the conditions, an Equitable Adjustment to the Contract will be made under this clause and the Contract modified in writing accordingly. If possible, Owner and Contractor shall agree on the adjustment to be made. If they are unable to agree, the Representative will determine the amount of the Equitable Adjustment and adjust the time to perform if appropriate. If the Representative finds that differing site conditions do not exist, that decision is final and binding upon the Contractor.

Contractor has waived its right to bring a Claim for additional compensation or Contract Time for encountering a differing site condition unless the Contractor has given the Notice required by the Paragraph above. No request by the Contractor for an Equitable Adjustment to the Contract as a result of a differing site condition will be allowed if the request is made after Final Payment under this Contract.

1.1.28 AUTHORITY OF THE OWNER'S REPRESENTATIVE'S

The Work shall be performed to the complete satisfaction of the Owner's Field Inspector and Contract Administrator.

Work will not be considered completed until it has passed final inspection by the Owner's Field Inspector and is accepted by the Owner. The authority of the Owner's Field Inspector is such that the Contractor shall at all times carry out and fulfills the instructions and directions of the Owner's Representative's in so far as they concern the work to be done under the Contract.

The Owner's Contract Administrators decisions will be final, binding and conclusive on the Contractor on all questions that arise regarding the quantity of materials and work, the quality of materials and work, the acceptability of materials furnished and work performed, the acceptable rate of progress of the work, the interpretation of the Plans and Specifications, the measurement of all quantities, the acceptable fulfillment of the Contract on the part of the Contractor, and payments under the Contract.

If the Contractor fails to comply with any reasonable order made under the provisions of this Subsection, the Owner's Contract Administrator shall have the authority to cause unacceptable work to be remedied or removed and replaced, and unauthorized work to be removed, and to deduct the costs thereof from any money due or to become due the Contractor.

Nothing in this Subsection or elsewhere in the Contract shall be construed as requiring the Owner's Field Inspector and Contract Administrator to direct or advise the Contractor on the method or manner of performing any work under the Contract. No approval or advice as to the method or manner of performing or producing any materials to be furnished shall constitute a representation or warranty by the Owner that the result of such method or manner will conform to the Contract, relieve the Contractor of any of the risks or obligations under the Contract, or create any liability to the Owner because of such approval or advice.

An Architect, Engineer, Designer or other person hired or employed by Owner under a separate Contract is not the Owner's Field Inspector nor Contract Administrator, unless the Contract Documents expressly state otherwise.

Contractor will be notified if the Owner's Representatives have been changed.

The Owner's Field Inspector and Contract Administrator may assign Inspectors, assistants and other persons to advise the Owner whether the work and materials meet Contract requirements. Such determination may extend to any or all parts of the Work and to the preparation or manufacture of materials to be used.

In the event that assigned personnel discover defective materials or work not being performed safely or in accordance with Contract requirements, the Owner's Contract Administrator shall have the authority to reject the materials or to suspend the Work.

Assigned personnel, including but not limited to, Inspectors and assistants, are not authorized to approve or accept any portion of the Work, to accept materials, to issue instructions or to give advice that is contrary to the Contract. Work done or material furnished that does not meet Contract requirements shall be at the Contractor's risk, and does not provide a basis for a Claim even if it is asserted that assigned personnel changed Contract requirements.

In the event that assigned personnel or the Owner's Representatives fail to observe, call out or note faulty work, defective materials, errors, or the Contractor's failure to comply with Contract requirements, that failure does not constitute acceptance or approval of that particular portion of the Work. If this occurs, the Contractor remains obligated to perform the Work in accordance with the Contract Documents, without additional compensation or Contract Time.

The provisions of this Subsection do not apply to Regulatory Inspectors.

If any Owner's Representatives note faulty work, defective materials, errors or the Contractor's failure to comply with Contractor requirements, it will notify the Contractor's Representative.

1.1.29 PROJECT MEETING REQUIREMENTS

The Contractor shall provide an onsite location where at least bi weekly meetings (every other week) shall be held between PGE and the Contractor. PGE representatives will include the Project Manager, Contract Manager, Project Engineer, Site Inspector, and may include others. The meeting time and dates will be scheduled in advance and agreed to by both parties. The meetings will review project progress, discuss future work, and work out other outstanding issues.

1.1.30 PROGRESS REPORTS

Weekly progress reports will be provided by the Contractor to the Project Manager and Contract Manager.

2 Site Work

6. SECTION 2100 Erosion and Sediment Control Plan (ESCP) and NPDES Stormwater Discharge Permits (1200-C or 1200-CN)

2.1.1 GENERAL

2.1.2 SCOPE

The work covered by this specification includes: furnishing of all labor, equipment and materials required for creating and providing an Erosion and Sediment Control Plan (ESCP) and submittal for a 1200-C or 1200-CN permit.

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), Contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit as required by the Department of Environmental Quality (DEQ) or its local agent. A copy of the approved permit and associated documents shall be kept onsite at all times and properly maintained and updated.

Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

2.1.3 SUBMITTALS

A. All 1200-C or 1200-CN documents (application, action plan, ESCP plan and /or drawings, narratives, inspection forms, etc.) shall be kept in a 3- ring binder or booklet as a minimum. Documents shall meet all requirements by the Oregon DEQ and/or local municipalities.
B. Contractor shall submit all necessary application forms, drawings, and other

required documents to Owner for review prior to submitting to DEQ.

2.1.4 Additional Information and Links

Information regarding application process and required submittals can be found at the Oregon Department of Environmental Quality NPDES Stormwater Discharge Permits – Construction Activities website:

http://www.deq.state.or.us/wq/stormwater/construction.htm

7. SECTION 2110 CLEARING & GRUBBING

2.1.5 General

2.1.6 Scope

The work covered by this specification includes: furnishing of all labor, equipment and materials required for clearing, grubbing, removal, and disposal of all rocks, trees, vegetation, rubbish, refuse trash and debris within the grading limits of the site, including access roads, drainage ditches, and other designated areas as shown on the drawings or specified herein.

2.1.7 Execution

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), Contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

Clearing: Contractor shall remove and dispose of trees, stumps, logs, limbs, sticks, vegetation, rubbish, debris, and other material on the natural ground surface. All areas within the designated grading limits or as required for access to the site or other purposes shall be cleared.

Grubbing: Contractor shall completely remove and dispose of roots, stumps, buried logs, debris, rocks and other materials that protrude through the surface within the site grading and site access limits.

All debris shall be disposed off-site by the Contractor.

Off-site disposal of debris shall be completed according to prevailing laws, ordinances, regulations, and rules, and at no additional cost to the Owner. The Contractor shall have on file a copy of the disposal permits or agreements.

8. SECTION 2120 SITE GRADING

2.1.8 General

2.1.9 Scope:

The work covered by this specification includes: furnishing labor, equipment and materials required for removal of topsoil, cutting, grading, filling, rough contouring, and compacting materials as required to establish the subgrade elevations for the site including interior and exterior access roads as shown on the drawings and specified herein.

2.1.10 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 176	Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T 180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft- lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft- lbf/ft3 (2,700 kN-m/m3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Oregon Department of Environmental Quality (DEQ)

Environmental Protection Agency (EPA)

National Pollution Discharge Elimination System (NPDES)

Occupation Safety and Health Administration (OSHA)

2.1.11 SUBMITTALS

A. Contractor shall submit:

1. Aggregate suitability using a gradation (AASHTO T 27) and sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.
2. Maximum dry density and optimum moisture content. Refer to ASTM D 1557, D 698, AASHTO T 180, Method D.
3. Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The Contractor shall verify that the aggregate and fill material meets Geotechnical engineering and state specifications.

2.1.12 MATERIALS

A General

Materials used for construction of embankments as shown on the drawings shall comply with the following:

i FILL TYPE RG-1 [In-Situ]: Re-use excavated and native material, as recommended in the Geotechnical Report and drawings. If a Geotechnical Report is not available, existing soil may be used for backfill if approved by Owner representative. Backfill shall be unsaturated, free of clay lumps, deleterious materials or stones larger than two inches in greatest dimension. Inorganic or organic silts, clays and peat soil types (ASTM soil group symbol ML, CL, MH, CH, OL, OH and PT) are not suitable for backfill. No frozen material shall be used as backfill.

ii FILL TYPE RG-2 [Imported Fill]: Imported fill free of friable material and debris; graded in accordance with ASTM T 27; within the following limits:

A. Gradation (per AASHTO T 27)

Sieve Size	Percent Passing
4 inch	100
3 inch	88 to 100
¾ inch	70 to 90
No. 10	40 to 60
No. 40	20 to 40
No. 200	less than

B. Sand Equivalent: 30 minimum per AASHTO T 176

iii Road Finish Rock: Imported fill consisting of untreated base course material meeting state Department of Transportation (DOT) requirements. Also refer to Section 2170 – Road Finish Rock

iv Aggregate Base Course: Imported fill as specified in Section 2150

2.1.13 EXECUTION

A Construction Layout and Surveying

Contractor shall provide all surveying work as required to maintain the lines, grades, and elevations required and shown on the drawings. Contractor shall set up temporary north-south and east-west base line markers outside the area to be graded so they will not be disturbed. Contractor shall set necessary cut and fill stakes. Before any earthwork, Owner shall approve all markers and stake locations.

After grading, Contractor shall establish and maintain horizontal and vertical references for locating all structures, fence lines and station equipment during construction.

Survey precision; for purposes of grading, elevations shall be within 0.1 feet and 0.01 feet for top of foundations and markers. Horizontal precision shall be sufficient to insure ease of erection of structures and placement of station equipment.

Contractor shall establish five permanent base line markers after station surfacing is complete. Markers shall be steel pins (rebar) extending below frost depth. The marker at the intersection of the lines shall be set about three inches below finished grade. The remaining four markers shall be set on the line, approximately three feet inside the fence. All markers shall be punched marked where the lines cross.

B Excavation

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), Contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

Excavation work shall include the removal and subsequent handling of all soil materials excavated or otherwise removed in performance of excavation work. Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area.

Topsoil material removed is deemed "unsuitable" for use in embankments or as a subbase for roads or substation subgrade. Contractor shall excavate the unsuitable material to the depth shown on the drawings and haul to an off-site disposal location. Location of a suitable disposal site is Contractor's responsibility.

After completion of topsoil removal, Contractor shall excavate to establish subgrade elevations in "cut" areas of the site. Excess excavated material not used in embankment shall be removed from the site and disposed of by the Contractor. The Contractor shall meet the recommendations in the Geotechnical Report and Drawings.

C Embankment

Embankment shall consist of the construction of fills and placing of miscellaneous backfills, to the lines, grades, dimensions and typical sections shown on the plans and according to the Geotechnical Report.

All embankments shall be constructed from material type (**RG-1 and RG-2**) as defined above.

When constructing embankments on existing slopes, slopes shall be benched to ½ horizontal to 1 vertical (1/2H: 1V) prior to placement of fill material.

If it should become necessary, because of weather or other conditions, to suspend grading operations, the entire area worked upon shall be bladed until smooth, free of depressions, and ruts, and crowned so that no water can collect or be impounded.

Embankment material shall be placed in uniform layers not to exceed nine (9) inches in loose thickness, for the entire width of the embankment. Each layer of embankment shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density. Each lift shall be conditioned to near optimum moisture content and compacted to a density equivalent to at least ninety-five (95%) or ninety-eight (98%) percent of the maximum dry density obtainable by the ASTM D 1557 or ASTM D 698 respectively or as recommended in the Geotechnical Report. In-place field density shall be measured in accordance with ASTM D 1556 (sand cone) or ASTM D 6938 (nuclear gauge).

D Road Finish Rock

Road Finish Rock consists of installation of untreated road base material on areas designated on the drawings for roadways or parking. Prior to placing road finish rock materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment. Areas that pump or significantly deflect shall be over excavated as required and the material replaced with Road Finish Rock. Refer to Section 2170 – Road Finish Rock for placement and compaction.

E Aggregate Base Course

Aggregate Base Course material shall be placed on areas designated on the drawings. Prior to placing Aggregate Base Course materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment.

Areas that pump or significantly deflect shall be over excavated as required by the Geotechnical Report and replaced with Aggregate Base Course.

Refer to Section 2150 – Aggregate Base Course for placement and compaction.

9. SECTION 2130 GENERAL EXCAVATION & BACKFILL

2.1.14 GENERAL

2.1.15 SCOPE

This section covers the backfill and compaction of excavations for footings, foundations, and other miscellaneous facilities. Included are specifications for excavation, compaction and backfill materials. Contractor shall review appropriate drawings for the following typical installations:

A. General Backfill and Compaction:
Backfill and compaction required to bring low areas, miscellaneous excavation work, and replace soft spots to required contours and elevations.

B. Structural Backfill and Compaction:
Backfill and compaction required to restore the grade around footings, foundation walls, retaining walls, slab and pier foundations to required contours and elevations.

C. Roadway Backfill and Compaction:
Backfill and compaction for the installation of access roads, substation interior roads and parking areas to required contours and elevations

2.1.16 Codes and Standards

AASHTO T 180	Moisture-Density Relations of Soils Using a 10-lb (4.54- kg) Rammer and an 18-in. (457-mm) Drop
ASTM C33:	Standard Specification for Concrete Aggregates ASTM C136: Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft- lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft- lbf/ft3 (2,700 kN-m/m3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.1.17 Submittals:

Contractor shall submit gradation test results per ASTM C136 and moisture- density relationships per ASTM D698, D1557 or AASHTO T180 to the Owner for approval for all imported aggregate materials two weeks prior to start of backfilling.

2.1.18 Field Measurements:

Contractor shall verify that survey benchmark and intended elevations for the work are as shown on drawings. Locate all underground utilities prior to starting excavation work.

2.1.19 Information Supplied by Owner:

Contractor shall obtain a copy of the Geotechnical Report which shall provide site specific geotechnical recommendations. If a Geotechnical Report is not available, the Owner will determine if existing soils are suitable for use as backfill.

2.1.20 Materials

A Fill Materials: as specified in Section 2120, Paragraph 2.0 (Materials) above.

2.1.21 Execution

A *Preparation*

i Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), Contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

ii Identify required lines, levels, contours, and datum.

iii Protect plant life, lawns, and other features remaining as a portion of final landscaping.

iv Protect bench marks, existing structures, foundations, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

v Maintain and protect existing above and below grade utilities.

vi Over excavate and remove any unsuitable soft native soils. Backfill as recommended in the Geotechnical Report. If a Geotechnical Report is not available backfill with Road Finish Rock as defined in Section 2170. Road Finish Rock shall be conditioned to within +/- 2% of optimum moisture and compacted to at least 95% of the maximum dry density according to ASTM D 1557 or 98% of the maximum dry density according to ASTM D 698.

2.1.22 EXCAVATION

A *Excavate subsurface soils as required for the installation of the work per the drawings.*

B *Do not interfere with the bearing splay of existing foundations, about 45o from the foundation base.*

C *Manually remove loose, lumped or frozen subsoil, boulders, rock greater than three (3") inches in diameter and other deleterious matter.*

D *Correct areas over excavated under the direction of the Geotechnical Engineer or Owner Engineer.*

E *Stockpile excavated material in an area where they will not contaminate other soils or Yard Finish Rock. If excavated soil is suitable for backfilling, designate an area within the construction limits and remove excess material not being used, from the site.*

2.1.23 BACKFILL

A *Backfill in accordance with the typical cross-sections, contours and elevations as shown on the drawings. Backfill materials shall be placed without frozen lumps, snow or entrained ice.*

B *Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Correct these areas under the direction of the Geotechnical Engineer or Owner Engineer.*

C *Employ a placement method that does not disturb or damage existing foundations, utilities, conduit duct, cable or wire. Backfill simultaneously on each side of unsupported foundation walls until support is in place.*

D *Condition soil to be used as backfill within +/- 2% optimum moisture content. Properly place backfill materials in (9") nine-inch loose horizontal lifts and compact as shown on the drawings. Each lift shall be compacted to at least 95% of maximum dry density per ASTM D 1557 modified.*

E *Contractor shall notify Owner prior to any backfill operation so equipment and intended compaction methods can be reviewed for approval by Owner.*

2.1.24 TOLERANCES

The top surface of backfilling shall match surrounding grade after compaction. Yard or Road Finish Rock shall be applied after completion of backfill work as required by drawings. Refer to Section 2160, Yard Finish Rock and Section 2170, Road Finish Rock.

2.1.25 FIELD QUALITY CONTROL

Owner shall hire an approved independent testing agency to perform compaction tests accordance ASTM D 6938. Work not meeting specified requirements shall be removed, replaced, compacted, and retested at the Contractors expense.

Test frequency shall be a minimum of one test per two-hundred (200 square feet (surface) or as determined by the Geotechnical Report or Owner Engineer.

Testing agency shall meet laboratory requirements according to ASTM and be certified in both AASHTO Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL).

2.1.26 PROTECTION OF FINISHED WORK

Contractor shall protect footings, foundation walls, piers, flat foundations, and embedded anchor bolts as required to prevent damage during backfill and compaction work.

10. SECTION 2140 TRENCH EXCAVATION & BACKFILL

2.1.27 GENERAL

2.1.28 SCOPE

This section covers the installation of electrical utilities, piping, conduits, culverts and other underground facilities. Included are specifications for excavation, compaction, bedding and backfill materials. Methods for excavation, placement of the utility and backfill differ for each utility installed and on-site conditions. Contractor shall review appropriate drawings for typical installed trench cross sections.

In general, they are as follows:

A. Grounding: Main ground girds are placed in narrow trenches and at termination and crossing points in wider excavations. Trenches are backfilled with in-situ soils only.

B. Conduit Banks: Conduit banks are placed in trenches either singularly or in groups. Main runs are placed on a sand bed and covered with a layer of sand, fluidized thermal backfill, red concrete, or red control density fill.

D. Culverts and Underground Piping: Culverts and piping installations vary and are specified in the drawings.

Contractor shall furnish all material, labor, tools and equipment necessary to install utilities as shown on the drawings and as specified herein.

2.1.29 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Society of Testing and Materials (ASTM)

ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft- lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft- lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.1.30 Submittals

Contractor shall submit gradation test results per ASTM C 136 and moisture- density relationships per ASTM D 698 or D 1557 to the Owner for approval for all imported aggregate materials two weeks prior to start of backfilling.

2.1.31 Field Measurements

Contractor shall verify that survey benchmark and intended elevations for the Work are as shown on drawings. Locate all underground utilities before starting excavation work.

2.1.32 Coordination

Contractor shall coordinate all substation work and verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

2.1.33 Information Supplied by Owner

Contractor shall obtain a copy of the Geotechnical Report which shall provide site specific geotechnical recommendations. If a Geotechnical Report is not available, the Owner will determine if existing soils are suitable for use as backfill.

2.1.34 Materials

A *Fill Materials*

i Soil Fill Type [In-situ]: Re-use excavated and/or native material as recommended in the Geotechnical Report and drawings. If a Geotechnical Report is not available, soil may be used for backfill if approved by Owner representative. Backfill shall be unsaturated, free of clay lumps, deleterious materials or stones larger than four inches in greatest dimension. Inorganic or organic silts, clays and peat soil types (ASTM soil group symbol ML, CL, MH, CH, OL, OH and PT) are not suitable for backfill. No frozen material shall be used as backfill.

ii Aggregate Base Course: As specified in Section 2150

iii Aggregate Surfacing – Road Finish Rock: As specified in Section 2170

iv Concrete: Structural concrete conforming to Section 3000 with a minimum compressive strength of 4,000 psi, unless otherwise specified by Geotechnical engineer.

v E Controlled Density Fill: As specified in Section 3010

2.1.35 Execution

A Preparation

i Prior to commencement of any land disturbing activities greater than one acre (>1 acre), If required, Contractor shall obtain a Storm Water Pollution Prevention Plan (SWPPP) General Permit or Notice of Intent (NOI) to be posted on site. Contractor shall adhere to the Best Management Practices (BMP’s) as indicated in the SWPPP.

ii Identify required lines, levels, contours, and datum.

iii Protect plants, lawns, and other features remaining as a portion of final landscaping.

iv Protect benchmarks, structures, foundations, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

v Maintain and protect above and below grade utilities which are to remain.

vi Over excavate and remove any unsuitable soft native soils. Backfill as recommended in the Geotechnical Report. If a Geotechnical Report is not available, reference table 1 for appropriate backfill.

2.1.36 EXCAVATION

A Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area.

B Excavate trenches sufficiently wide to enable installation of utilities and allow room for inspection. Trench widths shall be kept to a minimum to allow sufficient space for equipment installation.

C Excavations shall not interfere with the bearing splay of foundations, about 45o from the foundation base.

D Manually remove loose, lumped or frozen subsoil, boulders, rock greater than two (2”) inches in diameter and other deleterious matter.

E Correct areas over excavated under the direction of the Geotechnical Engineer or Owner Engineer.

F Stockpile excavated material in an area where they will not contaminate other soils or Yard Finish Rock. If excavated soil is suitable for backfilling, designate an area within the construction limits and remove excess material not being used, from the site.

G Blasting shall not be utilized for excavation of the trenched areas.

2.1.37 BACKFILLING

A *Backfill trenches in accordance with the typical cross sections, contours and elevations shown on the drawings. Backfill materials, listed above, shall be placed without frozen lumps, snow or entrained ice.*

B *Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Correct these areas under the direction of the Geotechnical Engineer or Owner Engineer.*

C *Employ a placement method that does not disturb or damage conduit duct, cable or wire in trench.*

D *Condition soil to be used as backfill within +/- 2% optimum moisture content. Properly place backfill materials in (9") nine-inch loose horizontal lifts and compacted to the required density shown in table*

E *Contractor shall notify Owner before any backfill operation so equipment and intended compaction methods can be reviewed for approval by Owner.*

F *At some locations, as shown on the drawings, a red concrete protective cap, or warning tape shall be installed over the cover backfill. Refer to construction drawings.*

2.1.38 TOLERANCES

The top surface of backfilling shall match surrounding grade after compaction. Yard Finish Rock shall be applied after completion of backfill work as required by drawings.

Trenches for duct banks shall be excavated to lines indicated on the drawings or at other locations acceptable to the Owner Engineer and to within ½ of depth required.

2.1.39 FIELD QUALITY CONTROL

Owner shall hire an independent testing agency to perform compaction tests accordance ASTM D 6938. Work not meeting specified requirements shall be removed, replaced, compacted, and retested at the Contractors expense.

Test frequency shall be a minimum of one for every 50 lf of trench installed or as determined by the Geotechnical Engineer.

2.1.40 PROTECTION OF FINISHED WORK

Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area. Removed soil from the excavation shall be stored away from the trench to avoid sloughing into the trench. Protection from freezing and water accumulation shall be provided for the bottom of excavations and soil adjacent to and beneath adjacent foundations.

Table 1

Materials, Compaction, and Testing Requirements

Material	Gradation Requirements	Plasticity Require-ments	Maximu m Density	Maximum Density Test Frequenc	Required Field Density	Field Density Test	Frequenc y	Field Water Conten t	Field Water Content Test	Lift Thick-ness	Remarks
Trench subgrades	-	-								-	Trench subgrades shall be firm, dense, free from mud, and sufficiently
30 inch pipe or smaller Crushed rock or crushed gravel embedment	Perform at least two gradation tests; at least 95% passing 1/2" sieve and not more than 5% passing No. 4 sieve	Nonplasti c	ASTM D4253 and ASTM D4254	2 initial tests; further tests as directed	70% Relative Density	ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 100 feet of trench for each lift	-	-	9" max	Minimum 4 passes with a vibratory flat plate tamper
Sand embedment	Perform at least two gradation tests; at least 95% passing No. 4 sieve and not more than 5% passing No. 100 sieve	Nonplasti c	ASTM D698, Method C	2 initial tests; further tests as directed	95% Max. Dry Density	ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 100 feet of trench for each lift	-	-	9" max	Clean sand

Groundwater barrier	-	Cohesive material (Soil Classifi-cation GC, SC, CL, or ML as indicated in ASTM D2487, Table 1	ASTM D698, Method C	2 initial tests; further tests as directed	95% Max. Dry Density	ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test for each groundwater barrier	-2% to +2% of optimum water content	ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D 2167)	9" max	Material may be finely divided suitable job excavated material, free from stones, organic matter, and debris

Table 1
Materials, Compaction, and Testing Requirements

Material	Gradation Requirements	Plasticity Require-ments	Maximum Density	Maximum Density Test	Required Field Density	Field Density Test	Frequency	Field Water Conte	Field Water Content Test	Lift Thicknes s	Remarks
Trench backfill	2" max particle size	LL < 40 PI < 15	ASTM 698, Method C	2 initial tests; further tests as directed	90% Max Dry Density	ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 50 feet of trench for each lift	-2% to +2% of optimu m water content	ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D 1556 or ASTM D	9" max	-
Trench backfill traversing subgrades of streets, roads, railroads, parking areas, undergroun d piping, undergroun d electrical ducts and conduit, and other facilities subject to damage by settlement	3" max particle size	-	ASTM D698, Method C	2 initial tests; further tests as directed	95% Max Dry Density	ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 100 feet of trench for each lift	-2% to +2% of optimu m water content	ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASATM D2167)	9" max	

11. SECTION 2150 AGGREGATE BASE COURSE

2.1.41 GENERAL

2.1.42 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Aggregate Base Course as shown on the drawings, geotechnical report, and specified herein.

2.1.43 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 176	Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T 180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft- lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft- lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.1.44 SUBMITTALS

A *Contractor shall submit:*

i Aggregate suitability using a gradation (AASHTO T 27) and sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.

ii Maximum dry density and optimum moisture content. Refer to

iii ASTM D 1557, D 698, and AASHTO T 180, Method D.

iv Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The Contractor shall verify that the aggregate and fill material meets Geotechnical Engineering and state specifications.

2.1.45 MATERIALS

Aggregate Base Course material shall be sound, hard, durable crushed rock uniformly graded from coarse to fine. The aggregate shall conform to the following specifications unless otherwise approved by Owner.

A. Gradation (per AASHTO T 27)

Sieve Size	Per Cent Passing
3”	100
2-½”	85-100
1-¼”	55-75
3/8”	30-45
#10	15-25
#40	10-20
#200	0-7

A. Sand Equivalent (per AASHTO T 176) Minimum of 30

B. Fractured Face

Provide at least one mechanically fractured face for a minimum of 50% of particles retained on the #4 US Standard size sieve.

2.1.46 EXECUTION

Aggregate Base Course material shall be placed on areas designated on the drawings. Prior to placing Aggregate Base Course materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment.

Areas that pump or significantly deflect shall be over excavated as required by the Geotechnical Report and replaced with Aggregate Base Course.

Aggregate Base Course material shall be placed in uniform layers not to exceed (9) nine inches in loose thickness, for the entire width of the surface. Each layer of Aggregate Base Course shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density.

Each lift shall be conditioned to +/- 2% of the optimum moisture content and compacted to a density at a minimum of ninety-five (95%) percent of the maximum dry density according to ASTM D1557modified, ninety-eight (98%) percent of the maximum dry density according to ASTM D 698, standard or as recommended by the Geotechnical Engineer. In place, field density shall be verified in accordance with ASTM D 1556 or ASTM D 6938.

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.

12. SECTION 2160 YARD FINISH ROCK

2.1.47 GENERAL

2.1.48 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Yard Finish Rock as shown on the drawings and specified herein.

Yard Finish Rock shall meet the criteria in section 2.0.

2.1.49 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

AASHTO TP 61 Determining the Percent of Fracture in Coarse Aggregate American Society of

Testing and Materials Standards (ASTM)

ASTM D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

2.1.50 SUBMITTALS

A. Contractor shall submit:

1. Aggregate suitability using a gradation (AASHTO T 27) within the gradation limit as stated in section 2.0.
2. Name of supplier, date sampled and location of source.
3. Five-gallon bucket sample of proposed yard finish rock to the Owner for testing.

Sample shall be submitted to the Owner for review, testing, and approval prior to placing any material.

2.1.51 MATERIALS

Yard Finish Rock used to surface the substation yard as shown on the drawings shall be sound, hard, durable, clean angular crushed rock.

The rock shall meet the following criteria:

A. Sieve Analysis (per AASHTO T27)

Sieve Size	Percent Passing By
1½"	100
1"	20-85
¾" *	0-30
⅝" *	0-30
1/4"	0-5

*Material must meet either the ¾-inch or ⅝-inch sieve requirement, but not both.

B. Rock Quality (per AASHTO TP 61, or ASTM D 5821)
Fractured Faces: At least one mechanically fractured face on 95% of all particles retained on each sieve 1/4-inch and above. In addition, at least three mechanically fractured faces on 70% of the same particles.

C. Rock Resistivity
A minimum wet resistivity of 3,000 ohm-m is required for all Yard Finish Rock.

2.1.52 EXECUTION

Yard Finish Rock shall be evenly spread and roller compacted on the designated areas of the yard as shown on the drawings. Final depth of Yard Finish Rock shall be four inches (4") or as shown on the drawings.

Subgrade layer shall be prepared per section 2130 General Excavation & Backfill. Surface of Yard Finish Rock shall be free from corrugations or waves. 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.

13. SECTION 2170 ROAD FINISH ROCK

2.1.53 GENERAL

2.1.54 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Road Finish Rock as shown on the drawings and specified herein.

2.1.55 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27	Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates
AASHTO T 176	Standard Method of Test for Plastic Fines in Graded

	Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T 180	Standard Method of Test for Moisture-Density of Soils Using a 4.54-kg (10-lb) Rammer and a 457- (18-in.) Drop
AASHTO T 89	Standard Method of Test for Determining the Liquid Limit of Soils
AASHTO T 90	Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.1.56 SUBMITTALS

A. Contractor shall submit:

1. Aggregate suitability using a gradation (AASHTO T 27) and sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.
2. Maximum dry density and optimum moisture content. Refer to ASTM D 1557, D 698, AASHTO T 180, Method D.
3. Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The Contractor shall verify that the aggregate and fill material meets Geotechnical engineering and state specifications.

2.1.57 MATERIALS

Road Finish Rock material shall be sound, hard, durable, crushed rock uniformly graded from coarse to fine. The Road Finish Rock shall conform to the following specifications unless otherwise approved by Owner.

A. Gradation (per AASHTO T 27)
Percent passing based on total aggregate (dry weight), and fine and coarse aggregate having approximately the same bulk specific gravities.

Sieve Size	Percent
1-½"	100
1"	90 - 100
¾ "	70 - 85
½ "	65 - 80
3/8"	55 – 75
#4	40 - 65
#16	25 - 40
#200	7 - 11

B. Sand Equivalent (per AASHTO T 176) Not less than 30

C. Fractured Face (per AASHTO TP-61)
Provide at least one mechanically fractured face for a minimum of 50% of particles retained on the #4 US Standard size sieve.

D. Liquid Limit/ Plastic Index (per AASHTO T 89, T 90) Non-plastic

2.1.58 EXECUTION

Road Finish Rock material shall be placed on areas designated on the drawings for roadways or parking. Prior to placing road finish rock the subgrade shall be smoothed and compacted to required specification.

Road finish rock shall be placed in uniform layers not to exceed nine inches (9") in loose thickness, for the entire width of the road surface. Each layer of road finish rock shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density. Each lift shall be conditioned to near optimum moisture content and compacted to a density equivalent to at least ninety-five (95%) of the maximum dry density according to ASTM D 1557 or a minimum of ninety-eight (98%) of the maximum dry density according to ASTM D 698, or as recommended in the Geotechnical Report. In place field density shall be measured in accordance with ASTM D 1556 or ASTM D 6938.

14. SECTION 2180 DRAIN ROCK

2.1.59 GENERAL

2.1.60 SCOPE

The work covered by this specification includes the furnishing of all labor, equipment and materials required for placement of Drain Rock as shown on the drawings and as specified herein.

2.1.61 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

2.1.62 SUBMITTALS

A. Contractor shall submit gradation (AASHTO T 27) tests to Owner for review and approval prior to placing any material.

2.1.63 MATERIALS

Drain Rock used for backfilling of oil containment pits or yard drain systems as shown on the drawings shall be sound, hard, durable, clean angular rock. The rock shall meet the following criteria:

A. Gradation (per AASHTO T 27)

Sieve Size	Percent Passing
2"	100
1 1/2"	90 - 100
1"	20 - 55
3/4"	0 - 15

Drain rock shall meet the void ratio requirements specified in the drawings.

B. Rock Quality
Fractured Faces: At least one mechanically fractured face on 95% of all particles retained on each sieve. In addition, at least three mechanically fractured faces on 70% of the same particles.

C. Rock Resistivity
A minimum wet resistivity of 3,000 ohm-m is required for all aggregate surfacing.

2.1.64 EXECUTION

Drain Rock shall be placed in a careful manner to prevent damage to drain piping or liner materials. Drain Rock shall be installed to the elevations or grades as shown on the drawings.

15. SECTION 2190 GEOTEXTILES

2.1.65 GENERAL

2.1.66 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of geotextile as shown on the drawings and specified herein.

2.1.67 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO M 288 Geotextile Specification for Highway Applications

2.1.68 SUBMITTALS

A. Prior to use: Contractor shall submit manufacturers certificate that each fabric complies with requirements of this section and drawings.

2.1.69 MATERIALS

Silt Fence Geotextile - Silt Fence Fabric: See AASHTO M 288 (Table 6 – Temporary Silt Fence Property Requirements)

Drainage Geotextile – Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as specified by the Owner. Notify Owner if soil conditions are different than shown on the drawings.

Non-woven geotextile shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum non-woven geotextile properties are as follows: Grab tensile strength ASTM D 4632 120 lb.

Grab elongation ASTM D 4632	50%
Mullen Burst ASTM D 3786 Mod.	230 psi
Puncture strength ASTM D 4833	50 lb.
Apparent opening size ASTM D 4751	≤ # 70 sieve
Permittivity ASTM D 4491	1.50 sec^{-1}
Ultraviolet stability ASTM D 4355	70 % strength retained

Erosion Control Geotextile – Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as specified by the Owner. Notify Owner if soil conditions are different than shown on the drawings.

Non-woven geotextile shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum non-woven geotextile properties are as follows: Grab tensile

strength ASTM D 4632	205 lb.
Grab elongation ASTM D 4632	50%
Mullen Burst ASTM D 3786 Mod.	350 psi
Trapezoidal Tear ASTM D 4533	85 lb
Puncture strength ASTM D 4833 size ASTM D 4751 rate ASTM D 4491	110 lb Apparent opening ≤ # 80 sieve Water flow 110 gpm/ ft^2
Ultraviolet stability ASTM D 4355	70 % strength retained

Separation Geotextile - Furnish Class I fabric as specified in AASHTO M288 with Apparent Opening Size of 0.22 mm maximum average roll value.

Non-woven geotextile - Non woven geotextile shall meet the minimum requirements as per Drainage Geotextile.

Woven geotextile is a slit film. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum woven geotextile properties are as follows: Grab tensile strength

ASTM D 4632	315 lb.
Grab elongation ASTM D 4632	15%
Mullen Burst ASTM D 3786 Mod.	675 psi
Puncture strength ASTM D 4833	150 lb
Trapezoidal Tear ASTM D 4533	120 lb Apparent
opening size ASTM D 4751	≤ # 40 sieve Water Flow
Rate ASTM D 4491	4 gpm/ ft^2
Ultraviolet resistance ASTM D 4355	70 % strength retained

Stability Geotextile and Geogrid – Furnish Class II fabric as specified in AASHTO M288 with Apparent Opening Size of 0.22 mm maximum average roll value.

Woven Geotextile – Woven geotextile shall meet the minimum requirements as per Separation Geotextile.

Geogrid is an integrally formed biaxial geogrid. This is a polypropylene, positive mechanical interlock system suitable for base reinforcement and subgrade improvement.

Minimum Biaxial Geogrid properties are as follows:

Aperture Dimensions 1 inch

Minimum Rib Thickness 0.05 inch Tensile strength @ 2% strain ASTM D 6637 410 lb.

Tensile strength @ 5% strain ASTM D 6637 810 lb. Ultimate Tensile Strength ASTM D 6637 1310 lb Junction Efficiency GRI-GG2-05 93%

Flexural Stiffness ASTM D 5732 750,000 mg-cm

Aperture Stability 0.65 m-N/deg
Resistance to Installation Damage ASTM D 6637

%SC/%SW/%GP 90/90/90

Ultraviolet resistance ASTM D 4355 100 % strength retained

Weed Barrier Geotextile – Furnish fabric as specified in AASHTO M288 with elongation less than 50 percent.

Woven to Non-woven geotextile shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum woven to non-woven mix geotextile properties are as follows:

Weight (Oz/Sq Yd) 5.0 oz/sq avg.

Grab tensile strength ASTM D 4632 100 lb.

Grab elongation ASTM D 4632 50%

Mullen Burst ASTM D 3786 Mod. 210 psi

Puncture strength ASTM D 4833 50 lb.

Trapezoid Tear ASTM D 4533 70 lb

Water permeability ASTM D 4491 12 gal/min/SF Ultraviolet resistance ASTM D 4355 70 % strength retained

Cushion Fabric Geotextile– is a polypropylene, stable fiber, needle punched non-woven geotextile. Fabric shall be installed according to drawings and manufacturers recommendations.

Geotextile cushion fabric shall be used for protection of the impermeable membrane and shall meet as a minimum of the following requirements:

Grab tensile strength ASTM D 4632	380 lb.
Grab elongation ASTM D 4632	50%
Mullen Burst ASTM D 3786 Mod.	750 psi
Puncture strength ASTM D 4833	240 lb.
Apparent opening size ASTM D 4751	≤100 US Std Sieve
Permittivity ASTM D 4491	0.7 sec^{-1}
Ultraviolet stability ASTM D 4355	70 % strength

The manufacturer of the liner shall approve Geotextile fabric used for underlayment of spray on liner system.

2.1.70 EXECUTION

A General

- i Place geotextile on areas that are smooth, and free of projections or depressions.
- ii Install geotextile by unrolling fabric across subgrade. Orient the geotextile and install in the direction of traffic, if applicable.
- iii Place first lift at a minimum of 6 inches of suitable fill material over geotextile without driving directly on the material. Do not end dump on the geotextile material.
- iv Minimize driving and turning on the first lift of soil placed.

B Install Drainage Geotextile

- i Excavate trench as specified on the drawings meeting section 02122 Trench Excavation and Backfill.
- ii Cut geotextile to width and place in trench. Geotextile should begin from one side of the trench and finish on the opposite side while lining the bottom of the trench.
- iii Overlap each sheet over the next sheet by 12 inches for placement in trench.
- iv Anchor the geotextile using pins with a minimum of 18 inches in length or boulders at the top of the trench prior to backfill.
- v Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

C Install Erosion Control Geotextile

- i Install as per drawings or as directed by the Owner.

ii If installing with rip rap at ends of pipe culvert, place geotextile under culvert.

iii Overlap the geotextile a minimum of 2 feet or as indicated by the manufacturer's specifications.

iv Overlap each sheet over the next downhill sheet for placement on slopes.

v Anchor the geotextile using pins with a minimum of 18 inches in length.

vi Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

D Install Separation Geotextile

i Install as per drawings or as directed by the Owner.

ii Overlap the geotextile a minimum of 1 foot at all longitudinal and tranverse joints or as indicated by the manufacturer's specifications.

iii Anchor the geotextile using pins with a minimum of 18 inches in length.

iv Place fill beginning with overlapped sheets to hold the geotextile while the remainder is backfilled.

v Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

E Install Stabilization Geotextile or Geogrid

i Install as per drawings or as directed by the Owner.

ii Overlap the geotextile a minimum of 2 feet at all longitudinal and tranverse joints or as indicated by the manufacturer's specifications.

iii Anchor the geotextile using pins with a minimum of 18 inches in length.

iv Place fill beginning with overlapped sheets to hold the geotextile while the remainder is backfilled.

v Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

F Install Weed Barrier Geotextile

i Place geotextile on areas that are smooth, and free of large stones or undesirable vegetation.

ii Cut an "X" over each plant and push geotextile under plant base if placing over an existing bed. Roll geotextile over soil and cut an "X" of each plant hole if placing over a new bed. Fold excess geotextile under and cover with soil or specified landscaping materials.

iii Anchor the geotextile using pins with a minimum of 18 inches in length.

iv Place a minimum of 4-inches of approved landscaping material on all areas as indicated on the drawings or as directed by the Owner. Do not leave any of the geotextile exposed to direct sunlight.

v Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

vi Maintain surfaces and supply additional landscape materials where necessary including areas affected by erosion.

16. SECTION 2200 DRILLED PIERS

2.1.71 GENERAL

2.1.72 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for installation of drilled concrete piers as indicated on the drawings and specified herein.

2.1.73 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

Federal Highway Administration (FHWA) Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, Section 565 dated 2003, FP-03

ASTM D6760 Crosshole Sonic Logging (CSL)

FHWA-NHI-10-016, Drilled Shaft Construction LFRD Design Methods

2.1.74 MATERIALS

Concrete and reinforcing steel shall comply with the requirements of section 3000.

Anchor rods shall comply with the requirements of section 5110.

2.1.75 QUALIFICATIONS AND SUBMITTALS

Submit the following for review at least 10 working days before constructing drilled piers. Owner review of the Contractor's personnel qualifications and installation plan does not relieve the Contractor of the responsibility for obtaining the required results in the completed work.

A *Personnel Qualifications*

Construction Personnel. Use a foreman with at least 3 years of experience in the construction of drilled piers. Foreman must remain on- site during all drilled pier installation activities. Upon request provide a resume of job experience, project description, the owning agency's name and current phone number.

Post Construction Testing Personnel. Personnel performing the nondestructive cross-hole sonic logging (CSL) shall have a licensed professional engineer supervising the testing and interpretation of results. The CSL consultant shall be provided by the Contractor. The CSL consultant shall be an independent testing agency with at least three years of experience in CSL testing. The on-site person(s) performing the testing shall have at least 12 months experience in performing CSL testing. Provide a resume of job experience, project description, owning agency's name and current phone number.

Provide experienced labor support as needed to adequately perform the required tests.

2.1.76 SUBMITTALS

Furnish the following in the installation plan:

A. An overall construction plan and the sequence of drilled pier construction.
B. Details of proposed pier drilling methods; methods for removing materials from the piers; procedures for maintaining correct horizontal and vertical alignment of the excavation; and a disposal plan for the excavated material.
C. A description, including capacities, of the proposed equipment to be used including cranes, drills, drilling unit, augers, bailing buckets, and final cleaning equipment.
D. Demonstrate an understanding of the subsurface conditions at the site. Reference the available geotechnical report and/or any other subsurface data provided by the Owner or Contractor.

E. Details of methods to be used to ensure drilled pier hole stability during excavation and concrete placement. Include a review of the chosen method's suitability for the anticipated site and subsurface conditions. If temporary casings are proposed or required, provide casing dimensions and detailed procedures for temporary casing installation and removal.
F. Details of reinforcement placement including bracing, centering centralizers, and lifting and support methods.
G. Details of concrete placement including proposed operations procedures for free fall, tremie, or pumping methods.
H. The method used to form an emergency horizontal construction joint during concrete placement.

3.2 Other Required Submittals

1. Concrete Mix Design
2. Grout Mix Design (for grouting CSL Tubes, when required)
3. Reinforcing Steel Certifications (including mill certifications)
4. Drilled Pier Installation Record
5. Concrete Pour tickets
6. Densified Drilling Fluid (when applicable)

3.3 Drilled Shaft Installation Preconstruction Meeting

A drilled shaft installation preconstruction meeting shall be held at least five (5) working days prior to the Contractor beginning any shaft construction work at the site to discuss investigative boring information, construction procedures, personnel and equipment to be used, and to review proposed shaft installation plan. Those attending shall include:

Representing the Contractor at the meeting will be the superintendent, on site supervisors, foreman and other key personnel identified by the Contractor. If slurry is used to construct the shafts, the slurry manufacturer's representative and a Contractor's employee trained in the use of slurry.

Representing Owner at the meeting will be the Project Civil Engineer, key Owner inspection personnel and other appropriate representatives.

2.1.77 Execution

A Drilling Operations

i Excavate holes according to the installation plan. Report all deviations from the plan to the onsite inspector.

ii When required, casings shall be installed as the drilling proceeds or immediately after the equipment is withdrawn to prevent sloughing and caving of the excavation walls. Casing shall be advanced ahead of the drilling operation in order to maintain a soil plug capable of producing a positive seal at the bottom that prevents piping of water or other material into or out of the hole.

iii Slurry may be used to stabilize the excavation; however a specific plan, including the material to be used, must be submitted for Owner review prior to use. Refer to FHWA Standard Specifications for Construction of Road and Bridges, Section 565 "Drilled Shaft Installation" for all slurry use requirements.

iv Steel casings of ample strength to withstand handling and installation stresses shall be used. Use casing with the outside diameter equal to or greater than the specified diameter of the pier and the inside diameter not exceeding the specified diameter of the pier by more than 6 inches. Casings are to be removed as the concrete is placed. Casing extraction shall not be aided by the use of a vibratory extractor, unless authorized by the Owner. During removal, the casing shall be kept plumb and the concrete head shall be maintained at a level to offset the water head outside the casing. As a minimum, a concrete head of 4 to 5 feet shall be maintained above the bottom of the casing during the casing removal.

v Each drilled pier shall be accurately located, sized and plumbed. The maximum deviation of the drilled pier from its designated location shall not be more than 2 inches at its top elevation. The drilled pier shall not be out of plumb more than 1 inch in 5 feet of height. Deviation of the drilled pier location within the specified limits shall not be cause for deviation in anchor bolt or concrete cap location. Adjustment shall be made for all concrete embedments.

vi Each drilled pier excavation shall be made to the approximate depth indicated on the drawings. All weathered and loose material shall be removed. The Owner shall verify the final tip elevation before concrete placement. The Contractor shall remove excavated materials from the site. Classification of the excavated materials will not be made except for identification purposes. Drilled pier excavation shall include the removal and handling of all excavated materials.

vii Blasting to accommodate drilling operations will not be permitted on the site.

viii All drilled pier excavations will be inspected by the Owner before the placement of concrete. All drilled pier excavations that cannot be visually inspected shall be treated as a wet hole. Refer to wet method for concrete placement.

4.1 Reinforcing Steel and Placement of Crosshole Sonic Logging Access Tubes

A. Reinforcing steel shall conform to Section 3000.2.6.

B. Reinforcing steel shall be tied at all (100%) intersections of vertical and horizontal bars. Individual or loose bars are not permitted.

C. Securely wire together contact reinforcing steel lap splices. Tie and support the reinforcing steel so it remains within the required tolerances. Securely tie concrete spacers or other approved spacing devices at filth points around the cage perimeter and space at internals not to exceed 10 feet along the length of the cage. Use spacers of approved material at least equal in quality and durability to the pier concrete. Acceptable feet made of plastic, or concrete shall be provided to ensure that the bottom of the cage is maintained at the proper distance above the base of the excavation unless the cage is suspended from a fixed base until concrete has set sufficiently to support the weight of the cage at the proper elevation.

D. Place reinforcing steel cage as a unit immediately after the pier excavation is completed and inspected prior to concrete placement. Handle reinforcing cages to avoid distortion or racking of the steel. During concrete placement, provide positive support from the top of the reinforcing steel cage. Maintain the top of the reinforcing steel cage no more than 6 inches above and no more than 3 inches below the required position. All bracing steel used to stabilize the cage during placement shall be removed prior to concrete placement.

E. Provide cross-hole sonic logging access tubes for all drilled piers of 6 feet in diameter or greater and/or 50 feet or greater in length, and all wet method construction. Install (1) access tube for every foot of diameter.

F. Provide cross-hole sonic logging access tubes of standard weight black steel pipe per ASTM A53 with nominal inside diameter of 2 inches. Use pipe and pipe joints that have a round, regular internal diameter, free of defects or obstructions, and will result in watertight access tubes that permit the free, unobstructed passage of source and receiver probes. Use access tubes that are free of corrosion, that have clean internal and external faces to ensure probe passage, and that have a good bond between the concrete and tubes.

G. Fit the access tubes with a water-tight shoe on the bottom and a removable cap on top.

H. Secure tubes firmly to the interior of the reinforcement cage. Install the tubes in a regular, symmetric pattern such that each tube is the maximum possible distance from each adjacent tube. Tubes shall be as near to parallel as possible. The tubes shall be installed from ½ foot above the pier bottom to at least 2 feet above the ground surface. Do not bend or damage the tubes during reinforcement installation operations.

I. Completely fill access tubes with water and maintain water level until Cross-hole sonic logging tests can be performed.

J. Contractor shall provide independent CSL testing agency.

K. Contractor is responsible to fully grout access tubes after Cross-hole sonic logging tests are approved by the Owner. Grout for filling access tubes shall be a cement grout with a maximum water/cement ratio of 0.45.

4.2 Concrete Placement

A. Dry Method

Use the dry construction method at sites where the groundwater level and soil conditions are suitable to permit construction of the pier in relatively dry excavation and where the sides and bottom of the pier may be visually inspected before placing concrete.

i. Unless otherwise accepted by the Owner, concrete shall be placed in drilled pier holes within 24 hours of completing excavation.

ii. All water and loose materials shall be removed from the holes and reinforcement shall be thoroughly cleaned before concrete is placed.

iii. Concrete shall be placed with a tremie or funnel to prevent segregation. Use free-fall placement only in dry holes with a maximum 6-foot free-fall height or Owner approved height. The concrete shall fall directly to the pier base without contacting either the rebar cage or hole sidewall. If concrete placement causes the pier excavation to cave or slough or if the concrete strikes the rebar cage or sidewall, reduce the height of free-fall and reduce the rate of concrete flow into excavation. If placement cannot be satisfactorily accomplished by free-fall, use tremie or pumping to place concrete.

iv. Concrete shall be rodded or vibrated in the top third of the drilled piers to provide a dense mass free of voids. As placed, the concrete shall have a slump between 6 to 8 inches. During the filling of the drill holes, if water begins to accumulate on the top of the concrete, the amount of water in succeeding batches shall be reduced. When scum or laitance accumulates on the top of the concrete, it shall be removed and replaced to the proper elevation.

v. Concrete shall be placed in a continuous process. The quantity of concrete required to fill the drilled hole of the pier shall be available at the site when concrete is placed in each hole. If concrete placement for any pier is suspended for more than 30 minutes, laitance and water shall be removed from the joint surface and the joint surface shall be coated with epoxy bonding compound before placement is resumed. Epoxy bonding compound shall be at the site before the concrete placement is started.

vi. Drilled piers shall be reinforced as indicated on the drawings.

Reinforcement shall be installed and secured to prevent shifting during concrete placement. Each drilled pier shall be cured as specified in the specification 3000.

vii. All casings shall be removed unless approved by the Owner. If approved casings are left in place, the void areas between the form and the excavation walls shall be filled with lean concrete mix. The lean concrete or grout mix shall be placed and tamped to fill the annular space.

viii. Records of the exact volume of each drilled pier excavation shall be kept. This volume shall be compared to the volume of concrete actually placed in each drilled pier. If the concrete volume placed is less than the calculated drilled pier volume, the Owner shall be notified.

ix. Concrete shall maintain a minimum 6-inch and maximum 8-inch slump for the duration of the pour. For all concrete pours with a duration of 6 hours or more the Contractor shall provide a slump loss test with concrete submittal.

B. Wet Method

Use the wet construction method or the casing construction method for piers that do not meet the above requirements for the dry construction method.

i. Concrete shall not be deposited under water except with Owner permission. The proportions for underwater concrete mix shall be adjusted to provide 7 to 9 inches of slump and the cement factor shall be increased by one sack per cubic yard.

ii. Underwater concrete shall be placed through a tremie equipped with a seal at the lower end and a hopper at the upper end. The tremie shall be watertight and large enough to allow a free flow of concrete. After the flow of concrete is started, the lower end of the tremie shall be kept below the surface of the deposited concrete. The entire mass of concrete shall be placed as quickly as possible and shall flow into place without shifting horizontally under the water. Make the tremie inside diameter at least 6 times the maximum aggregate size used in the concrete mix.

iii. The water shall be quiescent when concrete is deposited. After placing, the ground water level in the area adjacent to the drilled pier shall be kept static (no pumping) until the concrete has taken its initial set.

iv. Concrete shall maintain a minimum 7 inch and maximum 9 inch slump for the duration of the pour. For all concrete pours with duration of 6 hours or more the Contractor shall provide a slump loss test with concrete submittal.

v. When the wet method is used the water level shall be maintained to obtain hydrostatic equilibrium throughout the construction operation at a height required to provide and maintain a stable hole, but not less than 5 ft above the water table.

4.3 Drilled Pier Installation Record

An accurate record of the drilled concrete pier installation shall be completed that contains as a minimum the following information for

each. The Contractor shall submit the installation record to the Owner Field Representative at the end of each day. It will not become official until the Owner Field Representative agrees with the accuracy and completeness and approves the document.

The drilled pier installation record shall contain the following information:

- Contractor's name
- Drilled Pier number and location
- Depth to bedrock
- Depth to water
- Final depth if different from design drawings
- Note any caving, sloughing of excavation and drilling difficulties
- Casing insertion, size and length, and whether or not removed
- Date and time of start and finish excavation
- Length and diameter of reinforcing bar cage if different from design drawings
- Date and time concrete placed
- Calculated volume of excavation based on diameter of pier
- Total quantity of concrete placed
- Concrete Yield Plot
- Concrete batch plant ticket numbers
- Concrete slump, temperature, air content, strength

4.4 Timing of the Cross-hole Sonic Logging (CSL)

The drilled shaft shall be tested no sooner than three (3) calendar days after placement of concrete but within 45 days after placement.

After all CSL testing has been completed, and after acceptance of the drilled shaft test results by the Owner, the Contractor shall remove the water in the tubes, place grout tubes extending to the bottom of the access tube and fill all access tubes in the drilled shaft with grout. Cut CSL tubes at surface as indicated on drawings or flush with top of concrete.

17. SECTION 2210 ASPHALTIC CONCRETE PAVING

2.1.78 GENERAL

2.1.79 SCOPE

The work covered by this specification includes furnishing of labor, equipment and materials required for preparing the sub-base, subgrade, and placing of hot mix asphalt pavement as shown on the drawings and as specified herein.

2.1.80 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

ASTM D2041	Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures (Rice)
ASTM D 946	Penetration-Graded Asphalt Cement for Use in Pavement Construction
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN- m/m^3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
AASHTO T 19	Unit Weights and Voids in Aggregate
TAI MS-2	Mix Design Methods for Asphalt Concrete and Other Hot Mix Types
TAI MS-3	Asphalt Plant Manual
TAI MS-8	Asphalt Paving Manual
TAI MS-19	Basic Asphalt

2.1.81 SUBMITTALS

A. Submit mix design at least 10 working days before paving. Do not pave until Owner has approved the mix design.

B. Submit Road Finish Rock to be used as sub grade material according to Section 2170 Aggregate Surfacing – Road Finish Rock.

C. Submit new mix design if materials used change during construction. Provide written documentation explaining the reason for the change in material.

2.1.82 MATERIALS

All materials shall be in accordance with the above referenced specifications. Aggregate and asphalt mix design shall be submitted for review prior to construction.

2.1.83 EXECUTION

A Sub-base

Contractor shall grade and compact the sub-base layer prior to placing road finish rock (untreated base course) as recommended in the Geotechnical Report or as directed by the Owner. Owner shall inspect sub-base layer prior to placing road finish rock.

B Sub Grade

Contractor shall place road finish rock according to section 2120 Site Grading. Road finish rock shall meet specification Section 2170 Aggregate Surfacing – Road Finish Rock and drawings.

C Surface Preparation

- i Locate, reference, and protect all utility covers, monuments, curb and gutter and other components affected by the paving operations.
- ii Remove all moisture, dirt, sand, leaves, and other objectionable material from the prepared surface before placing mix.
- iii Do not place HMA on frozen base or during adverse climatic conditions such as precipitation or when roadway surface is icy or wet.

D 3.4 Primer

Contractor shall apply primer in accordance with manufacturer instructions on aggregate and all contact surfaces. Excess primer shall be blotted with clean sand.

E Tack Coat

Contractor shall apply a tack coat in accordance with manufacturer instructions and TAI MS-19. Apply tack coat on all contact surfaces to a minimum rate of 1/3 gallon per square yard. Allow sufficient cure time for prime coat/tack coat before placing hot mix asphalt.

F Placing Single Course Asphalt Pavement

Contractor shall place a minimum of three inches of asphalt within 24 hours of applying primer and tack coats. Compact pavement with rolling equipment or in tight areas with hand operated compactors. Perform rolling to with consecutive passes to achieve even and smooth surface without voids or roller and compactor marks. Compaction requirements see section 3.7.

G Tolerances

Final surface shall be within ¼ inch in 10 feet and allow surface water to freely drain the finished surface.

H Protection

- i Contractor shall immediately after placement, protect pavement from mechanical injury for 24 hours or until surface temperature is less than 140 ºF.
- ii Do not allow construction vehicles, general traffic, or rollers to pass over the uncompacted end or edge of freshly placed mix until mat temperature drops to a point where damage or differential compaction will not occur.

iii Taper the end of a course subjected to traffic at approximately 50:1 (horizontal to vertical).

(a) Remove the portion of the pass that contains the tapered end before placing fresh mix.

(b) Tack the contact surfaces before fresh mix is placed against the compacted mix.

iv Use a motor grader, spreader box, or other approved spreading methods for projects under 180 square yards, irregular areas, or for miscellaneous construction such as detours, sidewalks, and leveling courses.

I Compaction and Density

i Use a small compactor or vibratory roller at structures in addition to normal rolling.

ii Create a rolling pattern to drive approaches and aprons to aid in compaction. Rolling patterns should be approved by Owner before being driven.

iii Owner will provide a testing agency to verify compaction efforts according to ASTM D6938. A field sample of HMA shall be taken every 200 feet or once daily for small projects, whichever is of a higher frequency. Laboratory tests shall include ASTM D 2041 (Rice). Contractor shall reach a minimum average target for in-place density of 95% of the theoretical maximum specific gravity and density of bituminous paving mixtures (Rice). No test shall be less than 92%.

iv Asphalt which does not meet these requirements or is suspect shall be verified at the Contractor’s expense by providing a minimum of one core every 100 feet.

v Contractor obtains cores within two days after the pavement is placed.

(a) Coring locations shall be marked by Owner for in-place density verification.

(b) Move transversely to a point 2 feet from the edge of the pavement for in-place density if random location for coring falls within 2 feet of the edge overall pavement section (shoulders).

(c) Fill core holes with HMA or high AC content cold mix and compact.

(d) Owner approved testing agency witnesses the coring operation, takes possession of the cores immediately, and begins testing the cores within 24 hours of density acceptance.

18. SECTION 2220 CULVERTS

2.1.84 GENERAL

2.1.85 SCOPE

The work covered by this specification includes furnishing of labor, equipment and materials required for installation of corrugated steel, concrete and plastic pipe culvert, joints, accessories, bedding and slope protection at pipe end.

1.2 References

AASHTOT 180	Moisture-Density Relations of Soils Using a 10-lb. (4.54-kg) Rammer and an 18-in. (457-mm) Drop
ASTM A 760	Standard Specification for Corrugated Steel Pipe, Metallic- Coated for Sewer and Drains
ASTM C 14	Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 443	Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
ASTM D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 lbf/ft3 (600 kN-m/m3))
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3))
ASTM D 1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

2.1.86 SUBMITTALS

Contractor shall submit manufactures product data and installation instructions on pipe, fittings and accessories. Any special procedures required to install specified products shall be noted. Submittals shall be received at least two weeks before start of work.

Contractor shall provide submittals as required by Section 02122 Trench Excavation and Backfill.

2.1.87 PRE-INSTALLATION CONFERENCE

Contractor shall convene a Pre-Installation Conference one week before commencing work of this Section, if required under provisions of local, state or federal highway encroachment permits.

2.1.88 Regulatory Requirements

Conform to applicable highway specifications and codes for materials and installation of the work of this section within local, state and federal highway right- of-way.

2.1.89 Materials

A Culvert Pipe

i Corrugated Steel Pipe:

(a) ASTM A 760 II zinc metallic coated.

(b) Shape: Circular or elliptical with nominal dimensions as shown on the drawings.

(c) Tapered Ends: Same material as pipe, machine cut, for joining to pipe end.

(d) Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

B Concrete Pipe:

i ASTM C 14, Class 3; un-reinforced; plain end joints:

ii Shape: Circular with a nominal diameter as shown on the drawings.

iii Concrete Pipe Joint Devices: ASTM C 443, rubber compression gasket joint.

C Reinforced Concrete Pipe

i ASTM C 76, Class IV with Wall Type B bar reinforcement; bell and spigot end joints:

ii Shape: Circular with a nominal diameter as shown on the drawings.

iii Reinforced Concrete Pipe Joint Device: ASTM C 443, rubber compression gasket joint.

D Bedding and Backfill Materials

Bedding and backfill material shall be crushed aggregate surfacing as defined in Section 2170 Road Finish Rock.

E Accessories

i Filter Fabric: not required.

ii Materials at Pipe Ends: As required by permitting agency. Alternatives are soil cement material blend with 6 percent cement, premixed and burlap bagged for moist cure on site; rip rap rock with a nominal size of 12 inches.

iii End of Culvert Gratings: not required.

2.1.90 EXECUTION

A Trench Excavation

i Excavate culvert trench to 6 inches below pipe invert and to the depth and width shown on the drawings. If excavating through soft silty clay soils, use a smooth edge bucket to avoid disturbance of the bottom of the trench.

ii Cut trenches sufficiently wide to enable installation of culvert and allow room for compaction of backfill around the pipe and inspection.

iii Excavations shall not interfere with the bearing splay of foundations, about 45o from the foundation base.

iv Excavate by hand for accurate placement of pipe to elevations indicated.

v Remove loose, lumped or frozen subsoil, boulders, rock greater than two (2") inches in diameter and other deleterious matter which could damage piping or impede consistent backfilling or compaction.

vi Correct areas over excavated by backfilling with bedding material as defined below.

vii Stockpile excavated material, if suitable for backfilling, in area designated within the construction limits and remove excess material not being used, from the site.

B Examination

Before installation of culvert pipe, verify that trench base and excavations are true to the dimensions and elevations that are as indicated on the layout drawings.

C Bedding

Place bedding material at trench bottom and level bedding materials in one continuous layer not exceeding 6 inches in compacted depth. Compact to 92 percent of maximum dry density as determined by ASTM D 1557.

Backfill around sides to the top of the pipe. Tamp and compact each lift a minimum of (92%) ninety-two percent of the maximum dry density as determined by ASTM D 1557. Do not displace or damage pipe when placing or compacting backfill.

Maintain +/- 2% of optimum moisture content of the bedding material to attain the required soil density.

D Installation - Pipe

Install pipe and accessories in accordance with manufacturer's instructions. Lift or roll pipe into

position. Do not drop or drag pipe over prepared bedding.

Protect pipe and bedding from damage or displacement until backfilling operation is in progress.

Lay pipe to slope gradients noted on layout drawings with maximum variation from true slope of 1/8 inch in 10 feet.

Shore pipe to required position to ensure pipe remains in correct alignment and at the required slope until after compaction of adjacent fills is completed.

Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.

E Materials at Pipe Ends

Place materials at pipe ends as defined in section 2.3A, at embankment slopes and as indicated on the drawings, to the subscribed average thickness.

F Laying Tolerances

Culvert invert elevation: ½” Alignment offset: 1”

Profile: 1%

G Field Quality Control

All field-testing and inspection shall be performed by an independent testing agency hired by the Owner.

Inspection and testing will be performed before and immediately after placing aggregate cover over pipe. Inspection shall include checking for compliance with erection tolerances and placement specifications. Testing shall check compliance with bedding and backfill materials, and compaction. Tests shall be performed in accordance with ASTM D 1557, D 698 and D 6938.

If inspections and tests indicate work does not meet specified requirements, the work shall be removed, replaced, inspected and tested.

Test and inspections shall be performed for each culvert at road crossings or every 50 linear feet of culvert.

19. SECTION 2230 SEEDING AND EROSION CONTROL

2.1.91 GENERAL

2.1.92 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required by the Erosion and Sediment Control Plan (ESCP). Excluded are areas within the substation fence.

2.1.93 MATERIALS

Materials shall meet the following requirements:

Matting: Matting shall be biodegradable as the grasses become established.

Fertilizers: Standard commercial manufacture.

Mulch: Provide mulch materials free of noxious weed seeds and plants. Mulch shall be processed to have the ability to cover and hold grass seed in contact with the soil.

Seed: Supplied by a state certified seed vendor. Seed mixture shall include a variety of grasses, all of which are suitable to the local climate.

2.1.94 Execution

Contractor shall perform this work when local weather conditions are favorable. Contractor shall adhere to the post construction and soil stabilization Best Management Practices (BMP's) as indicated in the ESCP.

Remove all rocks, weeds, debris and matter detrimental to seed germination and growth. Cultivate surface soil to a condition favorable to seed growth.

Form minor ridges in the fill and cut slopes to retard erosion and improve germination.

Apply seed and fertilizer as recommended by the seed supplier. Contractor shall use hydroseeding techniques to apply seed and mulch.

In ditches and where running water is possible Contractor shall apply matting. Matting shall be placed in strips in the direction of water flow. Place matting in contact with the ground at all points and secure in place with wire staples.

2.1.95 SECTION 2240 SOIL STERILIZATION

2.1.96 General

2.1.97 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for application of soil sterilant as shown on the drawings and specified herein.

2.1.98 Submittals

Contractor shall submit the following for Owner records:

A. Copy of applicators license (if required by state regulations or Department of Environmental Quality (DEQ))
B. Material Safety Data Sheets (MSDS) for selected herbicide.

2.1.99 Materials

Contractor shall be responsible for selecting herbicide(s) which are most effective for the given season of application, soil conditions and plant material at the substation site and which minimize the potential for environmental impact to surrounding areas. Herbicide(s) shall be selected and applied in a manner to prevent plant growth for a minimum period of one year from date of application. Extra precaution in herbicide selection is necessary if the substation site is accessible to wetlands or waterways. Only herbicide(s) with current EPA registration shall be used.

2.1.100 EXECUTION

Contractor shall obtain a certified applicator's license if restricted use herbicides are applied. Contractor shall also obtain all necessary state licenses for application of selected herbicide(s). Herbicide(s) shall be applied in strict accordance with manufacturer's instructions and in a manner to avoid migration outside treated areas.

Unless otherwise indicated or shown on the drawings, Contractor shall apply herbicide(s) over all areas within the substation and five (5) feet outside the substation fence.

Storage and disposal of herbicide(s) is the responsibility of the Contractor. Contractor shall follow manufacturer's instructions for herbicide storage and disposal. Contractor shall be responsible for proper handling and disposition of any unused herbicide(s).

3 Concrete

20. SECTION 3000 REINFORCED CONCRETE

3.1.1 GENERAL

3.1.2 SCOPE

Furnish all material, equipment, accessories, tools, services, transportation, labor, and supervision required for the supply and installation and testing of cast in place concrete. The index to this specification is as follows:

3.1.3 CODES AND STANDARDS

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

ACI 211	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
ACI 212	Chemical Admixtures for Concrete
ACI 301	Specifications for Structural Concrete for Buildings
ACI 304 ACI 305R	Guide for Measuring, Mixing, Transporting and Placing Concrete Hot Weather Concreting
ACI 306R	Cold Weather Concreting

ACI 315 Details and Detailing of Concrete Reinforcement ACI 318 Building Code Requirements for Structural Concrete ACI 347 Guide to Formwork for Concrete

American Welding Society D12.1, Recommended Practices for Welding

Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction

Concrete Reinforcing Steel Institute (CRSI), as noted.

3.1.4 MATERIALS

A *Cement shall be Portland Cement conforming to ASTM C 150, Type II, or as specified by Geotechnical Engineer. All cement supplied shall be of one manufacturer.*

B *Water used in mixing shall be clean and free from deleterious amounts of acids, alkalis, organic matter, or other impurities likely to be injurious to concrete.*

C *Admixtures:*

i Chemical Admixtures shall conform to "Chemical Admixtures for Concrete" (ASTM C 494) and shall not be used unless prior approval in writing is obtained from the Owner. Where approved, the admixture shall maintain or improve the strength of concrete of the original design mix. Admixtures shall be used in strict accordance with the manufacturer's recommendations and shall be accompanied by the services of the qualified field representative of the manufacturer to supervise the use thereof. A certificate from an approved laboratory attesting that the admixture equals or exceeds ASTM C 494, Type D will be required.

ii Air Entraining Admixtures shall conform to "Specifications for air-Entraining Admixtures for Concrete" (ASTM C 260). Air content shall be determined in accordance with ASTM C 231. The agent and the cement proposed for use shall be selected well in advance of concrete placing. Approved air-entraining admixtures are as follows:

Darex AEA (Grace Construction Materials) MB-VR (Master Builders Company) Sika AER (Sika Chemical Corporation)

iii The use of accelerators shall not be allowed unless approved by the Owner.

D *Aggregate:*

i Fine aggregate shall conform to "Concrete Aggregates" (ASTM C 33), except for gradation which shall be as follows:

Sieve Size	Percent Passing by Weight
3/8 inch	100
No. 4	95-100
No. 16	45-80
No. 50	7-30

No. 100	No More Than

ii Coarse aggregate shall conform to "Concrete Aggregates" (ASTM C 33), except for gradation which shall be as follows:

Sieve Size	Percent Passing by Weight
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10

E Concrete Quality:

i All concrete shall meet the quality requirements specified in ACI 318, Chapter 4.

ii The 28-day compressive strength, fc', of the concrete shall not be less than 4000 psi or as specified on the drawings.

iii Method of proportioning shall be in accordance with ACI 211.1, "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete."

iv The determination of the water-cement ratio to attain the required strength shall be in accordance with ACI 301, Method 2 (For combinations of materials previously evaluated or to be established by trial mixes), and with ACI 211.1. In addition, the maximum water- cement ratio (by weight) shall be 0.45 and the minimum cement content shall be six (6) sacks per cubic yard.

v From the test results of the aforementioned procedures, a curve shall be plotted showing relationship between the water-cement ratio and compressive strength, and the maximum water-cement content ratio to be used shall be the value shown by the curve to produce the strength a minimum of 25 percent greater than the strength specified.

vi The concrete mix design shall be submitted to the Owner for approval at least two weeks prior to beginning of any concrete work.

vii Maximum aggregate size shall meet the requirements of ACI 318, Section 3.3.

viii Unless otherwise noted or approved, all concrete shall be air-entrained. Air entertainment shall be accomplished using an approved admixture.

ix Air Content shall be 3.5 to 6.5 percent.

x Slump shall be between two (2) and four (4) inches, except for drilled piers. See specification 02200 for drilled pier concrete slump requirements.

xi Mixing, transporting and placing concrete shall conform to applicable portions of ACI 211, ACI 212 and ACI 304 and as specified herein.

F Reinforcement:

i Deformed reinforcing steel bars shall conform to ASTM A 615, Grade 60 unless noted otherwise. Bars shall be tagged with marked number and size before shipment. Welding of ASTM A615 bars is not permitted. Where welding of deformed bars is required, such bars shall conform to ASTM A 706.

ii Coated Bars: if specified by the drawings, reinforcing bars shall be either galvanized or epoxy coated. Galvanized-coated reinforcement shall be Class I hot dipped after fabrication zinc coated in accordance with ASTM A 767. If the galvanized surface is damaged prior to placement of concrete, it shall be repaired in accordance with ASTM A 780. Epoxy coated reinforcement shall be epoxy coated in accordance with ASTM A 775. If the epoxy surface is damaged prior to placement of concrete, it shall be repaired with 3M Scottcoat 306 in accordance with manufacturer's specifications.

iii Welded Wire Fabric shall conform to "Welded Steel Wire Fabric for Concrete Reinforcement" ASTM A 185.

iv All cold-drawn steel wire for concrete reinforcement shall be in accordance with ASTM A 82.

v Synthetic reinforcing fibers shall be collated fibrillated polypropylene, as manufactured by Fibermesh, Inc. or equal.

vi Accessories shall conform to CRSI Manual of Standard Practice of Reinforced Concrete Construction. Include all devices necessary for proper placing, spacing, supporting, and fastening steel reinforcement in place. Accessories shall be galvanized after fabrication if underside of concrete will be exposed.

vii Concrete squares, or dobies, shall be approximately two inches square and of a thickness adequate to provide the cover for the reinforcing steel as called for on the plans. The squares shall be made using a mixture of one part Portland Cement to three parts sand (fine aggregate) and the tie wires shall be cast integrally with each square.

G Formwork:

i Formwork shall be designed for loads and lateral pressures outlined in Chapter 1, Guide to Formwork for Concrete (ACI 347) and wind loads as specified by the controlling local building code. Formwork design and construction are the responsibility of the Contractor.

ii Forms shall be constructed of wood, steel, or other approved material. Material shall be chosen based on strength and concrete finish requirements.

H Embedded Items:

i Anchor rods shall comply with section 05110.

ii Embedded metals shall comply with section 05100.

iii Waterstops shall be of the dumbbell or center built type made from either rubber, PVC or TPER unless otherwise noted on the drawings. The Owner representative before installation shall approve type and material of water stop.

iv Expansion joint filler shall be ½" thick and shall meet the requirements of ASTM D 1751 for bituminous type or ASTM D 1752 or ASTM D 2628 for non-bituminous type. Where required or shown on the drawings a non-impregnated compressible foam backer rod shall be installed in the expansion joint prior to applying joint sealer. The backer rod shall be 1/8" inch larger in diameter than the joint width and shall be placed in the joint to provide a clear depth above the backer rod from the finished concrete surface equal to one half the joint's width.

v Joint sealer shall conform to ASTM D 1190. Sealant used in expansion joints requiring backer rods shall be a non-priming urethane sealant conforming to ASTM C 920.

vi Subsurface covering shall be polyethylene sheeting 6 mil (0.006") thick natural clear conforming to ASTM D 2103.

vii Felt joints shall be 15-lb. asphalt felt shall conform to ASTM D 250.

3.1.5 EXECUTION

A Preparation:

i In no case shall concrete be placed on muddy, spongy, or frozen subgrade.

ii All wood scraps and debris shall be removed from the areas in which concrete is to be placed.

iii All areas where concrete is to be placed shall be thoroughly cleaned to ensure proper placement and bonding.

iv Forms and subgrade shall be wetted and all standing water removed prior to placing concrete.

v All transporting and handling equipment shall be thoroughly cleaned.

B Form-work:

i Installation: Forms shall be constructed to the shape, line, and grade required and shall be maintained sufficiently rigid to prevent deformation under load, including placing and compacting of concrete. Set forms and screens for floor and decks to provide uniform slopes to drains and positive drainage for exterior slabs and steps. Forms shall be tight enough to prevent leakage of mortar. Formwork shall be secured to prevent sagging, yielding, bulging, depressions, waves, or other defects in the finished work. Forms shall be smooth and free from warp. Temporary openings shall be provided at base of column and wall forms for cleaning and inspection. All debris including mud shall be removed before placing concrete. Use of patented prefabricated panel sections for forming straight wall sections shall receive prior approval of type and procedure including type of ties to be used. Lumber once used shall be carefully cleaned and oiled before reuse.

ii Earth Sides: Earth sides shall not be used except for drilled piers where the top is formed to at least six inches below finished grade.

iii Chamfering: Exposed corners of concrete shall have ¾" chamfers or tooled edges unless shown otherwise.

iv Form Treatment:

(a) Board Forms: Keep wet previous to placing concrete; wet thoroughly just before placing.

(b) Plywood Forms: For surfaces to be painted use silicone type bondbreaker, Burke, West Chemical or approved equal, applied in accordance with manufacturer's directions. Coat other surfaces with approved stainless form oil, using minimum quantity required for satisfactory removal.

(c) Metal Forms: Approved type release compound, applied in accordance with manufacturer's directions.

v Form Removal: Side forms of walls and beams can be removed after 1 to 3 days. Load-supporting forms and shoring shall not be removed until after 7 days or two-thirds of designed 28 day compressive strength is obtained or the 7-day test cylinders have been tested and results indicate an average strength adequate to support the load imposed on the concrete. All forms shall be completely removed after setting of concrete together with all temporary supports, etc., employed for construction purposes. Forms shall be readily removable without hammering or prying against the concrete. Days having temperatures below 40oF are not to be counted for form removal unless thermal protection for the concrete has been provided.

C *Reinforcement:*

i Detailing and Fabrication:

(a) Reinforcing steel shall be detailed and fabricated in accordance with ACI 315.

(b) The fabricating Contractor shall prepare complete placing drawings and bending schedules. All shop drawings shall be submitted to the

Owner Representative for review. No fabrication or reinforcing steel shall be done until drawings have been reviewed.

ii Splicing:

(a) 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.

(b) Bar splices shall be made in accordance with ACI 318 Chapter 12 unless noted otherwise on the design drawings. Any deviation will require approval of the Owner representative.

(c) When welded splices are specified on the design drawings, the welding shall conform to AWS D 12.1.

(d) Splices in welded wire fabric shall be made by lapping a minimum of one spacing of outermost cross wires of each fabric sheet plus two inches.

D Installation: Before being placed, reinforcing shall be free from loose flaky rust, oil, grease, mud, or other coating, including ice that would reduce or destroy the bond. Reinforcement shall be accurately placed and properly secured in position by pre-cast concrete squares, metal chairs or spacers. The use of heat to bend or straighten reinforcing will not be permitted. Tolerances, spacing, splices, and concrete protection shall conform to Chapter 7 and 12 of the ACI 318 Building Code.

E Ties: With the exception of temperature reinforcement, which shall be tied to main steel, reinforcement shall be accurately placed and securely tied at all intersections and splices with 18 gauge black annealed wire, and shall be securely held in position during the placing of concrete by spacers, chairs, squares, or other approved supports. Wire tie ends shall point away from the form. Unless otherwise indicated, the number, type, and spacing of supports shall conform to ACI 315 Manual.

F Stirrups: All stirrups, except ties, shall be held in place by two spacer bars extending the full length of the beam or girder.

G Mesh: Reinforcing mesh shall be installed by one of the following methods to obtain the spacing indicated on the drawings:

i Deposit a layer of concrete and strike off at the level required for the indicated spacing. Lay the mesh on the struck-off surface, place reinforcing bars, if required, and then continue pouring to full slab thickness. Use this method only when position of mesh is critical.

ii Place mesh on pre-formed concrete blocks wired to the mesh, pour concrete, and adjust mesh as required. This is the preferred method when exact positioning is not critical.

H *Watertight Construction: Standard accessory items (i.e. chairs, etc.) shall not be used in the construction of tanks, reservoirs, basins or other structures to contain water or sewage. All reinforcing steel in the walls, beams, columns and slabs of such structures shall be supported on and held away from the forms by using pre-cast concrete "squares" so that no metal is exposed on the face of the concrete when the forms are stripped.*

I *Synthetic Fiber Secondary Reinforcement: When indicated on the drawings, synthetic fiber secondary reinforcement shall be added to concrete mix to provide concrete crack control. Method of fiber addition to concrete, amount of fibers added, and mixing time shall be in accordance with manufacturer's recommendations.*

J *Embedded Items:*

i No pours are to be made until all embedded items, anchor rods, electrical conduits, steel frames, pipe supports, etc., are properly positioned and secured. The Contractor shall be responsible for and coordinated with other trades to obtain necessary data and information.

ii All sleeves, inserts, anchor rods, waterstops, and other embedded items shall be positioned accurately and supported against displacement.

iii Anchor Rods:

(a) Fabrication: Anchor rods shall be fabricated in accordance with specification 05110.

(b) Installation: Anchor rods shall be set true to the lines and grades shown on the drawings and shall be set plumb and be securely braced to prevent displacement during placing of concrete. Exposed threads shall be protected by coating with oil or grease and encasing them in burlap or paper. Upon completion of concrete placement, anchor rods shall be rechecked for correct location and elevations. When any anchor rod exceeds acceptable tolerances such corrections as are necessary shall be made at no additional cost to the Owner.

(c) Anchor Tolerances: Tolerance limits in setting of anchor rods shall be as follows:

Location, sleeved: 3/16 inch Location, unsleeved: 1/8 inch

Projection: plus 1/4 inch, minus 0 inch

iv Embedded Metals:

v Fabrication: embedded metals shall be fabricated in accordance with specification 5100.

vi Installation: All embedded curb angles, beams, frames, pipe sleeves, etc. shall be set true to the lines and grades shown on the drawings.

Embedded items shall be secured and braced to prevent shifting during concrete placing. Where dissimilar metals are to be embedded in direct contact with one another, the contacting surfaces shall be heavily coated with bituminous mastic or other Owner-approved surface treatment to prevent galvanic coupling.

K Mixing Concrete:

i The mixer and mixing time shall be in accordance with ACI 304. Hot weather concreting shall comply with ACI 305R, and cold weather concreting with ACI 306R.

ii No additional water shall be added to batched concrete without the permission of the Owner. The water shall be incorporated by additional mixing equal to at least half of the total mixing required for the batch. Any addition of water above that permitted by the limitation on water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio.

iii Concrete shall be mixed only in such quantities as are required for immediate use. The maximum allowable time between charging of the material in the mixing drum and final placing for mean ambient temperatures below 90oF shall be ninety (90) minutes or 300 drum revolutions, whichever comes first. Concrete to be delivered when the mean ambient temperature exceeds 90oF shall be mixed and delivered in accordance with the requirements of ACI 305 "Recommended Practice for Hot-Weather Concreting". Concrete not placed within these time limits, or if an initial set has developed, shall not be used. Tempering concrete by adding water or by other means will not be permitted.

3.1 Placing Concrete:

A. Concrete shall not be placed prior to a recorded pre-placement inspection and/or authorization to proceed by the Owner representative.

B. Concrete delivered without batch tickets shall not be accepted. Copies of concrete delivery tickets shall be provided to the inspector.

C. The slump may be increased up to 6 inches if concrete pumping is to be used. The proposed mix design for pumped concrete shall be approved by the Owner representative.

D. Conveying and placing of concrete shall be in accordance with ACI 304.

E. Each day's pour shall be properly scheduled to assure that concrete surfaces can be finished correctly and the use of cold joints can be minimized.

F. All concrete shall be mechanically vibrated, except for slabs on grade that are six inches or less in thickness. See specification 02200 for concrete consolidation requirements for drilled piers.

G. Concrete shall be placed in layers not over 24 inches deep. Each layer shall be consolidated by mechanical internal-vibrating equipment supplemented by hand spading, rodding, and tamping to work concrete into all angles and narrow places. Duration of vibration shall be limited to time necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrators shall be applied vertically and at uniformly spaced points not farther apart than the visible effectiveness of the machine. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall not be used to transport concrete inside forms. The use of form vibrators or form tamping will not be permitted and shall be in accordance with ACI 309R.

H. The free fall on concrete from the end of the spout or chute, or from a transporting vehicle, shall not exceed 10 feet for thin walls (10 inches or less in thickness) or more than 5 feet for other types of construction.

I. A tremie or flexible metal spout shall be used when the distance through which concrete must be dropped vertically exceeds the maximum specified above. Flexible metal spouts shall be composed of conical sections not more than three feet long, with the diameter of the outlet and the taper of the various sections such that the concrete will fill the outlet and be retarded in its flow.

J. Chutes, troughs, or pipes used as aids in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. Chutes and troughs shall be of metal or metal-lined. When steep slopes are necessary, the chutes shall be equipped with baffle boards or a reversed section at the outlet. Open troughs and chutes shall extend, if necessary, down inside the form or through holes left in the forms; or the ends of such chutes shall terminate in vertical downspouts. All chutes, troughs, and pipes shall be kept clean and free from coatings or hardened mortar by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged outside of the forms.

K. The concrete shall be deposited, as nearly as possible, in its final position and shall not be caused to flow laterally in the form any considerable distance. Each pour shall be completed in a continuous operation with no interruptions in excess of forty-five minutes. Each layer shall be placed and compacted before the preceding layer has taken initial set.

L. The placing sequence shall always be arranged to allow for the effects of settling and shrinkage. Walls 10'-0” and over in height shall be stopped about 1 foot short of the top and allowed to settle one hour minimum before topping out. Walls and columns bearing superimposed slabs or beams shall be allowed to settle a minimum of two hours before pouring slabs or beams. Laitance shall be removed before pouring superimposed structural members.

3.2 Bonding:

A. The existing surfaces shall be thoroughly cleaned of all foreign material and laitance before depositing new concrete on old concrete or against concrete which has set. Existing surfaces shall be coated with a bonding agent in accordance with ASTM specification C 881 (Sika Chemical Corporation’s Sikadur 32, High-Mod structural epoxy adhesive meets this specification).

3.3 Joints:

A. Construction and control joints shall be placed as indicated on drawings.

B. Use of construction and control joints, not shown on the drawings, shall be in accordance with ACI 318, Chapter 6.4, and subject to approval of the Owner representative.

C. Waterstops shall be installed as shown on the drawings, forming a continuous diaphragm in each joint. Support for waterstops shall be provided and waterstop material shall be protected from damage. Field joints in waterstops shall be fabricated in accordance with manufacturer's instructions.

D. Saw cutting of contraction joints shall be done as soon as concrete hardens sufficiently (normally 4-12 hours) so as not to be torn or damaged by the blade. Sawing shall not be done while concrete temperature is falling. Construction and control joints shall be filled with an approved sealant with pre-molded joint filler and backer rod as shown on the drawings.

E. Joints not specified on the design drawings shall be in accordance with ACI 301, Chapter 6, and Section 11.5.

F. All reinforcing shall be continued across construction joints. Keys shall be provided only if required by the design drawings.

G. When called for on the design drawings, the concrete surface at construction joints shall be roughened uniformly to approximately 1/4 inch. Laitance, loosened aggregate or damaged surface concrete shall be removed.

H. Paving or slab construction joints, when not specified on the design drawings, shall be located at column centerlines and at intermediate intervals so that each panel shall be not more than 400 square feet in the area, unless slab is reinforced, in which case the area shall not be more than 600 square feet. Maximum spacing of construction joints in un- reinforced slabs shall not exceed twice the slab thickness in inches (i.e., 6 inch slab: 12 feet) nor 1-1/2 times the width for narrow slabs such as sidewalks. Concrete shall be placed in checkerboard patterns or in alternate paving lanes utilizing construction and contraction joints to provide panels of the size shown on the drawing (when shown).

3.4 Finishing Concrete:

A. Form ties shall be broken back 1 inch from the surface of the concrete. Seal patching using 1-to-2 mix of cement-sand mortar shall fill the remaining holes.

B. All voids and honeycomb in formed concrete shall be filled with a 1-to- 2 cement-sand mortar mix. Form ridges and other projections shall be removed immediately, after forms are removed. Exposed form concrete shall be rubbed with a carborundum brick and a thin cement grout shall be applied as necessary to produce a true, even, finished surface. Grout shall extend at least 3" below finished backfill grade on grade walls.

C. Concrete surfaces left low for grouting shall be roughened to expose aggregate and all loose particles and laitance removed. Anchor rod threads shall be wire brushed, and greased, after concrete has set. Nuts and washers shall be placed on the rods.

D. Finish for Floors and Walls:

1. Interior building slabs including pit floors shall be screeded, floated, and steel trowelled.
2. Exterior slabs shall be screeded, floated, trowelled, and broomed.
3. Special care shall be exercised on floors that have drains or trenches. Floors shall be sloped uniformly to provide even fall for drainage.

D. Screeding, Floating, Troweling, Brooming & Nonslip Finishing:

1. Surfaces shall be screeded to the elevations shown on the drawings. "Con-Film" or Owner-approved equal shall be sprayed on the screeded surface in conformity with manufacturer's directions if the air temperature is expected to reach 80°F or above before cure is complete.
2. Floating shall start as soon as the screeded surface has stiffened sufficiently. Floating shall be performed as necessary to produce a smooth, even, textured finish. Floating shall be performed by hand using magnesium tools.
3. The slab surface shall be tested for accuracy with a straight edge after the first floating finish is completed. Any depressions shall be filled and high areas shall be cut down and reworked. Straight edge testing and refloating shall continue until there are no deviations of more than 1/8 inch under a ten-foot straight edge.
4. Interior slabs shall be troweled except as noted on drawings or specified otherwise. Steel troweling shall begin after straight edge testing is finished and while concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint. Steel troweling shall produce a smooth troweled finish per ACI Standard 301, Section 11.7.3 "Trowel Finish". Time lapse and number of trowelings to produce a hard surface will vary depending on weather conditions.
5. Exterior slabs and other surfaces, as noted, shall be broomed after final floating to provide a nonskid surface. A soft bristled push broom shall be used, with a swirling motion.
6. Surfaces indicated shall have a nonslip finish obtained by sprinkling not less than 1/4 pound of abrasive aggregate over each square foot of the screeded and floated concrete, and finishing immediately with a steel trowel. The abrasive aggregate shall consist of not less than 55 percent aluminum oxide or silicone-carbide abrasive ceramically bonded together to form a homogeneous material that will be sufficiently porous to provide a good bond with Portland cement. The aggregate shall have an abrasive hardness of not less than 40 as determined by the test for wear resistance in the National Bureau of Standards Report BMS 98.

3.5 Curing and Sealing:

A. All finished concrete shall be cured by a curing method compatible with the final floor finish for a minimum of 7 days in accordance with ACI 301 Chapter 12. One or more of the following methods may be used, if approved by the Owner, except where specified curing method is called for:

1. Water curing by ponding or continuous wetting of sand or burlap.
2. Form curing by leaving on the forms and wetting for seven days.
3. An approved sprayed on curing compound applied in accordance with the manufacturer's instruction.
4. Steel troweled floor slabs, not covered with other materials shall receive a coat of Cenco Seal 301 surface hardener applied after all other equipment and work in the building has been installed and/or

completed and the floor has been thoroughly cleaned of all dust, dirt, masks, and foreign matter. Floor surfaces designated to receive tile or other treatment shall not be treated with sealers or hardeners.

3.6 Cold Weather Concrete:

A. Thorough preparation for protection against cold weather damage to concrete shall be made well in advance. Cold weather concreting shall be performed in accordance with ACI 306R.

B. Concrete shall be protected from freezing for not less than the first 48 hours after placing after the first frost, or when the mean 24-hour temperature at the job site falls below 40^{o}F.

C. The placing temperature of the concrete shall be maintained above 50^{o}F when the mean 24-hour temperature falls below 40^{o}F.

D. The temperature of fresh-placed concrete shall be between 50 and 60^{o}F.

3.7 Hot Weather Concrete:

A. Thorough preparation for protection against hot weather damage to concrete shall be made well in advance. Hot weather concreting shall be performed in accordance with ACI 305.

B. The maximum concrete temperature, at time of placement, shall be limited in accordance with ACI 305, Figure 2.1.4. The evaporation rate of the mixing water shall not exceed 0.2 pounds of water per square foot per hour.

C. One or more of the ingredients may have to be cooled to keep the temperature of the concrete from being excessive at time of placement. The replacement of part of the mixing water with an equal weight of crushed ice is recommended for effective cooling per ACI 305, figure 2.3.6.

D. In-place concrete shall be protected and cured so as to minimize drying and absorption of heat.

3.8 Pumped Concrete:

A. The Owner shall approve the use of pumped concrete in each case.

B. The proposed mix design for each class of concrete to be pumped, including all necessary background data of test results, shall be submitted to the Owner for approval.

C. All slump and cylinder test samples shall be taken from the end of the discharge line.

3.9 Testing and Inspection:

A. Testing and acceptance of tests of concrete shall be done in accordance with ASTM C 31, C 39, C 94, C 143, C 172, and C 173, D 75 and C 136.

B. A testing laboratory engaged by the Owner will be responsible for:

1. Supplying the test cylinder molds to the job-site and taking the cylinder samples.
2. Testing for air, slump, temperature, compression strength and aggregate gradation.
3. Preparing test reports.

C. The Contractor shall supply concrete for all tests.

D. Concrete shall be sampled, cured, tested and accepted for compressive strength in accordance with ASTM C 172, C 31, C39, and C 94. Compressive test cylinders shall be prepared in sets of three cylinders for each test. Specimens for each set shall be obtained from the same batch of concrete after about one half of the batch has been placed in the forms. The rate of sampling shall be as follows:

1. Structures and Foundations and Slabs on Grade
   One set per 50 cubic yards of concrete or one set at the beginning of each days concreting.

2. Underground Duct Envelopes and Fireproofing
   One set taken at the beginning of concreting work. Subsequent testing may be performed at the discretion of the Owner representative.

3. All Other Concrete
   See Paragraph 3.14.D.1 above.

E. Test cylinder sets shall be dated, numbered consecutively, and identified as to location.

F. All cylinders shall be immediately stored under wet sand or burlap for about 24 hours after preparation. All vibration or impact shall be avoided during this critical period.

G. After initial storage, the cylinders (still in their molds) shall be packed in sealed polyethylene bags, wet sand or other resilient material for shipment to the testing laboratory.

H. Concrete slump tests shall be made in accordance with ASTM C 143 and shall be taken as necessary to assure well-placed concrete.

I. In-Place Tests: Where questions as to the quality of the concrete placed, Owner representative may require tests per ASTM C 42 or order a load test on structures as outlined in Chapter 20 of ACI 318, Building Code Requirements for Structural Concrete.

J. Inspection: All forms, reinforcement, and anchor rods shall be inspected and approved by the Owner representative before concrete is placed. If work is found unsatisfactory, the work shall not proceed until all defects have been remedied. The Owner representative shall approve repaired work. Such approval will in no way relieve the Contractor of his obligation to produce finished concrete as required by the drawings and specifications.

3.10 Submittals:

Three (3) copies of the following shall be submitted to the Owner representative for review before proceeding:

A. MIX DESIGN: Design of concrete mixes in accordance with this specification and ACI 301, Chapter 3.

B. Copies of concrete delivery batch tickets.

C. SHOP DRAWINGS: Reinforcing steel shop drawings, bar lists and bending and erection drawings.

D. TEST REPORTS: Test Reports and material certifications as noted elsewhere in this specification.

21. SECTION 3010 CONTROLLED DENSITY FILL

1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of non-settling backfill mixtures described as a Controlled Low Strength Material-Controlled Density Fill. Hereafter referenced by the acronym: CLSM-CDF. (Fill mixtures are sold commercially under a variety of producer names: K-Krete®, M-Crete, Darafill®, Flash Fill®, Flowable Fill, Flowable Mortar, Unshrinkable Fill, etc.) CLSM-CDF is used as a low strength, high slump self-consolidating fill material that provides support strength for traffic loads and which can be easily excavated at a later time. It may be used as a trench backfill, structural backfill, pipe bedding, or pipe filling for abandonment in place.

1.2 Codes and Standards:

ACI SP-150	Controlled Low-Strength Material ACI 229R Controlled Low-Strength Materials
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C150	Standard Specification for Portland Cement
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM D6103	Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM)
ASTM D6023	Standard Test Method for Unit Weight, Yield, Cement Content and Air Content (Gravimetric) of Controlled Low Strength Material (CSLM)
ASTM D5971	Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material
ASTM A 674	Standard Practice For Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids
ASTM D 1558	Standard Test Method for Moisture Content Penetration Resistance Relationship of Fine- Grained Soils
ASTM D 4832	Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders
ASTM D 5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

1.3 Submittals

A. Before manufacture of any CLSM-CDF mixture, the Contractor shall comply with the following requirements.

B. Demonstrate the ability to produce a uniform CLSM-CDF mixture as outlined in this specification. The National Ready Mix Concrete Association's (NRMCA) plant and truck certification will satisfy the producer certification requirement.

C. Certified engineering data, for the proposed mixture to be used, shall be submitted for twenty eight (28) and ninety (90) day unconfined compressive strength (C') tests as described in ASTM D 4832, except that cylinders will not be capped.

D. Yield and dry unit weight (ASTM D6023)

E. Flowability (ASTM D6103)

F. Removability (Removability Modulus RE =<1.0)

G. Mixture's components (cement, water, fly ash, filler aggregate etc.) and sources (company and location): Previous test results, on the same mixtures using the same mixture components, will satisfy this requirement. If it is determined, that for the engineering data presented, flowability, adequate strength, and removability requirements are not acceptable, the use of this mixture will not be allowed.

22. 2.0 Materials

CLSM-CDF Materials

Materials for CLSM-CDF mixtures will be the responsibility of the Contractor. All mixture components must be environmentally acceptable. A Material Safety Data Sheet (MSDS) for each component in the mixture must be available upon request.

Materials for CLSM-CDF mixtures shall be evaluated as non-corrosive by appropriate ASTM standards including ASTM A 674. If the CLSM-CDF mixture has an electrical resistivity value of less than 5000 W cm, then to ensure compatibility with any proposed or encountered metal conduit, a polyethylene encasement shall be required conforming to ASTM A 674.

The CLSM-CDF shall have a 28 day unconfined compressive strength of 50 psi to a maximum of 100 psi. Total air content shall not exceed 30 percent. The mix shall have a flow of 6 to 8 inches when tested in accordance with ASTM D6103. Pumpable CLSM-CDF shall be proportioned to allow transport by pumping methods without segregating or excessive bleeding.

2.1 Portland Cement: ASTM C150, Type I or Type II.

2.2 Fly Ash: ASTM C618, Class F. Fly ash shall not inhibit air entrainment.

2.3 Air-Entraining Admixture: ASTM C260

2.4 Aggregate: ASTM C33, graded aggregate, maximum size of 3/8 inch, and the 3/8 inch aggregate shall comprise no more than 20 percent of the total aggregate. Amount passing a No. 200 sieve shall not exceed 12 percent. No plastic fines shall be present.

2.5 Water: Water used for the mixture shall be free from oil, salts, acid, strong alkalis, vegetable matter, and other impurities that would have an adverse effect on the quality of the backfill material.

23. 3.0 Materials

3.1 Proportioning of Mixtures

The proportioning of CLSM-CDF mixtures is the responsibility of the Contractor. The mixture will be rejected for failure to meet, or sustain, the mixture's consistency for the previously stated properties.

Where gas leak, odor migration, is a concern for the identification of possible gas leaks, the CLSM-CDF material shall meet a minimum permeability coefficient (k) of one x 10-5 (cm/sec), or more, based on ASTM D 5048.

3.2 Placing (Pouring)

The CLSM-CDF mixture shall be placed directly into the trench or excavation. The material's flow characteristic will be such that no labor will be required in the trench or excavation. No vibration or compaction equipment shall be used. If the trench or excavation contains water, the CLSM-CDF mixtures may be used to displace the water.

A Fast Setting Mixture shall be used for backfilling trenches under pavement when it is deemed that the pavement must be quickly reopened to traffic so as to minimize inconvenience to vehicular traffic as shown on the plans. The use of a Fast Setting Mixture is intended to allow for placement of an asphaltic concrete pavement within two hours after mixture placement. Fast Setting Mixture shall produce a load bearing strength of 20 psi in two hours as measured with a penetrometer using the 1.124" diameter head (ASTM D 1558).

3.3 Construction Requirements

The trench or excavation shall have vertical wall limits that confine the flowable CLSM-CDF mixture in a given area. For long trenches, requiring large amount of CLSM-CDF material, bulkheads can be used to control required placement quantities.

The CLSM-CDF material shall be brought up uniformly to the lines or limits shown on the plans or as directed by the Engineer. The placing of Portland cement concrete and/or asphaltic concrete pavements can be performed when a load bearing strength of 20 psi is achieved as referenced in Section 3.2.

A. The following limitations of operations shall govern:
   1. The mixtures shall not be placed on frozen ground.
   2. The placed mixtures shall be protected from freezing.
   3. Each filling stage shall be as continuous as possible.
   4. Setting time of CLSM-CDF may be affected by temperature. At temperatures near freezing, or below, additional time may be needed for proper setting of the material prior to any type of paving operation.

3.4 Acceptance of Material and Field Test Requirements The material acceptance will be

based on the following.

A. Contractor certification (Section 03010.1.3)
B. Field testing for flowability (ASTM D6103)
C. Sampling freshly mixed CLSM (ASTM D5971)
D. Cylinder (3" x 6") strengths (ASTM D 4832). Six (6) cylinders will be required for any placement of 50 cubic yards and each 50 cubic yards thereafter. Three (3) cylinders will be broken at 28 and three at 90 days. If the placement is less than 50 cubic yards, three (3) cylinders will be taken every day of production. Two cylinders will be broken at 28 days and one (1) cylinder at 90 days.
   The Contractor shall be responsible for the curing and protection of the cylinders until such time that they are ready to be picked up by the testing

laboratory. The Contractor shall coordinate this activity. A testing laboratory will hold the cylinders until the required breaking date.

E. Unit weight tests (ASTM D6023) will be performed when cylinders are made. All tests shall be performed by laboratories approved by the Owner. Copies of all test reports shall be submitted to the Owner. If the produced CLSM- CDF material fails any of these acceptance tests, indicating future removal difficulty (RE > 1.0), the material will be rejected with the possibility of removal. All CLSM-CDF tests are to be performed by qualified testing personnel.

24. SECTION 3020 CONCRETE REPAIR

1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for the preparation of damaged concrete foundations and application of repair materials.

1.2 Submittals

A. Submit under provisions of Section 01300 the following information.

B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

C. Manufacturer's Certificate: Certify that specified products meet or exceed specified requirements.

1.3 Qualifications

A. Materials Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

1.4 Delivery, Storage, and Handling

A. Deliver, store, protect and handle products under provisions of manufacture instructions for storage, shelf life limitations, and handling.

25. 2.0 Products

2.1 Manufacturers

A. Mortar: Sika Corporation; Product SikaRepair SHA

B. Steel Primer: Sika Corporation; Product SikaArmatec 101 EpoCem

C. Latex: Sika Corporation; Product SikaLatex (R)

D. Substitutions: All substitutions shall meet the specifications below and be approved by the Owner.

2.2 Patching Materials

A. Patching material shall be a fast setting, on component, cementitious repair mortar meeting the following minimum characteristics:

Characteristic	Test Method	Results
Bond Strength	ASTM C 882 (Modified)	1,800 psi Flexural Strength
	ASTM C 293	1,100 psi
Compressive Strength	ASTM C 109	5,000 psi at 28 days

B. Reinforcement primer shall be moisture-tolerant, epoxy-modified, cementitious product specifically formulated as a bonding agent and an anti- corrosion coating.

Characteristic	Test Method	Results
Splitting Tensile Strength	ASTM C 496	600 psi at 28 days
Flexural Strength	ASTM C 348	1,250 psi
Compressive Strength	ASTM C 109	8,500 psi at 28

C. Acrylic-polymer latex, shall be a general-purpose admixture to produce polymer-modified concrete and mortar.

Characteristic	Test Method	Results
Bond Strength	ASTM C 882	>500 psi

2.3 Mixing Cementitious Materials

A. Mix cementitious mortar in accordance with manufacturer's instructions for purpose intended.

B. Include latex polymer as a substitute for mixing with water.

26. 3.0 Execution

3.1 Surface Preparation

A. Remove all deteriorated, broken and soft concrete. Cut all edges to sound surface concrete to a minimum depth of ¼-in. Clean concrete and exposed reinforcing steel surfaces of corrosion from steel, dirt, oil, grease, laitance, corrosion, or other contamination by high-pressure water blast, scabbler, wire brush or other appropriate mechanical means. Concrete shall obtain an aggregate fractured surface profile of 1/16-in. Rinse surface, flush out cracks and voids and allow to dry to a saturated surface dry (SSD) condition with no standing water.

3.2 Application of Cementitious Mortar

A. Apply the mixed cementitious mortar by working it well into the primed surface, filling all pores and voids. Compact well. Force the material against edge of repair working towards the center, thoroughly compacting towards the center. If multiple lifts are required, score the top surface on each lift and allow the lift to harden before applying fresh material. The final surface shall be finished smooth with steel trowel.

B. Cure as per ACI recommendations for Portland cement concrete. Curing compounds must be pretested for compatibility. Protect fresh mortar form direct sunlight, wind, rain and frost.

4 Fencing

27. SECTION 4000 FENCING AND GATES

4.1.1 GENERAL

4.1.2 SCOPE

This section includes specifications for furnishing all materials, labor, tools, and equipment necessary to construct the substation perimeter fence and gates.

4.1.3 General Requirements

The project substation perimeter shall be fenced. The fence shall be tied into the project substation grounding grid.

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.

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.

Contractor shall furnish and install a contact sign at the entrance to the Project Substation.

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 applicable 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.

Fence and gates shall comply with M1-01-07 (Security and Compliance).

The fence shall be tied into the Project Substation grounding grid.

vehicle gate shall be installed at the Project Substation. The vehicle gate shall be a 20-foot-wide (minimum), [motorized/manual], rolling, locking gate. one (1) pedestrian gate shall be installed at the Project Substation.

4.1.4 Materials

4.1.5 Concrete

Reinforced concrete for the fence and gate foundations shall meet the requirements of Section 3000 Reinforced Concrete.

4.1.6 Execution

Perimeter fence and gates shall be installed in accordance with drawings provided by the Owner.

5 Metals

28. SECTION 5100 STRUCTURAL STEEL FABRICATION

5.1.1 General

5.1.2 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for fabrication of structural steel as shown on the drawings and specified herein.

5.1.3 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

ASTM A6	Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Steel Piping, and Bars for Structural Use
ASTM A36	Standard Specification for Carbon Structural Steel ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless (Grade B type E or S only)
ASTM A143	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength
ASTM A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/205 ksi Minimum Tensile Strength
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts ASTM A572 Standard Specification for High-Strength Low-Alloy
	Columbium- Vanadium Structural Steel
ASTM A992	Standard Specification for Structural Shapes
ASTM A1011	Standard Specification for Steel, Sheet and Strip, Hot- Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (replaces A 570)
ASTM F436	Standard Specification for Hardened Steel Washers American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges", AISC 303.

American Institute of Steel Construction (AISC) “Specification for Structural Steel Buildings” including “Commentary”, ANSI/AISC 360.

American Institute of Steel Construction (AISC) “Specification for Structural Joints Using ASTM A325 or A490 Bolts”, Prepared by Research Council on Structural Connections (RCSC) Committee A.1.

American Welding Society "Structural Welding Code - Steel D 1.1"

5.1.4 Submittals

A. Contractor shall submit manufacturer’s mill certificates certifying that products meet or exceed specified chemical composition, yield strength and other specified requirements.

B. Where Owner provided drawings are not sufficiently detailed for fabrication or where Contractor produces drawings for fabrication purposes, such drawings shall be issued to Owner for review and approval prior to fabrication.

5.1.5 Materials

All materials shall conform to the following specifications unless otherwise approved by Owner

W-Shapes	ASTM A992
Misc. Channels	ASTM A36
Channels	ASTM A36
Angles	ASTM A36
Plates & Bars	ASTM A36
Plates for Tubular Sections	ASTM A572 Grade 65 Sheets
	ASTM A1011 CS Type B
HSS (Rectangular)	ASTM A500 Grade B
HSS (Round)	ASTM A500 Grade B
Pipe	ASTM A53 Grade B,

All steel shall have a silicon content between 0.0% - 0.04% or 0.15% - 0.25% only

Bolts	ASTM A325 Type 1
	ASTM A307 Grade A
Nuts	ASTM A563 Grade DH
Washers	ASTM F436 Type 1

5.1.6 Execution

5.1.7 General

All workmanship and finish shall be equal to the best modern practice for fabrication of structural steel. All parts of the structure shall be neatly finished and free from kinks or twist. All holes, blocks and chips shall be clean-cut without torn or ragged edges. Fabrication shall be in strict accordance with detail drawings. Welding of two or more pieces to obtain the length of a member will not be accepted.

Structural steel shall be fabricated in accordance with the following requirements:

A *Straightening Material: Structural steel shall be straight and shall be clean of all rust before being laid off or worked in any manner. Straightening of material shall be done by a method that will not injure the metal.*

B Shearing and Cutting: Shearing and cutting shall be performed so that edges are not distorted or jagged; and all edges that will be exposed to view shall have a smooth finish. Copes and re-entrant cuts shall be filleted before cutting.

C Holes: All holes shall be cylindrical and perpendicular to the member's surface.

D To avoid hole distortion, holes close to the points of bend shall be made after bending. The use of burning torch for cutting holes will not be permitted. Punched holes shall be made with a punch that is equal to the diameter of the specified hole, and the die shall be not more than 1/16" larger than the diameter of the punch.

E Hole Correction: Misdrilled or mispunched holes may be corrected by filling holes with weld and redrilling or punching. Welding shall be in accordance with AWS D1.1. The following procedure shall be used for filling holes:

i All surfaces within the area of the weld shall be stripped of galvanizing and free from scale, slag, rust, grease or other foreign material that will prevent proper weld.

ii Electrodes used shall be of a classification that will provide weld metal of the tensile strength of the base metal being welded.

iii Welds shall be made in a flat position with the use of a suitable chill plate.

iv The arc shall be carried around the periphery of the hole and then in a spiral path to the center of the hole, fusing and depositing a layer of weld metal in the bottom of the hole. The arch shall then be carried back to the periphery of the hole and the procedure repeated, fusing and depositing successive layers to fill the hole. Slag covering the weld metal shall be kept molten until the weld is finished. If the arch is broken, the slag must be allowed to cool and be removed before restarting the weld.

v The surface of the completed weld shall be ground flush with the original surface prior to redrilling or repunching of the hole.

F Welding: All welding shall be performed in accordance with the latest edition of the "Structural Welding Code" AWS D1.1. A shielded arc-welding process shall be used. All welds shall be of the type specified on the drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum. For material to be galvanized; all welds shall completely seal; there shall be no voids or seams between adjoining surfaces into which pickling acids or other fluids may enter. The welding process and the welding operators employed in performing the work covered by these specifications shall be qualified, in accordance with American Welding Society Standard Qualification Procedure.

G Bending: The inside radius of cold bends in plates shall be: 3 times the thickness of plates up to 0.5 inches thick; 4 times the thickness of plates between 0.5 inches and 1.0 inches thick; and 6 times the thickness of plates between 1.0 inches and 1.5 inches thick. These cold bend radii may be *reduced by 50% when the bend lines are transverse to the direction of the plate rolling. Angles and other sections requiring tension bends of the out-standing element greater than 3.375:12 or compression bends of the outstanding element greater than 5.625:12 shall be formed by cutting and welding one leg of the angle or the flanges of the section.*

H Marking: All individual pieces shall be marked clearly with the correct designation shown on the drawings. The marks shall be stamped into each piece with a ½" high metal die before galvanizing; and the letters shall be clearly legible after galvanizing. In addition, all piece marks shall be circled with water-resistant marking pen after galvanizing.

I Inspection: All material shall be subject to inspection. Contractor shall notify Owner after completion of fabrication and before galvanizing that the structures are complete and ready for inspection. Owner will have the option to waive inspection or will have 72 hours to inspect the structures before they are sent to be galvanized. This inspection or waive of inspection by Owner shall not relieve Contractor from entire responsibility for materials, workmanship, and all other liabilities under the contract.

Final inspection will be at the site of construction after complete installation. Final acceptance will be after the material has been completely installed and found to comply with all requirements of the specifications.

Contractor shall notify Owner of all discrepancies and drawing errors found during fabrication.

29. SECTION 5110 ANCHOR RODS

5.1.8 General

5.1.9 Scope

The work covered by this specification includes the requirements for furnishing, detailing, fabrication, delivering and installing anchor rods including nuts, washers, anchor rod sleeves and accessories.

5.1.10 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall apply.

American Institute of Steel Construction (AISC) “Code of Standard Practice for Steel Buildings and Bridges”, AISC 303.

American Institute of Steel Construction (AISC) “Specification for Structural Steel Buildings” including “Commentary”, ANSI/AISC 360.

ASTM A6	Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Steel Piping, and Bars for Structural Use
ASTM A53	Standard Specification for Pipe, Steel, Black and Hot- Dipped, Zinc-Coated Welded and Seamless (Grade B type E or S only)

ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM F436 Standard Specification for Hardened Steel Washers ASTM A563 Standard Specification for Carbon and Alloy Steel Nut ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 150- ksi Yield Strength American National Standards Institute (ANSI):

B1.1, Unified Inch Screw Threads

B18.2.2, Square and Hex Nuts (Inch Series)

5.1.11 SUBMITTALS

The Contractor shall submit two copies of material certifications and shop detail drawings to confirm that anchor material supplied is in conformance with applicable codes and standards, this specification and the design drawings.

5.1.12 QUALITY ASSURANCE

Manufacturer's material certificates or the mill test reports, as required by the applicable codes or standards, shall be submitted to the Owner with the delivery of the anchor rods to the project site.

5.1.13 MATERIALS

A Unless noted otherwise on the drawings, materials shall be in accordance with the following.

Anchor Rods	ASTM F1554 Grade 55
Sleeves	ASTM A53 Grade B Nuts (Heavy Hex) ASTM
A563 Washers	ASTM F436
Anchor Plates	ASTM A36

B Galvanizing for anchor rods, nuts, washers, sleeves and plates shall be in accordance with Specification Section 05140 Hot Dip Galvanizing.

5.1.14 EXECUTION

A General

Installation of anchor rods shall be in accordance with AISC Code of Standard Practice for Steel Buildings and Bridges, Section 7.5

B Protection of Anchor Rods

Anchor rod threads shall be protected against damage. Damaged anchor rods shall be repaired or replaced. Welding (including tack welding) to anchor rods is **not permitted**.

C Setting of Anchor Rods

Templates shall be provided for all anchor rods. Templates shall be designed and constructed of sufficiently thick and rigid material to hold the rods to the lines and elevation as set.

Anchor rods shall be accurately located and set to the line and elevation before concrete is poured. Accuracy of position of anchor rods shall be maintained throughout the placing and finishing of concrete.

Anchor rods shall not vary from the dimensions on the erection drawings by more than the following:

1/8” center to center of any two rods within an anchor group or individually from the dimension line

¼” center to center of adjacent anchor rod groups

½” elevation of the top of anchor rods

¼” maximum accumulation of error per hundred feet along established line

D Leveling Nuts:

Leveling nuts shall NOT be used unless noted specifically on drawings provided by Owner. Structures shall be set directly on foundations.

If use of leveling nuts is specified, the leveling nuts shall be set to the required elevation. The space between the bottom of the leveling nut and the top of concrete shall not exceed one anchor rod diameter. A flat washer shall be set on top of the leveling nut prior to setting the structure.

E Tightening

Nuts for anchor rods shall be brought to a snug-tight condition, followed by an additional one-quarter of a full turn. Snug-tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

30. SECTION 5120 STRUCTURAL STEEL ERECTION

1.0 General

1.1 Scope

The work covered by this specification includes the furnishing of all accessories, tools, equipment, services, scaffolding, transportation, labor and supervision necessary for the erection of fabricated steel.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges”, AISC 303.

American Institute of Steel Construction (AISC) “Specification for Structural Steel Buildings” including “Commentary”, ANSI/AISC 360.

American Institute of Steel Construction (AISC) “Specification for Structural Joints Using ASTM A325 or A490 Bolts”, Prepared by Research Council on Structural Connections (RCSC) Committee A.1.

American Society of Testing and Materials, (ASTM), as noted in the specification American Welding Society, (AWS), Structural Welding Code - Steel D 1.1

1.3 Storage and Handling

Contractor shall store materials to permit easy access for inspection and identification. Steel members shall be stored off the ground. Protect steel members and packaged materials from corrosion and deterioration.

31. 2.0 Materials

2.1 Miscellaneous Materials

A. Electrodes for Welding - AWS A5.1, Class E70 Series

B. Wedges, shim packs and other adjusting devices.

2.2 Corrections of Shop Errors

The erector shall perform moderate amounts of reaming, chipping and cutting to allow proper fit-up of structural members. Any errors, which prevent the proper assembly of the structure, must be reported to the fabricator who is responsible either to correct the error or approve the most efficient and economical method of correction to be made by the erector. The cost of such corrections shall be borne by the fabricator.

2.3 Correction of Design Errors

If the erector deems a misfit of structural steel a design error the erector must notify Owner. If an error is determined, Owner shall provide resolution.

32. 3.0 Execution

3.1 Inspection

Observe areas and conditions under which structural steel is to be installed and notify Owner of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected and approved.

3.2 Erection

A. General

1. Comply with the AISC Specifications and Code of Standard Practice as herein specified. Erection tolerances as listed in the AISC Code shall apply unless otherwise specified herein or indicated on the drawings.
2. Verify elevations of bearing surfaces and locations of anchor rods before erection work proceeds. Do not proceed with erection until corrections have been made, or until compensating adjustments to the structural steel work have been made.

B. Setting Bases

1. Set base plates and bearing plates for structural members directly on foundation surface. Leveling nuts shall NOT be used unless otherwise indicated on the drawings. Shims shall be used as necessary to level and plumb structures.
2. Nuts for anchor rods shall be brought to a snug-tight condition, followed by an additional one-quarter of a full turn after the structural

steel is plumbed. Snug-tight is defined as the tightness attained by a few impacts of an impact wrench, or the full effort of a man using an ordinary spud wrench. The space between the bottom of the base plate and the top of the concrete shall not be grouted unless indicated otherwise.

C. Bracing
1. The erector is responsible for the stability of the structure during its erection.
2. Any bracing shown on the erection drawings has been designed to provide a stable structure upon the completion of erection. Permanent bracing shall be installed as each level of steel is erected.
3. The erector shall design and install all additional temporary bracing or guying required to meet loading imposed during erection, consistent with the erection sequence used, or required at the end of any work period to ensure safe and stable conditions.

D. Field Assembly
1. Set structural members in accordance with approved drawings accurately to the lines and elevations indicated. Align and adjust the various members forming a part of the complete frame or structure before permanently fastening. Before assembly clean bearing surfaces and other surfaces which will be in permanent contact.
2. Level and plumb individual members of the structure within specified AISC tolerances.
3. Splice members only where shown or specified.
4. Erection Bolts. On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.
5. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.
6. Gas Cutting. Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing. Cutting may be permitted only on secondary members and subject to the approval of Owner.
7. Provide temporary bracing or anchors in formwork for metal fabrications that are built into concrete or similar construction.

E. Installation of High Strength Bolts

1. Pretensioned Bolts. All high strength bolts shall be pretensioned by the Turn-of-Nut-Method as described in AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Alternate methods that ensure pretensioned bolt installation shall be approved by the Owner. Bolts shall be installed in all holes of the connection and brought to a "snug tight" condition. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges until all bolts are simultaneously snug tight and the connection is fully compacted.
   Following this initial operation, all bolts shall be tightened further by the application of the rotation specified in the following table:

33. Nut Rotation from Snug Tight Condition

	Disposition of Outer Face of Bolted Parts		
Bolt Length (underside of head to end of bolt)	Both faces normal to bolt axis	One face normal to bolt axis and other sloped not more than 1:20 (beveled washer not used)	Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used)
Up to and including 4 diameters	1/3 turn	½ turn	2/3 turn
Over 4 diameters but not exceeding 8 dia.	½ turn	2/3 turn	5/6 turn
Over 8 diameters but not exceeding 12 dia.	2/3 turn	5/6 turn	1 turn

<u>Table Notes</u>

i. Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For required nut rotations of ½ turn and less, the tolerance is plus or minus 30 deg; for required nut rotations of 2/3 turn and more, the tolerance is plus or minus 45 degrees.

ii. This table is only applicable to connections in which all materials within the grip of the bolt are steel.

iii. During the tightening operation, there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to the free edges.

2. Snug-Tightened Bolts. When indicated in the drawings snug-tightened bolts shall be installed with locking devices such as lock washers or locknuts. Snug tight is defined as the tightness that exists when all plies are in firm contact and can be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

F. Attachment to Existing Steel

1. Connections of new steel to existing shall be performed according to the drawings showing hole layout where existing steel must be drilled or punched to provide connections for new members.
2. All bolting of new steel to existing shall be made using high strength bolts (A 325 or A 490) unless otherwise indicated on the drawings.
3. Previously used high strength bolts shall not be reused but shall be replaced with new high strength bolts of the required size and length.

4. When shown on the drawings, connections of new steel to existing may be welded. All welding shall be performed in accordance with AWS Structural Welding Code - Steel D1.1.

G. Repair of Finish

1. After erection is complete, all protective coatings damaged during transportation and erection shall be touched in accordance with Specification 05130, "Painting of Structural Steel", or Specification 05140, "Hot Dip Galvanizing".

H. Inspection and Examination

1. All work is subject to inspection and examination by Owner for full compliance with all the requirements of this Specification and the design drawings.
2. Owner may retain the services of an independent inspection agency to perform inspections and examinations. Owner's testing agency will not be available for the erector Contractor's use.

34. SECTION 5130 PAINTING STEEL

1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for shop painting and field touch-up of fabricated steel.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall govern.

ASTM D16	Standard Terminology for Paint, Related Coatings, Materials, and Applications
NACE	Industrial Maintenance Painting
NPCA	Guide to U.S. Government Paint Specifications SSPC Steel

Structures Painting Manual

1.3 Submittals: Submit three copies of each requested item for review by the Owner.

A. Product Data: Provide data on all finishing products.

B. Samples: Submit 2 samples, ½ x 1½ inch in size illustrating selected color.

35. 2.0 Materials

2.1 Primer

Primer shall be Tnemec Typoxy Series 27WB or equivalent. Color shall be Gray (33GR), unless indicated otherwise on the drawings.

2.2 Top Coat

Top Coat shall be Tnemec Typoxy Series 27WB or equivalent Color shall be Gray (33GR), unless indicated otherwise on the drawings.

Coating system performance:

a) VOC: Un-thinned 11 grams per liter; thinned 25% 11 grams per liter HAPS 0 Lbs/gal per solids
b) Adhesion: Method ASTM D3359B Crosshatch Adhesion Requirement: No less than a rating of 5
c) Salt Spray (Fog): Method ASTM B117

2.3 Approved Manufacturer Information Tnemec Company Incorporated
P.O. Box 165770

North Kansas City,MO 64116 Phone: 1-800-TNEMEC-1

36. 3.0 Execution

3.1 Preparation

a) Bare Steel:
After fabrication, all steel shall be solvent cleaned of oil, grease, wax or other contaminants in accordance with SSPC SP-1. All welds shall be properly cleaned of slag and splatter removed. Surfaces to be painted shall be sandblast cleaned in accordance with SSPC SP-6 commercial blast.

b) Galvanized Steel:
All exterior surfaces shall receive a high-pressure wash – 3,000 psi at 3.5 gallons per minute minimum. Care should be taken not to damage or remove galvanizing. Rust should be removed from old galvanized steel by hand or power tool cleaning in accordance with SSPC-SP2 or SP3.

c) Field Retrofit of painted steel:
Remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of power-assisted hand tools in accordance with SSPC SP3 requirements.

3.2 Application of Coatings

a) Shop Application on Bare Steel: All coatings shall be applied in the shop in strict accordance with paint manufacturer's instructions.
Apply one coat of Tnemec Typoxy, Series 27WB at 5.0 to 7.0 mils dry film thickness. This is a self-priming product. Additional coats may be applied as required or specified in the drawings.

b) Shop Application on Galvanized Steel: Apply one coat of Tnemec Typoxy, Series 27WB at 5.0 mils (minimum) dry film thickness.
c) Field Retrofit of painted steel:
Spot prime bare steel areas with on coat of Tnemec Typoxy Series 27WB at 3.0 to 5.0 mils dry film thickness. Apply top coat of Tnemec Typoxy Series 27WB at 5.0 to 7.0 mils dry film thickness.

3.3 Repair of Damaged Coating
Areas damaged during handling, transport or erection shall be cleaned with wire brush and coated with two coats of paint. Field repair shall only be performed during dry weather

conditions with temperatures above 50 degrees and below 90 degrees or as allowed by paint manufacturer.

37. SECTION 5140 HOT DIP GALVANIZING

1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for hot dip galvanizing of fabricated structural steel and fasteners.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143	Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A384	Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
ASTM A385	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM A767	Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement
ASTM A780	Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

38. 2.0 Materials

2.1 Owner shall approve coating applicators.

2.2 Steel materials shall be geometrically and chemically suitable for galvanizing as described in ASTM A384 and A385. Steel materials suitable

for galvanizing include structural shapes, pipe, sheet, fabrications and assemblies. Recommended steel materials for hot dip galvanizing include:

W-Shapes	ASTM A992
Misc. Channels	ASTM A36, A572 Grade 50
Channels	ASTM A36, A572 Grade 50

Angles	ASTM A36, A572 Grade 50
Plates & Bars	ASTM A36, A572 Grade 50 or 65
Sheets (Rectangular and Round)	ASTM A1011 CS Type B HSS ASTM A500 Grade B Steel Pipe ASTM A53 Grade B

All steel shall have a silicon content between 0.0% - 0.04% or 0.15% - 0.25% only

Bolts	ASTM A325 Type 1
	A307 Grade A or B
Nuts	ASTM A563 Grade DH
	A563 Grade A
Washers	ASTM F436 Type 1

39. 3.0 Execution

3.1 Pre-clean steelwork to produce an acceptable surface for quality hot dip galvanizing.

3.2 Application of Coating:

A. Galvanize steel members, fabrications, and assemblies by the hot dip process in accordance with ASTM A123.

B. Galvanize bolts, nuts, washers, and steel hardware components in accordance with ASTM A153.

C. Safeguard products against steel embrittlement in conformance with ASTM A143.

D. Galvanize reinforcing steel in accordance with ASTM A767.

E. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and minimize distortion.

F. Long tubular steel structures, which require double dipping to galvanize, shall be galvanized using a process in which the fluxing is a complete separate operation from the zinc dip (dry process).

3.3 Coating Requirements:

A. Coating Weight: Conform to paragraph 5.1 of ASTM A123, Table 1 of ASTM A767, or Table 1 of ASTM A153, as appropriate.

B. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defects detrimental to the stated end use of the coated article.

C. Adhesion: Withstand normal handling consistent with nature and thickness of the coating and normal use of the article.

3.4 Testing:

A. Inspection and testing of hot dip galvanized coatings shall be done in accordance with ASTM A123, A767 or A153 as applicable to determine the thickness of the zinc coating on the metal surface.

3.5 Repair of Damaged Coating:

A. The maximum area to be repaired as defined in accordance with ASTM A123, Section 4.6, current edition.

B. Repair areas damaged during handling, transport or erection by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16 inch in width. Minimum thickness requirements for the repair are those described in ASTM A123, Section 4.6, current edition. Approved product is “Cold Galvanizing Compound” as manufactured by ZRC Corporation.

3.6 Delivery, Storage and Handling:

A. Store and protect products from damage to coating.

B. Load and store galvanized articles in accordance with acceptable industry standards.

6 Electrical

40. SECTION 6000 STATION EQUIPMENT

6.1.1 GENERAL

6.1.2 SCOPE

Except where material is specified to be supplied by the Owner, the Contractor shall furnish all material, labor, tools and equipment necessary to the station equipment as specified on the drawings and in the Owner’s Specifications.

6.1.3 CODES AND STANDARDS

Except as otherwise shown or specified, the Contractor shall comply with the provisions of the National Electrical Safety Codes, Owner and Industry specifications and standards, and the applicable codes, standards, and regulations set forth in M4-01-01 (Energy Storage Technical Documents) (the “BESS Spec”). The latest edition of the code or standard shall govern.

6.1.4 SUBMITTALS

The Contractor shall submit to Owner a manufacturer's specification and/or data sheet for all material the Contractor wishes to be considered as a substitute for what the Owner has specified. No substitutions are to be made without prior Owner approval.

6.1.5 MATERIALS

All materials furnished by Contractor shall comply with the specification and be approved by Owner. Non-metallic bollards shall be placed as appropriate around the perimeter of above-grade equipment (including the trenwa as needed), in particular in areas within or adjacent to driving lanes.

6.1.6 EXECUTION

6.1.7 COMMON REQUIREMENTS

Detailed information on type, rating and amount of equipment is shown on the drawings. At the time of installation, the Owner will furnish to Contractor one copy of manufacturers' drawings for assembling and installing major equipment.

Major equipment labeling shall be permanent and include type and location information.

Any equipment that is delivered to the site in crates shall be uncrated by Contractor. All equipment shall be completely assembled; including the installation of any accessories that may be shipped detached. All equipment shall be adjusted and lubricated in accordance with the manufacturers' instructions or as directed by Owner, so that all equipment is left in a satisfactory operating condition. Extreme care shall be exercised in handling porcelain or glass parts to avoid chipping or breakage.

Contractor shall perform all field drilling as required and attach any brackets, extensions or switch clip angles necessary for securely mounting the equipment. All field drilled holes shall be painted with ZRC (Zinc Rich Coating) as manufactured by Sealtube Owner of Wakefield, Massachusetts, or equivalent. Application shall be in accordance with the manufacturer's recommendations. Such field drilling and treatment shall not be a basis for additional compensation.

6.1.8 Power Transformers

The Contractor shall be responsible for assembling and preparation of the power transformer. Design, factory testing, assembly, field inspections, and field testing shall comply with the applicable specifications in M1-04-02 (General Transformer Specification).The power transformer shall be "Readied for Service" by Contractor under the supervision of the Owner's Representatives. Unless otherwise stated, the transformer shall be placed on the foundation with the centerlines of the tank installed directly above the centerlines of the foundation.

Assembling includes installing all bushings, arresters, radiators and auxiliary equipment. Contractor shall supply dry breathable air and purged through the transformer while work is being performed inside the transformer or any time any portion of the transformer is open. When all inside work has been completed, a pressure of 3 psi will be put on the transformer with dry breathable air to check for leaks. Unit must stand for 24 hours and maintain pressure. Some transformers come oil filled and ready for service.

The Owner will vacuum fill the transformer with oil if required.

6.1.9 Power Circuit Breakers

Contractor shall unload and place breakers in their final position on the foundation and install the bushings as required. The breaker shall be affixed to the foundation in the method specified on the drawings.

SF_6 type breakers shall be required in any instance where a circuit breaker is required and system voltage is equal to or above 69kV. For SF_6 type of breakers, the gas will be shipped in separate containers provided by the Owner. All gas containers, full, partially full, or empty are to be retained for proper inventory and returned to the Owner at the point of delivery. Contractor shall maintain a log of the amount of gas used for each piece of equipment, the gas container tracking number, equipment PGE number, date received, date used and date returned to Owner.

Contractor, please note that SF_6 gas is not toxic but care is advised.

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

The low-voltage compartment of the circuit breakers shall contain the control

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

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

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

6.1.10 AIR BREAK DISCONNECT SWITCHES

The substation shall include the use of motor-operated and manually-operated disconnect switches. Feeder switches which are located between a feeder and a bus on the generation-side of a power transformer shall be worm gear or swing handle in type. Switches which separate a generator-side substation bus and a power transformer shall be group-operated and worm gear in type. Disconnect switches on the line-side bus of the power transformer shall be group-operated, and a disconnect switch which separates the interconnection line from the substation shall also be motor-operated.

The three-pole group-operated switches, including ground blades, when

supplied, shall be mounted as indicated on the drawings, with manual and control mechanisms to provide for operation from the ground. The switch mechanisms shall be adjusted for proper operation in accordance with manufacturer's instruction data.

All switches shall be suitable for outdoor use and shall be non-load break type.

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.

6.1.11 CONTROL ENCLOSURE

The Contractor shall be responsible for assembling and preparation of the control Enclosure. The control house shall be placed on the foundation as recommended by the manufacturer.

The control enclosure shall be a new, prefabricated building. All electrical equipment shall be installed in the building prior to shipment.

The control enclosure shall be located within the fenced area of the project substation with a minimum of 20 feet of clearance on all sides.

The control enclosure shall be grounded and include HVAC.

The control enclosure shall contain a data concentrator and communications processor to collect project substation data signals for facility use.

The control enclosure shall include adequate space and clearance for all supplier-furnished SCADA system equipment.

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 enclosure.

Assembling includes installing all racks, external wiring, cable tray, and auxiliary equipment.

6.1.12 MetalClad Switchgear

The Contractor shall be responsible for assembling and preparation of the switchgear. The switchgear shall be placed on the foundation as recommended by the manufacturer.

Assembling includes installing all bushings, external wiring, bus connections, and auxiliary equipment.

6.1.13 Potential Transformers

Contractor shall install the potential transformers, including voltage transformers and capacitor coupled voltage transformers on the specified structure as indicated on drawings.

The secondary junction boxes shall be assembled by the Contractor and mounted as shown on the drawings.

6.1.14 Lightning Arresters

The Contractor shall install the lightning arresters on the structure provided and as shown on the drawings.

High-side voltage surge arrestors shall meet the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation. Surge arrestors shall be provided on the high-voltage bushings of the main step-up transformer.

34.5-kV surge arrestors shall meet the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation. Surge arrestors shall be provided at the 34.5-kV breakers.

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

6.1.15 Shunt Capacitors

The Contractor shall assemble and install the capacitor rack elevating structures, in accordance with the manufacturer's instructions and on the foundations indicated on the drawings. The capacitor racks and current limiting reactors, if required, shall be installed on the elevating structures by the Contractor and as shown on the drawings. The Contractor, if specified, shall also be required to install the individual capacitor unit fuses.

Capacitor banks shall be sized and incorporated into the protect electrical design as necessary to comply with project requirements, including the Interconnection Agreement and FERC Order 827. Sizing of each device shall comply with the

Contractor-prepared Reactive Compensation Study as specified in M1-04-01 (General Electrical Study Requirements).

6.1.16 JUNCTION BOXES AND CAPACITOR BANK CONTROL CABINETS

The Contractor is to assemble boxes, and cabinets, if assembly required, and mount them in the location on the structures as indicated on the drawings.

6.1.17 CURRENT TRANSFORMERS

The Contractor shall install the current transformers in the locations on the structures as indicated on the drawings. Contractor shall provide calculations to determine the possibility of AC saturation, DC saturation, and pregmanetization occurring at major equipment bushing current transformers and stand-alone current transformers.

6.1.18 REACTORS

Reactor banks shall be sized and incorporated into the protect electrical design as necessary to comply with project requirements, including the Interconnection Agreement and FERC Order 827. Sizing of each device shall comply with the Contractor-prepared Reactive Compensation Study as specified in M1-04-01 (General Electrical Study Requirements).

Reactors will be delivered with coils, insulators and foundation fittings packed separately. The Contractor is to assemble the units per the manufacturer's mounting instructions and install on the structure as shown on drawings.

6.1.19 METERS

A revenue meter shall be installed at the project substation. The revenue meter shall be high accuracy and shall comply with the requirements as defined in Owner specifications, the interconnection agreement, and power purchase agreements.

Meters shall be installed on each medium-voltage 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.

6.1.20 RELAYS

Protective relaying shall provide secure and selective isolation of equipment when necessary during faults, abnormal or hazardous operating conditions.

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.

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.

Protective relaying design and equipment selection shall be provided in accordance with applicable Requirements, including, but not limited to, the results of the Coordination study as defined in M1-04-01 (General Electrical Study Requirements), applicable standards and prudent electrical industry practices.

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

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

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

The local utility shall require review and confirm line protection and signal exchange requirements. Owner shall facilitate such reviews.

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

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.

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.

High-side lines shall include primary and backup relaying.

Main step-up transformer protection shall include primary and backup relaying and monitor for oil and winding temperature.

Observe IEEE 1050 for protective instrument grounding.

6.1.21 Incidental Work

The Contractor shall provide and install the phase letter plates, high voltage warning signs, and the switch and equipment number plates as shown on the construction drawings or as directed by the Owner's representative.

This work shall be considered incidental to the station equipment and the cost thereof shall be included in the contract prices for installation of station equipment.

6.1.22 Lightning Protection

Lightning protection shall be designed in accordance with IEEE 998.

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.

Steel masts for direct stroke protection shall be round tapered seamless extruded or spun aluminum tubes. (a) The overall height of the masts above grade shall be determined from the direct stroke protection study, as defined by requirements set forth in M1-04-01 (General Electrical Study Requirements. (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 applicable structural requirements. (h) Each mast shall be provided with two grounding pads located 12 inches above the foundation.

41. SECTION 6010 BUS, CONNECTORS, and SHIELD WIRES

6.1.23 GENERAL

6.1.24 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials (except supplied by Owner) required to install the tubular and wire bus, bus vibration damping, flexible steel shield wires, suspension and pedestal insulators, supports, fittings and connectors. Contractor shall also make connections to all equipment installed by Contractor.

6.1.25 CODES AND STANDARDS

Except as otherwise shown or specified, the Contractor shall comply with the provisions of the National Electrical Safety Codes, Owner and Industry specifications and standards, and the applicable codes, standards, and regulations set forth in the BESS Spec. The latest edition of the code or standard shall govern.

6.1.26 SUBMITTALS

The Contractor shall submit a manufacturer's specification and data sheet for all material the Contractor wishes to be considered as a substitute for what the Owner has specified. No substitutions are to be made without prior Owner approval.

6.1.27 MATERIALS

All material furnished by the Contractor shall comply with the specification and be approved by the Owner.

6.1.28 Execution

3.1 Bus Erection. The bus, connectors and supports furnished by the Contractor shall be of the type and manufacture as shown on the drawings.

Connectors shall be of the proper size and design to assure permanent, secure, and low-resistance connections.

3.2 Aluminum Bus.

Design of the bus systems shall be in accordance with IEEE 605, at a minimum.

Loading and seismic performance shall be in accordance with the Project design and Project Site location. Such information is subject to verification by Contractor.

Rigid bus, at a minimum, shall be seamless, Schedule 40 tube made of 6063-T6 aluminum alloy fabricated per ASTM B241.

External bus dampers shall be installed on all horizontal bus.

Bus shall have one-quarter inch (1/4”) drain holes in all bus/fittings that could possibly trap water.

Station post insulators shall be of sufficient strength to support the rigid bus and shall be ANSI 70 gray color.

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.

The Contractor shall unpack, clean, and check all aluminum bus immediately upon receipt from the carrier. Bus delivered by the carrier with unsatisfactory finish shall be rejected. The Contractor shall remove all materials which might damage the bus finish and shall store the bus in such a manner that the finish will be protected. The Contractor shall be responsible for maintaining the finish on bus accepted from the carrier. Defective bus finish discovered after initial unpacking and inspection shall be the responsibility of the Contractor. All costs associated with the cleaning of minor black marks, abrasions, and scratches shall be included in the Contractor's bid. Any stored or erected bus found to have unsatisfactory finish shall be refinished or replaced by the Contractor at the option of the Project Field Manager. All expense for such refinishing or replacement shall be borne by the Contractor.

All bus shall be carefully handled and erected to provide a complete bus system without dents, abrasions, discolorations, or other structural or surface damage. Any bus so damaged shall be replaced by the Contractor at his expense.

Prior to the installation of fittings for the bus, conductors for vibration dampening, as required by the drawings, shall be installed within all horizontal buses for the full length of each bus.

Filler wires or rods shall be of 4043 aluminum alloy and of the proper diameter to suit the various applications. Installation of dampening wire shall be as shown in the drawings.

3.3 Field Bends. All field bends of bus shall be made with a hydraulic type bender which is acceptable to the Project Inspector. Each bend shall be smooth and uniform and shall retain the original inside bus diameter.

Bend radii shall be as indicated on the drawings. Each bend in 2 inch bus shall have a center line radius of at least 9-1/2 inches. Each bend in bus larger than 2 inches shall have a center line radius of at least five times the inside diameter of the bus.

3.4 Alignment. All bus components shall be aligned and supported prior to and during the welding operation. Support and alignment shall be as required to provide a finished bus arrangement with center lines of adjacent sections coincident. Bus shall be aligned for welding in such a manner that the welded bus remains essentially straight after removal of erection supports.

During splicing operations, each piece of bus shall be supported at not less than three points in approximately equal spans of 12 feet or less.

3.5 Fittings. The joint components to be welded shall be fitted to allow for expansion and contraction during welding without loss of alignment. The joint design shall be in accordance with manufacturers' recommendations. Connections shall be positioned and located to prevent the retention of water or drainage from copper or copper alloys to aluminum surfaces. The Contractor shall locate bus splices in locations that will not impose a moment on the splice hence damaging the splice. The location of maximum bending moment usually exists at the midspan and at the bus support. The Contractor shall not locate a bus splice within a distance of 10 percent of the total span length from the bus midspan or from the bus support. Only one bus splice is allowed within one bus span.

Fittings shall be of the proper size and design to assure permanent, secure, and low-resistance connections.

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. Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

Fittings for shield wire dead ends, splices, and taps shall conform to the following:

- Shield wire dead-end fittings shall be compression type with bolted jumper connection. Shield wire insulators shall be located as indicated.
- Compression sleeves for shield wire tension splices shall be used which will develop at least ninety percent (90%) of shield wire strength.

3.6 Weep Holes. Weep holes shall be provided as required. Weep holes shall be ¼" cleaned and deburred, at a minimum, one weep hole will be located approximately mid span for all horizontal bus spans. Weep holes shall be circled with a black marker for easy verification.

3.7 Wire Bus Fittings. Wire bus fittings for aluminum conductors shall be compression type only. Wire bus fitting for copper conductors shall be clamp type with high-strength nonferrous bolts and spring washers supplied with the fittings. 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. Contractor shall leave all bolts thoroughly tightened. Compression connections shall be installed as shown on the drawings. Compression tools used shall be of the type and size that is recommended by the connector manufacturer or as approved by Owner. For all terminal connections involving the bolting together of an aluminum terminal connector with a bronze connector, all surfaces shall be thoroughly cleaned and an oxide-breaking, corrosion-inhibiting compound shall be applied to the contact surfaces before being bolted together. The Contractor shall leave all bolts thoroughly tight. 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. 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.

3.8 **Cable Jumpers.** Cable jumpers and vertical cable taps shall be installed as specified on the drawings and be of such length and form as to maintain maximum clearance from surrounding objects and to give assurance that such contour will be stable.

3.9 **Cleaning.** Immediately prior to welding, each surface to be joined by the weld shall be thoroughly cleaned. Greases, oils, waxes, etc., shall be removed by standard degreasing solutions as recommended by the manufacturer. Oxides shall be removed from the areas to be welded by vigorous scrubbing of the surfaces with stainless steel wire brushes.

3.10 **Welding.** Welding processes and methods shall be subject to code qualification and acceptance by the Engineer. Only the following welding methods will be permitted for joining bus sections and fittings:

- Gas metal arc welding.
- Gas tungsten arc welding.

Shielding gas for each process shall be welding grade argon when welding material is less than 3/4 inch thick. A combination of helium and argon shall be used for each process when the welding material is 3/4 inch thick and greater.

Welding energy and filler metal requirements shall be as recommended by AWS D10.7-86, "Recommended Practices for Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe." The following from AWS D10.7 shall apply:

3.11 **Welding Qualifications.** The Contractor shall prepare written welding procedure specifications. The procedure shall be qualified as defined below. Welding procedure specifications, procedure qualification reports, and welder qualification reports shall be submitted to the Owner and Engineer for review. Welding shall not begin until the Owner's and Engineer's review is complete.

All procedure qualification testing and welder qualification testing shall be in accordance with the methods defined in AWS D10.9-80, "Specification for Qualification of Welding Procedures and Welders for Piping and Tubing."

Testing shall be conducted to the requirements of AR-1 qualification level under the following conditions:

Materials	P-Number 23, aluminum base alloys
Weld	Groove
Position	6G

All qualification testing shall be performed by an acceptable independent testing laboratory. Report formats shall be similar to the examples in AWS D10.9-80 for the following:

Typical Welding Procedure Specification (WPS).

Typical Contractor's Procedure Qualification Test Record (PQR). Typical Contractor's Welder

Qualification Tests Record.

All costs for testing, including material costs, shall be paid by the Contractor.

Welders, after qualification, shall not be replaced on this welding duty unless such action is acceptable to the Project Field Manager.

3.12 **Handling of Bus.** The tubular bus, wire bus and bus fittings, including corona shields or grading rings, shall be handled in such a manner that insures no surface damage will occur. The outer surfaces of all installed conductors and fittings shall remain smooth and free from scratches, nicks, dents or any other surface damage. Methods of handling and transportation of all material will be subject to the approval of Owner.

3.13 **Repair of Damaged Bus & Fittings.** All damaged material, at the cost of the Contractor, shall be repaired or replaced to full satisfaction of Owner. Damage is considered to include all surface defects, which can be felt by the fingers as well as all visible defects. Minor damage to the tubular bus, the bus fittings and the corona shields or grading rings may be repaired by filing and smoothing out the damaged area with a fine emery cloth. Damaged areas will be considered restored when no surface defect can be felt on the damaged piece. Tubular bus that is severely damaged shall be repaired. The damaged portion shall be cut out and replaced with a coupling or as directed by Owner. At the cost of the Contractor, severely damaged fittings and corona or grading rings shall be replaced.

All tubular bus repaired and items replaced because of damage after delivery to the Contractor shall be the responsibility of the Contractor. All bus, repair couplings and other repair or replacement items are to be furnished by the Contractor.

3.14 Handling of Cable Conductor. The cable conductor shall be handled in such a manner that no surface or internal damage will occur. The outer surface of all installed conductor shall remain as smooth and free from scratches, nicks, dents or other surface damage as it does on reels at the time of delivery to the Contractor. Contractor shall reinforce the reels or if required, rewind on new reels to permit handling without damaging the conductor. Methods of handling and transportation of all material will be subject to the approval of Owner.

3.15 Installation of Insulators. The Contractor shall furnish insulators as specified on the Bill of Materials, unless otherwise specified. All suspension and pedestal type of insulators shall be located and installed as shown on the drawings. Any surplus material shall be properly identified, tagged and returned to the designated Owner storeroom.

3.16 Bus Supports. Bus supports of the type and size specified on the drawings or Bill of Materials list shall be supplied by the Contractor and installed as indicated on the drawings.

3.17 Connections. The Contractor shall make all cable and bus connections to the installed equipment as directed and as specified on the drawings. Any changes as to type of connector, bus or cable size and type, method of connecting, or any other deviations from what is specified on the drawings shall not be made without approval from the Owner.

3.18 Shield Wire. If required the Contractor will supply steel shield wire unless otherwise specified. The Contractor is to install the shield wire in the locations and as specified in the drawings.

42. SECTION 6040 CONTROL AND POWER CABLE

6.1.29 GENERAL

6.1.30 SCOPE

Insulated cable, conductors, and conductor accessories shall be furnished and installed in accordance with the requirements of this section of these specifications. Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation as indicated in the circuit lists, on the drawings, and in these specifications. 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.

All Project Substation control and instrument cables shall be shielded.

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

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

Cable reels shall be stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface to prevent contact between cable insulation and earth due to sinking of the reel.

Installation shall be defined to include placement, terminating conductors, coiling and taping of spare conductors, identification, testing, and verification of each circuit, cable, and conductor. Installation of cable in existing trays or cable trench shall also include removal and replacement of existing cable tray or cable trench covers.

Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location and insulating the entire connection where specified or required by the application.

6.1.31 CODES AND STANDARDS

Contractor shall comply with the appropriate provisions of the National Electric Safety Codes, PGE standard S-144-10, Industry specifications and standards except as otherwise specified or shown and the applicable codes, standards, and regulations set forth in the BESS Spec. The latest edition of the code or standard shall govern.

6.1.32 SUBMITTALS

The Contractor shall submit to PGE Substation Engineering, a manufacturer's specification and/or data sheet for all material the Contractor wishes to be considered as a substitute for what the Company has specified. No substitutions are to be made without Owner's approval.

6.1.33 MATERIALS

The cable furnished shall conform to the Cable Specification Sheet(s) included at the end of this section.

The term "Type" used in the circuit list, on the drawings, and in these specifications refers to the letter identification indicated on each Cable Specification Sheet.

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.

2.1 **Coaxial Cable.** Coaxial cable (when specified) used for connection between carrier cabinets and line tuning units shall be 52 ohm RG-8A/U coaxial cable. The cable shall have an 8 mil thick aluminum flat tape water block and an overall chlorinated polyethylene jacket. The cable shall be Belden Catalog No. 9251-A282-BV. This cable is a special run item.

2.2 **Color Coding.** The color code used for Type F, multiconductor, shielded or unshielded control cable shall be in accordance with Tables E-2 of ICEA S-73- 532 as indicated on the Specification and Data Sheet(s). All of the wiring diagrams being prepared by the Engineer are based on the color code specified on the

Specification and Data Sheet(s). The Tables E-2 color codes are as follows:

Conducto	**Method 1 Table E-2**
1	Black
2	Red
3	Blue
4	Orange
5	Yellow
6	Brown
7	Red-Black
8	Blue-Black
9	Orange-Black
10	Yellow-Black
11	Brown-Black
12	Black-Red
13	Blue-Red
Conducto	**Method 1 Table E-2**
14	Orange-Red
15	Yellow-Red

2.3 **Conductor Accessories.** All conductor accessories including connectors, terminations, insulating materials, support grips, markers, and cable ties shall be furnished and installed by Contractor.

Supplier's installation instructions shall be provided by Contractor for cable accessories. These instructions shall be in the possession of the craftsmen while installing the accessories and shall be available to the Project Field Manager for reference.

2.4 **Terminal Connectors for Conductors 8 AWG and Larger.** Terminal connectors for conductors 8 AWG and larger shall be pressure or bolted clamp type, Burndy Qiklug, Varilug, or acceptable equal; or compression type, Burndy Type YAV or YA (long barrel), Panduit Type LCA or LCC, or acceptable equal. Acceptable connectors included with Owner-furnished equipment may be used.

2.5 **Terminal Connectors for Conductors Smaller than 8 AWG.** Terminal connectors for conductors smaller than 8 AWG shall be compression type connectors properly sized for the conductor and the terminal. The connectors shall be constructed of fine grade high conductivity copper in accordance with QQ-C-576 and shall be tin plated in accordance with MIL-T-I0727. The interior surface of the connector wire barrel shall be serrated, and the exterior surface of the connector wire barrel shall be provided with crimp guides.

Noninsulated terminal connectors shall be provided on conductors terminated on devices equipped with individual fitted covers, such as General Electric Type SB-I control switches and General Electric Type HEA lockout relays. Non-insulated ring type terminal connectors shall be used on all current and potential transformer circuits. All other terminal connectors for conductors smaller than 8 AWG shall be non-insulated ring type or preinsulated spade type.

Ring type connectors shall be manufactured by AMP, 3M, Panduit, or acceptable equal. Spade type connectors shall be AMP slotted spring spade, 3M Scotchlok Series 6I snap spade, or Panduit locking fork terminal connectors.

2.6 **Crimping Tools.** Use only ratchet type crimping tools a for all lugs and splices. Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the conductor sizes involved. The crimping tools shall accurately crimp the connector barrel and shall accurately crimp the conductor insulation support sleeve where provided. Crimping tools shall be provided with guides to position connectors in the tool, shall be provided with stops to prevent overcrimping, and shall be of a type which prevents the tools from opening until the crimp action is completed. Crimping tools shall be a product of the connector manufacturer or shall be as recommended by the connector manufacturer and acceptable to the Engineer for use with the connectors.

The Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.

2.7 **600 Volt Cable Insulating Materials**. Insulating materials for terminal connectors or compression type connectors shall consist of varnished cambric tape, rubber tape, and vinyl tape. Taping materials shall be as listed below or acceptable equal:

- Varnished Cambric Tape--3M Company Irvington 2520.
- Rubber Tape--3M Company Scotch 130C.
- Vinyl Tape--3M Company Scotch 33+.

2.8 **Support Grips.** Cable support grips shall be either split or closed woven wire type as manufactured by The Kellems Division, Harvey Hubbell Incorporated, Stonington, Connecticut.

2.9 **Wire and Cable Markers.** Markers for wire and cable circuits shall be of an opaque nylon material arranged to include a marker board, nonreleasing holding device, and cable fastening tail. The marker board shall not be less than 3/4 inch wide, 2-1/2 inches long, and 15 mils thick and shall be Panduit Corp. Part No. MP250 marker plates or acceptable equal. One side shall be roughened to hold black nylon marking ink from a fine tip pen similar to Thomas & Betts Company "TY-RAP" marking pen, Catalog No. WTI63M-I, or Panduit Corp. Part No. PFX-0 marking pen. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device and prevent the removal of the tail without cutting it loose from the marker.

2.10 **Cable Ties.** Lacing materials for field installed cable shall be nonreleasing weather-resistant black nylon ties manufactured by Thomas & Betts Company, Elizabeth, New Jersey; Panduit Corp., Tinley Park, Illinois; 3M Company; or acceptable equal.

2.11 **Cable Shield Bonding Connectors.** Cable shield bonding connectors for use with shielded power, control, and instrumentation cable shall be Scotchlock 4460, manufactured by the 3M Company; Nicopress Shield Connector B-2974, manufactured by National Telephone Supply Company; Surgegard Shield Bond Connector, manufactured by Brand-Rex Company; or acceptable equal.

Cable shield bonding connectors shall be installed on one end of each shielded power, control, and instrumentation cable listed in the circuit lists.

Concentric neutral of all 15 KV-34 KV power cable, all concentric neutral will be long enough to reach the station ground grid/bus without being spliced

3.1 Execution

Conductor installation shall be in accordance with the cable manufacturer's recommendations and the articles which follow.

3.2 **Cable Placement.** All cable described in the circuit lists shall be routed as indicated therein. Routing of other cable shall be as indicated on the drawings. Cable shall not be handled when the cable temperature is below the minimum temperature recommended by the manufacturer. If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for at least 24 hours.

Cable shall be placed the same day it is removed from heated storage.

If at any time during the progress of the work the Contractor finds raceways which appear inadequate to accommodate the assigned cable, he shall notify the Project Field Manager at once and shall discontinue any further work on the questionable raceway until advised by the Project Field Manager as to how he shall proceed.

Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cable assigned to a particular duct or conduit shall be grouped and pulled in simultaneously using cable grips and acceptable lubricants.

All cable shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein shall be removed and replaced by and at the expense of the Contractor. Cable removed from one conduit or duct shall not be pulled into another conduit or duct.

3.3 **Cable in Trays**. All cable shall be carefully laid in or pulled through the tray system so that neither the cable nor the trays are damaged. Cable may be laid along the side of the tray system during placement provided it is protected from dirt, water, oil, or other detrimental materials and from mechanical injury. Cable shall be cut sufficiently long to conform to the contour of the trays, with particular attention paid to vertical inside bends. All excessive slack shall be removed from the cable so that it lies parallel to the sides of the trays. Multiple single conductor cable which constitutes a single power circuit shall be grouped together to minimize magnetic influence on other cable in the area.

The cable shall be tied to the trays with nylon ties at l0 foot intervals to hold it in place. Cable clamps designed for holding the cable inside the trays shall be installed at all vertical bends.

3.4 **Cable in Vaults**. Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor. Cable ends must not be submerged. Cable racks or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Project Field Manager.

3.5 **Cable Pulling**. Fishing and pulling shall be done with flexible round metal tape, CO_2 propelled polyethylene cord, nylon rope, or manila rope.

Unless specified otherwise or acceptable to the Project Field Manager, cable shall not be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box. Cable shall be pulled out at each manhole and pull box to the length required for termination. Prior to re- pulling of the pulled out cable, the cable shall be thoroughly inspected, cleaned, and relubricated. Damaged cable shall be removed and replaced by and at the expense of the Contractor.

Cable may be pulled in a single pull through two sections of Engineer- designed raceway connected by a manhole or pull box only if it can be determined by calculation to the satisfaction of the Project Field Manager, that the pulling tension will not exceed the maximum tension allowed by the cable manufacturer.

3.6 **Cable Grips**. Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable 2/0 AWG and larger, where pulling eyes are not available, and all multi-conductor cable. Pulling loops shall be used to pull single conductor cable smaller than 2/0 AWG. All sharp points and edges on the hardware attaching the pulling rope to the cable shall be taped to prevent snagging or damaging the raceway. When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 6 inches shall be cut off and discarded when the pull is completed. When pulling loops are used, the entire loop shall be cut off and discarded when the pull is completed.

As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed and any cable which was sealed shall be resealed.

3.7 **Swivels**. A reliable nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.

3.8 **Feeding Tubes**. A 4 inch or larger flexible feeding tube, with a removable nozzle sized to fit the ducts, shall be used in pulling all underground cable. The feeding tube shall be long enough to extend from the duct entrance to the outside of the manhole and shall be so arranged that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface. The bending radius of the tube shall not be less than the minimum bending radius of the cable specified in this section under the article titled Cable Bends.

3.9 **Pulling Lubricants**. Only lubricants recommended by the cable manufacturer and acceptable to the Project Field Manager shall be used. Lubricants shall be applied liberally and continuously during the pull.

3.10 **Inspection**. The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

3.11 **Pulling Tension**. The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.

3.12 **Sidewall Pressure**. To avoid insulation damage from excessive sidewall pressure at bends, the pulling tension in pounds at a bend shall not exceed 300 times the radius of the bend in feet.

3.13 **Cable Bends**. Tape shielded, flat tape armored, and wire armored cable shall not be bent to a radius of less than 12 times the overall cable diameter. Nonshielded conductors shall not be bent to a radius of less than eight times the cable diameter.

3.14 **Supports**. All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation. Adequate cable end lengths shall be provided and properly placed in junction boxes and manholes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings and duct end bells.

Final inspection shall be made after all cable is in place and, where supports or raceway fittings deform the cable jacket, additional supports shall be provided as directed by the Project Field Manager. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar material shall be provided where required.

Cable in vertical runs shall be supported by woven wire grips in accordance with the NEC requirements, except that the distance between supports shall conform to the following:

Conductor Size	Vertical Cable Support Spacing	
	Aluminum Conductor	Copper Conductor
1/0 AWG and smaller	100 feet	100 feet
2/0 AWG thru 500 Mcm	120 feet	50 feet
Larger than 500 Mcm	85 feet	35 feet

3.15 **Cable Racks**. Where cable trays are not specified in man-holes, cable racks shall be furnished and installed according to the drawings and as required to provide the proper cable support. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolt secured to permanent wall surfaces with self-drilling anchors or continuous slot concrete inserts.

3.16 **Spare Conductors.** All spare conductors of a multi-conductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable. Each spare conductor shall be neatly coiled and then taped to the conductors being used.

3.17 **Lacing**. Nylon ties shall be used to neatly lace together conductors entering switchboards and similar locations after the conductors have emerged from their supporting raceway and before they are attached to terminals.

3.18 **Cable Identification**. The Contractor shall identify the ends of all circuits listed in the circuit lists. Use PGE standard S-144-10 and its addendum.
Each marker shall bear the number of the circuit according to the circuit lists and drawings.

At terminations, the Contractor shall identify each conductor of power circuits, each multi-conductor cable, and each conductor of circuits consisting of multiple single conductors where the conductors are not otherwise identified. Markers shall be attached where the first individual conductor is routed away from the assembly. Each phase of multiphase power circuits shall be individually identified.

One end of each marker board shall remain free of the fastening tail, and the entire marker shall be so attached that it is readily visible for circuit identification.

3.19 **Moisture Seals**. Each cable with an aluminum conductor shall be kept sealed except when termination and splicing work is being performed.
The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable OD and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive water-tight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture. Heat shrinkable caps shall be "Thermofit" as manufactured by Raychem Corporation or acceptable equal.

Before and after pulling, the leading end seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

3.20 **Splices.** No splices shall be made in conductors for instrument circuits or control circuits. Shields may be spliced where necessary to permit connection to the station ground.
Power cable circuits may be spliced only by methods and at locations acceptable to the Project Field Manager.

3.21 **Terminations.** Cable shall be terminated in accordance with the following requirements:
Train cable in place and cut squarely to required length. Avoid sharp bends.

Remove necessary amount of cable jacket and insulation without damage to the conductor.

Install terminals or terminal connectors as required, ensuring a firm metal-to- metal contact.

Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors.

3.22 **Insulation of 600 Volt Cable Connections**. Where connections of cable rated 600 volts or less require insulation, all exposed conductor and connector surfaces shall be covered with tape in accordance with the following:
One half-lapped layer of varnished cambric tape.

A minimum of three half-lapped layers of rubber tape, elongated not more than 20 percent, applied over the varnished cambric tape.

A minimum of three half-lapped layers of vinyl tape applied over the rubber tape. The vinyl tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the insulation of the conductor to which the cable is connected.

6.1.34 TESTS AFTER PLACEMENT

All insulated conductors shall be electrically tested after placement.

All circuits, including lighting circuits, shall be tested with the circuit complete except for connections to equipment. All splices, stress cones on shielded cable, and terminal connector attachments shall be complete prior to testing.

In addition to the tests performed after cable placement is complete, continuity tests and insulation tests shall be performed on all supervisory and communication cable before and after each splice is made.

Any circuit failing to test satisfactorily shall be replaced or repaired and then retested.

All equipment and labor required for testing shall be furnished by the Contractor.

4.1 Continuity and Identification Tests. All insulated conductors shall be tested for continuity and conductor identification.

- **Continuity tests**. Continuity tests shall include all tests necessary to confirm that each conductor is continuous throughout its entire length.
- **Identification tests**. Identification tests shall include all tests necessary to confirm that the conductor being investigated originates and terminates at the locations designated in the circuit lists or indicated on the drawings.
- Contractor shall supply Owner with yellow-lined schematic and wiring diagrams verify circuit testing and verification.

4.2 Insulation Tests. Resistance from ground provided by the insulation on all field installed insulated conductors shall be measured.

- **Cable rated 600 volts and below**. All insulated conductors except supervisory and communication cable, rated 600 volts and below shall be tested with a 1000 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be approximately 100 megohms.
- **Supervisory and communication cable**. All insulated conductors of supervisory and communication cable shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and the cable shielding tape and between the two conductors in each pair. Minimum acceptable resistance values shall be 2 megohms.

6.1.35 FIBER-OPTIC DUCT CABLE

Fiber-optic duct cable (FODC) and accessories shall be furnished in accordance with the requirements of this section of these specifications. FODC cable and accessories shall be furnished in quantities sufficient for a complete installation as indicated in these specifications.

Contractor will provide the fiber optic cable per the cable schedule and lists of materials. Fiber requirements for the communications rack will be provided by PGE. DTS fiber that will be pulled with the 34.5kV power cable will be supplied by PGE.

Cable reels shall be stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface to prevent contact between cable insulation and earth due to sinking of the reel. Impact damage between reels shall be prevented by aligning reels flange to flange or by using guards across flanges.

Cable ends, whether exposed or concealed, shall be sealed to prevent moisture penetration. Cap sizes shall be as recommended by the cap manufacturer for the cable. Caps shall contain sufficient adhesive so that the cap provides a watertight seal capable of withstanding complete immersion or totally exposed storage over a period of several months without permitting the entrance of moisture.

5.1 **Attenuation Measurements.** Attenuation measurements shall be performed on all fibers of each reel of FODC at both 1310 nm and 1550 nm. An optical time domain reflectometer (OTDR) shall be used for all attenuation measurements. The measurements shall be made from both directions and the results shall be averaged. The optical loss measured at any stage of manufacturing shall not exceed the allowable attenuation as specified in the Cable Specification Sheet included at the end of this section. The attenuation specified is the maximum allowable attenuation for each reel of FODC, not the average attenuation of all reels for each path. Contractor shall provide fiber link loss calculations which verifies that each individual fiber segment's attenuation as determined by attenuation per splice, connector, and fiber length does not exceed maximum attenuation requirements as defined by Owner. Contractor shall be responsible for designing and installing fiber such that it does not exceed the maximum attenuation as determined by fiber link loss calculations.

5.2 **Innerduct.** All fiber shall be installed in innerduct. Innerducts shall be high density polyvinylchloride corrugated induct as manufactured by Phillips Drisco Pipe, Carton, Endot or Dura-Line. The innerduct shall be 1 inch or 1- 1/4 inch inside diameter, or as indicated on the drawings, and shall contain 1/4 inch polyproplene stranded rope for use in pulling the cable or other pulling line. Interduct shall be orange and labeled "Fiber-Optic" at 10 feet intervals.

43. SECTION 6050 PRE-CAST CABLE TRENCH & VAULTS

6.1.36 GENERAL

6.1.37 SCOPE

The work covered by this specification includes furnishing of all labor, equipment and materials required for the purchase and installation of pre- cast cable trenches and vault, and fiberglass covers as shown on the drawings and specified herein.

6.1.38 MATERIALS

2.1 Contractor Supplied Materials

A. Contractor shall furnish a trench and vault system consisting of precast concrete support brackets, sidewalls and removable fiberglass covers to form a completely enclosed trench, except with an open earth bottom.

B. The manufacturers shall be specified on the drawings or bill of material.

C. The trench system (with the exception of the road rated trench sections) shall be designed to support at least 200-psf live load.

D. Road rated trench sections and vaults identified on the drawings shall be designed to carry HS-20 (32,000#) axle loading. The clear interior cross section shall be the same as the connecting trench.

E. Typical trench width, depth and cross sections are shown on the drawings.

F. Typical vault width, depth and cross sections are shown on the drawings.

G. Backfill used for trench installation shall be road rock as specified in Road

Finish Rock section, unless noted otherwise.

H. Contractor shall supply sand for cable bedding.

I. Concrete materials used in fabrication of the trench components shall be in accordance with ACI 318. Reinforcing shall be in accordance with ASTM 615 grade 60. Miscellaneous steel, bars, and plate shall be in accordance with ASTM A36.

J. Concrete mixing and placement shall be in accordance with ACI 304. Concrete strength shall be designed for durability, have a minimum compressive strength of 4,000 psi and contain 6% (plus or minus 1%) entrained air.

K. Reinforcement will be sized and located by the manufacturer. Placement shall be in accordance with ACI 315 and ACI 318.

L. Precast concrete sections shall be inspected when delivered to the site. Cracked or otherwise visibly defective units shall be rejected and removed from the site.

6.1.39 EXECUTION

Precast concrete sections shall be lifted by suitable lifting devices at points provided by the precast supplier and installed in accordance with the precast supplier's recommendations. Joints between precast sections shall be sealed with a rubber gasket.

Where masonry is required to close the conduit openings in the precast sections, mortar shall be used within 40 minutes after mixing. Mortar that begins to set shall be discarded. Outside surfaces of brick and block masonry shall be plastered with mortar.

Contractor shall install the trench system and vaults at a depth ensure that all conduits and trench interfacing with the vault are at the appropriate depth.

The fiberglass lid shall be easily removed and replaced

6.1.40 TRENCH SYSTEM

Contractor shall install the trench components and covers in accordance with the manufactures instructions and drawings.

Contractor shall install a 4" deep layer of loose bedding of sand the entire length of the trench including road crossings.

After cables have been laid all road crossing and pedestrian covers shall be in place.

All trench road crossings within the station must remain open to traffic. Removal of covers is allowed but they must be returned at the end of each workday unless provision is made for an alternate route or temporary road plates are used.

Throughout construction all open trenches shall be marked with non- conductive safety tape when not actively worked.

Two bare copper ground conductors, equal in size to the ground grid conductors, shall be routed with each trench route as indicated on the drawings. The trench ground conductors shall be connected to the substation ground grid.

6.1.41 VAULTS

Contractor shall install the vault components and covers in accordance with the manufacturer's instructions and drawings.

44. SECTION 6060 CONDUITS AND DUCT BANKS

6.1.42 GENERAL

6.1.43 SCOPE

The work covered by this specification includes the furnishing of all labor, tools, and equipment necessary to install the control/power cable conduit system in the substation / switchyard as shown on the drawings and as specified herein.

6.1.44 CODES AND STANDARDS

Except as otherwise shown or specified, the Contractor shall comply with the provisions of the National Electrical Safety Codes, Owner and Industry specifications and standards, and the applicable codes, standards, and regulations set forth in the BESS Spec. The latest edition of the code or standard shall govern.

AISC's "Manual of Steel Construction"

ANSI C62.11

NESC Section 32: Underground Conduit Systems

IEEE Standard 525 - IEEE guide for the Design and Installation of Cable Systems in Substations

IEEE Standard 693 - Recommended Practice for Seismic Design of Substations

IEEE Standard 835 - Standard Power Cable Ampacity Tables

National Electric Code

NEMA Standard Publication #OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA Standard Publication #OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

6.1.45 MATERIALS

Electrical conduit and associated materials shall conform with the requirements of the articles which follow.

2.1 **Rigid Aluminum Conduit**. Aluminum conduit and couplings shall be rigid type conforming to ANSI C80.5 and shall bear the Underwriters' Laboratories label.

2.2 **Rigid Steel Conduit**. Steel conduit, couplings, and elbows shall be hot-dip galvanized rigid mild steel in accordance with ANSI C80.I and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent organic polymer topcoat. The transparent organic polymer topcoat shall be chromate free. Rigid steel conduit shall be as manufactured by Triangle PWC, Incorporated or acceptable equal.

2.3 **Plastic Conduit**. Plastic conduit shall be Schedule 40, high impact, polyvinyl chloride and shall be used with plastic conduit fittings. Each length of conduit shall be furnished with one standard coupling. Joints shall be made with solvent cement. All additional conduit couplings, factory bends, plastic-to- steel conduit adapters, solvent cement, and special fittings for the complete conduit system shall be included. Couplings shall have a center stop to ensure proper seating.
All 6 inch and larger PVC elbows shall have a radius of 36" (thirty-six inches); with 5 inch and smaller PVC elbows adhering to recognized standards and procedures. All PVC conduit joints shall be solvent welded in accordance with the recommendation of the cement manufacturer.

All 6" PVC elbows into switchgear shall be backfilled with slurry backfill to prevent conduit from coming loose when power cables are pulled in.

2.4 **Couplings and Thread Protectors**. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.

2.5 **Flexible Conduit**. All flexible conduit shall be plastic jacketed, liquidtight, galvanized steel, Sealtite Type EF for general service areas or Type HC for high temperature locations. Owner approval is required prior to the installation of each flexible conduit.

2.6 **Metal Conduit Fittings**. All metal conduit fittings shall conform to the requirements of ANSI/NEMA FB1 and UL 5l4 where these standards apply. Galvanized iron or galvanized steel fittings shall be used with steel conduit. All fittings for aluminum conduit shall be copper free aluminum or aluminum alloy.

2.7 **Flexible Conduit Fittings**. All flexible conduit fittings shall be liquidtight, galvanized steel, Appleton Type STN, STB, or acceptable equal, and shall bear the UL label.

2.8 **Special Fittings**. Conduit sealing, explosion proof, dustproof, and other types of special fittings shall be provided as required by the drawings and these specifications, and shall be consistent with the area and equipment with which they are associated. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction.

2.9 **Bushings**. Insulated bushings with insulating inserts in metal housings shall be provided for the termination of all conduit not terminated in hubs and couplings. Grounding type insulated bushings shall be provided for all conduit containing power circuits. Standard bushings shall be galvanized.

2.10 **Locknuts**. One interior and one exterior locknut shall be provided for all conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

2.11 **Unions**. Conduit unions shall be acceptable to the Project Field Manager. Watertight conduit unions shall be Crouse-Hinds Type UNF or acceptable equal.

2.12 **Raintight Conduit Hubs**. Raintight conduit terminating hubs, where indicated on the drawings or required by these specifications, shall be Efcor "Water-Tite" rigid conduit hubs or acceptable equal. Malleable iron hubs shall be used for steel conduit.

6.1.46 EXECUTION

Conduit installation shall be as indicated on the drawings and as described in these specifications.

3.1 **Routing**. Except as otherwise specified or indicated on the drawings, all conduit shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members. To the extent that it is possible, conduit shall not be unnecessarily routed under equipment foundations.
All conduit field routing shall be acceptable to the Project Field Manager. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

3.2 **Moisture Pockets**. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

3.3 **Couplings and Unions**. Metal conduit shall be joined by threaded conduit couplings with the conduit ends butted. The use of running threads will not be permitted.
Where metal conduit cannot be joined by standard threaded couplings, conduit unions or split couplings may be used if their location is acceptable to the Project Field Manager. Only ground seat type watertight unions shall be used outdoors or where the union may be submerged.

Where couplings or unions which do not have ground seats are used in vertical or inclined conduit runs, the coupling nut shall be installed uppermost to prevent the entrance of water into the union.

3.4 **Bends and Offsets**. A run of conduit shall not contain more than the equivalent of four quarter bends, including those immediately at outlets or fittings. Bends in conduit shall be made without reducing the internal diameter of the conduit. The use of a pipe tee or vise for bending conduit will not be permitted. The inside radius of conduit bends shall be not less than six times the inside diameter of the conduit. Conduits deformed or crushed in any way shall be removed from the jobsite.

3.5 **Cutting and Threading**. The plane of all conduit ends shall be square with the center line. Where threads are required, they shall be cut and cleaned prior to conduit reaming. The ends of all conduit shall be reamed to remove all rough edges and burrs.

A cutting oil shall be used in threading operations. The dies shall be kept sharp and provisions shall be made for chip clearance.

All steel conduit, after threading, shall be regalvanized with "Galvanizing Powder M-32l" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; with "Zincilate 8l0" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; with "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or acceptable equal. The Contractor shall supply this protective material and shall apply it in the field.

3.6 **Connections to Boxes and Cabinets**. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box.
All conduit entering enclosures outdoors or in wet areas shall enter through watertight hubs or threaded openings.

3.7 **Cleaning**. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Project Field Manager, the conduit shall be replaced.

3.8 **Flexible Conduit**. Flexible conduit inserts not greater than 30 inches in length shall be installed at the locations specified in this article. To the extent that it is possible, conduit shall not be unnecessarily routed under equipment foundations.

Flexible conduit inserts shall be installed in all conduit runs which are supported by both building steel and by structures subject to vibration or thermal expansion.

Flexible conduit shall be installed in conduit runs which cross expansion joints or which connect to building supported independent structures.

Flexible conduit inserts should be considered in all long conduit runs where differential expansion problems may be expected.

3.9 **Plastic Conduit**. Except as specified in the following paragraphs, polyvinyl chloride conduit shall be installed in accordance with the installation requirements previously specified for metallic conduit. Expansion joints for exposed conduit or buried conduit which will be exposed to temperature variations shall be provided as recommended by the manufacturer.
Joints shall be unthreaded solvent cement type as recommended by the conduit manufacturer. The contact surfaces of the conduit and fitting socket shall be cleaned with Stoddard solvent, methyl ethyl ketone, or acetone, liberally coated with solvent cement, promptly and fully engaged, and either conduit or fitting rotated approximately l/4 turn to dispel air and evenly distribute solvent cement over contact surfaces. For proper connection, total elapsed time between the start of the cement application to the surfaces being joined and final assembly of the joint should not exceed 60 seconds. The initial strength of the joint will permit

continuous conduit installation; however, additional stress at the joint shall be avoided for at least 24 hours after joining.

Bends shall be made from straight conduit lengths or shall be factory fabricated. Bend radii shall be in accordance with NEC.

The conduit length for field bending shall be heated to approximately 275 F by radiant heat, hot air, or hot liquid immersion. Open flame heating will not be permitted. Special mandrels or forms shall be used to provide a smooth bend without reduction of the conduit diameter. Conduit discolored by prolonged heating will not be acceptable.

Where plastic conduit is required to be buried directly in the earth as indicated on the drawings, the conduit shall be bedded in a graded 3 inch deep soft bedding of sand or finely divided job excavated material free from debris, organic material, and stones. Backfill, to approximately 6 inches above the conduit, shall be the same as bedding material.

All polyvinyl chloride conduit, including factory bends and sweeps, shall be schedule 40 in accordance with NEMA TC-2.

3.10 Below Grade Steel Conduit. Steel conduit shall not be direct buried in the earth. Below grade steel conduit shall be encased with not less than 3 inches of concrete. Concrete used for conduit encasement shall contain not less than 500 pounds of cement per cubic yard. It shall contain clean and well graded aggregates and low water content. The slump shall be such that the mixture is stiff and will stand erect when placed. The concrete shall be vibrated to consolidate it around the steel and shall be slow cured for several days to provide strength and prevent shrinkage. Conduit shall be supported for encasement by steel wire hangers attached to temporary supports laid across the conduit trench. After the concrete encasement has hardened, the supports and those parts of the wire hangers not encased in concrete shall be removed.
A minimum separation of 3 inches shall be maintained between multiple conduits enclosed in the same concrete encasement but not assembled as a duct bank.

Concrete used for encasing steel conduit shall contain no additives which contain chlorides. The concrete shall be mixed with pure, clean potable water.

The Contractor shall field route conduit according to the general routing indicated on the drawings and shall coordinate conduit locations with other work. Conduit shall be accurately positioned and securely anchored before the concrete is poured to encase it.

Conduit which will be visible above the finished floor shall be straight and plumb.

Conduit which is stubbed up shall be plugged prior to pouring of concrete and shall remain plugged until the conduit is extended later.

3.11 Spacing and Attachment of Supports. Except where buried in concrete, all conduit runs shall be rigidly supported. Each conduit shall be supported within one foot of junction boxes and fittings. Support spacing along conduit runs shall be as follows:

Conduit Size	Maximum Distance Between Supports
1/2 inch through 1-1/4 inch	5 feet
1-1/2 inch and larger	10 feet

Conduit clamps shall be bolted to building steel using drilled and tapped screw holes. Support channels for three or more conduits shall be welded to building steel or bolted using drilled and tapped screw holes.

3.12 Conduit Fill
Conduit fill shall not exceed guidelines as provided in the National Electric Code. Conduit fill calculations shall consider all cables and conductors in a given conduit.

3.13 **Inspection:** All conduit work, including all associated trenching and backfill, shall be subject to inspection. This inspection or the waiver of inspection by Company shall not relieve the Contractor from his responsibility for use, supply, and installation of materials, workmanship, and all other liabilities specified under the contract.

6.1.47 Underground Duct Bank Construction

Duct banks consisting of individually assembled plastic duct, arranged as indicated on the drawings, shall be furnished and installed in accordance with the following specification. The duct banks shall be concrete encased, direct buried with a protective concrete cap, or direct buried as indicated on the drawings.

6.1.48 Material

Underground duct system materials furnished under these specifications shall be new and undamaged and shall conform to the following requirements:

Duct	Polyvinyl chloride, Type DB in accordance with NEMA TC-6 for concrete encased duct, Schedule 40 Type TC-2 for direct buried duct.
Couplings	Plastic, for use with duct previously specified and "Duct-to-steel" adapters as required, including joint cement.
Spacers	Plastic high impact, interlocking, base and intermediate type.

Factory bends	PVC, for long radius sweeps. Rigid and sweep galvanized steel (concrete encased) 90 degree bends with 36-inch minimum radius.
End bells	Plastic.
Plugs	Plastic, high impact, tapered to fit end bell provided.
Duct binder	Hemp or sisal twine.
Riser termination	Rigid hot-dip galvanized mild couplings steel.
Riser bends	Rigid steel conduit elbows, factory or field made, 36-inch 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.
Duct terminators	Formax type with 3-inch separation as indicated on the drawings.
Manhole materials	Shall be as specified and indicated on the drawings.

6.1.49 DUCT BANK INSTALLATION

Each duct bank shall be laid to exact grade in the trench and the ends shall enter manholes, switchgear, or buildings as indicated on the drawings. No dips or low points which retain water in any duct will be permitted in ducts between manholes or between buildings or switchgear and manholes. End bells shall be used on individual ducts at the end of duct banks entering manholes or buildings except where another type of termination is specified or detailed on the drawings. All field bends and sweeps shall be fabricated with straight sections of duct, bent to provide the radius indicated on the drawings.

The ends of the individual ducts shall be cleaned and swabbed with joint sealing compound, and the duct shall then be forced tightly into the coupling to make a watertight connection. The individual ducts shall be laid in place, held by standard spacers placed at 5 foot intervals, and bound with hemp or sisal twine. The ends of the ducts in each of the upper layers shall be stepped back approximately 2 feet from the end of the layer immediately below it. The concrete envelope (when indicated on the drawings) shall be poured after the individual ducts are securely tied in place and adequately anchored and/or weighted to completely counteract the buoyancy of the ducts in the fluid concrete. Care shall be taken in pouring the concrete to prevent the empty ducts from being damaged or displaced, either in grade or alignment.

Defective ducts shall not be installed and shall be removed immediately from the site of the work. Particular care shall be taken to keep concrete or other substances from the inside of the individual ducts during construction. All reinforcing materials and other magnetic materials installed in a duct bank shall be parallel to the lengths of the individual ducts, except for ties enclosing all ducts of the duct bank.

In cases where the conduit passes above or below an underground obstruction such as a utility line, a minimum clearance of 12 inches shall be maintained from the conduit to the utility. A minimum of 12 inches of clearance shall be maintained between the concrete encasement and a paralleling utility.

Two cable marking ribbons shall be installed by the Contractor. The cable marking ribbons shall be installed above the concrete encased conduit, the concrete protective cap, or the direct buried ducts. The ribbons shall be placed side-by-side at a depth of 1 foot 6 inches below grade and directly above the conduit.

6.1.50 Testing and Cleaning

After completion of the duct bank or before cable is pulled into existing duct banks, each duct shall be tested and cleaned, and ducts which will not be used immediately shall be plugged at each end. As a clearance test, each duct shall pass a mandrel with a diameter l/4 inch less than the inside diameter of the duct. All foreign material, earth, sand, and gravel shall be removed from the ducts with circular stiff bristled brushes. A 1/4 inch nylon rope shall be installed in all unused ducts.

45. SECTION 6070 GROUNDING SYSTEM

6.1.51 General

6.1.52 Scope

This section covers the furnishing and field installation of a grounding system and all components. The grounding system and installation shall be in accordance with the drawings and these specifications.

6.1.53 Codes and Standards

Work performed under these specifications shall be done in accordance with the following codes and standards and the applicable codes, standards, and regulations set forth in the BESS Spec. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply.

Grounding systems and components furnished with these specifications shall be manufactured in accordance with applicable standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), the National Electrical Manufacturers Association (NEMA), the American Society for Testing and Materials (ASTM), and Underwriters' Laboratories, Inc. (UL). Grounding systems and components shall be installed in accordance with the applicable requirements of the National Electrical Code (NEC) and the Occupational Safety and Health Administration (OSHA) standards.

6.1.54 SUBMITTALS

Contractor, under the supervision of the Owner, shall submit to the Owner test results of the completed ground grid area. The results include grid resistance and a current injection continuity check of the ground mat. If these results do not comply with the finalized ground grid calculations as defined in M1-04-01-General_Electrical_Study_Requirements, then Contractor will, at their expense and at Owner's approval, make adjustments to the ground grid construction to meet applicable ground grid requirements.

All ground resistance measurements shall be made with the Fall of Potential or slope methods as defined in IEEE 81. Some of the acceptable instruments are as follows: Advanced Geosciences, Inc., Sting R1, Mini Sting, Super Sting R1, or Super Sting R8, Iris Instruments, SYSCAL R1 Plus, SYSCAL R2, or SYSCAL Pro AEMC 6472 & 6474 combination After connection of ground rods to the ground system, the Contractor shall obtain a grid resistance measurement using PGE test procedures with recommended distances. This data shall be obtained, identified, and recorded.

6.1.55 MATERIALS

An electrical grounding system shall be furnished and installed in accordance with the drawings and the following specifications. Grounding components shall include ground rods, ground conductor, ground bus, above and below grade grounding connections, grounding lugs, and hardware required for a complete system.

2.1 Grounding Materials: Grounding component materials shall be furnished new and undamaged, and shall conform to the requirements of the articles that follow.

2.2 **Ground rods:** Unless otherwise stated, ground rods shall be 5/8 inch diameter, 8 foot long, copper clad, cold drawn carbon steel manufactured in accordance with UL 467. The copper cladding shall be electrically bonded to the steel rod or bonded by a molten welding process. Cold rolled copper cladding will not be acceptable. Ground rods shall have a conical taper on one end to facilitate soil penetration.

2.3 **Below Grade Conductors:** Below grade ground conductors shall be soft drawn, 250 kcmil, 19 or 37 stranded, copper cable conforming to the requirements of ASTM B-8.

2.4 **Ground Stingers:** Ground stingers shall be soft drawn, 19#9 stranded copperweld cable, with 40 percent conductivity.

2.5 **Exothermal connections:** Exothermal connections shall be a standard duty copper molten weld conforming to the requirements of IEEE 837, IEEE 80 Section 11, and UL 467. Molds and powder cartridges used for making exothermal connections shall be furnished by the same manufacturer. Exothermal connections shall be similar to Type CADWELD as manufactured by Erico, or an Engineer acceptable equal.

2.6 Above Grade Ground lugs: Ground lugs to structures or equipment shall PGE two hole ground clamp provided by Portland Foundry.

2.7 Below Grade Ground lugs: Below grade ground lugs shall be PGE approved DMC grounding connector specified in the bill of materials. Below grade Burndy connections are not acceptable. DMC P/N: GC721B025-025 shall be used for 250-250 MCM CU grounding connector. DMC P/N: GC732B025-562 shall be used for 250 MCM – 5/8" rod connector

2.8 Hardware: Clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be of copper, copper alloy, or stainless steel.

2.9 Ground connectors: Bolted ground connectors and flexible type grounding jumpers shall be provided for operating handles of disconnect switches. All grounding connectors in contact with galvanized structures shall be tinned bronze material.

6.1.56 EXECUTION

3.1 Routing. Except as otherwise specified or indicated on the drawings, all ground conductors shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns.

All ground field routing shall be acceptable to the Project Field Manager. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

Any ground wire that runs over concrete more than 12" will require an anchor every 12" to the concrete.

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.

3.2 Trenching and Backfill. Except as otherwise specified or indicated on the drawings, refer to trenching and backfill section for fill requirements.

Grounding backfill material shall be either job excavated material or material furnished by the Contractor from offsite sources that is similar to job excavated material. The method of compaction and the equipment used shall be appropriate for the material being compacted and not damage the ground grid. Backfill material obtained from off-site sources shall be free of contamination.

3.3 Conductors. Unless noted otherwise, all below grade ground conductors shall be buried 18 inches below finish grade. Ground grid conductors under foundations shall have 6 inches of earth cover between conductor and bottom of foundation.

Conductors routed around 90 degree corners shall be kept in close contact with the perpendicular surfaces and shall not be physically damaged due to an insufficient bending radius.

Below grade ground conductors shall be placed as indicated on the drawings.

Damaged ground system conductors shall be repaired or replaced by the Contractor.

3.4 Stingers. All Copperweld ground stingers shall be brought above grade as noted on the design drawings. A 10-foot pigtail shall be coiled and left above grade for future connections to equipment.

Stingers shall not be physically damaged. Any damaged stingers shall be repaired or replaced.

3.5 Ground Rods. All ground rods shall be located as indicated on the drawings and installed to the depth indicated. Where the required ground rod length exceeds 10 feet (3 m), ground rod standard sections shall be welded together to provide an extended rod with one true centerline. During welding, the ground rod sections being welded shall be supported by a guide to ensure proper alignment.

3.6 Connections. The manufacturer's instructions on the use of exothermal welding materials shall be followed in all details.

All surfaces to be joined by the welds shall be thoroughly cleaned. Powder cartridges and molds shall be kept dry and warm. Worn or damaged molds shall not be used.

All exothermally welded connections shall successfully resist moderate hammer blows. Any connection which fails such test, or which upon inspection indicates a porous or deformed weld, shall be remade.

All exothermal welds shall encompass 100 percent of the ends of the materials being welded. Welds that do not meet this requirement shall be remade.

All bolted and screwed connections shall be securely tightened.

3.7 Column Grounding. Structural steel columns shall be grounded as indicated on the drawings. Prior to the installation of the servit post, paint, scale, and other non-conductive substances shall be removed from surfaces of un- galvanized structural steel members by grinding. Galvanized steel surfaces shall be cleaned with emery paper.

3.8 Conduit Grounding. All conduit grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug grounding bus with a bare copper conductor. Grounding bushings shall be grounded with conductor sized in accordance with the NEC, but not smaller than 8 AWG.

All grounding bushings on conduit runs which are terminated at tray shall be connected to the tray grounding cable or tray side rail with bare copper conductor as indicated on the drawings.

Where a conduit run is terminated at tray and the conduit carries a separate insulated grounding conductor, this grounding conductor shall be terminated on the tray grounding cable. If the conduit run is terminated with a grounding bushing and the separate ground conductor it carries is sized in accordance with the requirements of the preceding paragraphs for conduit bushing grounding, the ground conductor in the conduit run may be continued through the conduit bushing ground connection and terminated on the tray grounding cable making unnecessary the installation of a separate conduit bushing grounding cable.

Conduit bushing ground conductors shall be connected to the tray ground cable using split bolt connectors or an Engineer acceptable equal mechanical connector.

Conduit terminated at equipment and device in threaded hubs shall not require additional grounding provisions.

3.9 Tray Grounding. A bare copper grounding conductor shall be installed on all power level cable trays containing single conductor power cables. The tray grounding conductor shall be installed on the outside of the tray side rails, along the entire length of the trays, attaching to each tray fitting and to each straight section of tray at 6 foot (1.8 m) maximum intervals. The tray grounding conductor shall be attached to the trays using bolted ground clamps, and shall be connected to the ground grid at locations indicated on the drawings. Splices for the tray grounding conductor shall be made using compression connectors.

Cable trays containing multi-conductor power cables, control, or instrument circuits shall not require a continuous ground conductor installed along the tray. Instead, these tray levels shall be grounded by means of a ground jumper extended from the tray side rail to the continuous ground conductor installed along a power level cable tray, to building steel, or to the ground grid. Grounding intervals shall not exceed 100 feet (30 m).

Grounding jumpers shall be required across all expansion splice plates, dropouts and adjustable splice plates where a continuous ground conductor is not installed along the tray level.

3.10 Equipment Grounding. Electrical equipment that requires a ground grid extension stinger shall be connected to the ground grid with copper grounding conductor as indicated on the drawings. The term "electrical equipment," as used in this article, shall include all enclosures containing electrical connections or bare conductors except that individual devices such as solenoids, pressure switches, and limit switches shall be exempt from this requirement unless the device requires grounding for proper operation. Large electrical power distribution equipment such as medium or low voltage switchgear or motor control centers will be furnished with a ground bus which the Contractor shall connect to the ground grid at each end of the ground bus. Other equipment will be furnished with grounding pads and/or ground lugs which the Contractor shall connect to the ground grid. All ground connection surfaces shall be cleaned immediately prior to connection.

Where ground grid extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the grounding conductor to the equipment ground bus, pad, or lug. In addition to the ground grid extension stingers, a ground conductor shall be provided from the tray ground cable to the incoming line end of the ground bus in each assembly of medium or low voltage switchgear and motor control centers indicated on the drawings.

Where a ground conductor is included with the phase conductors of power circuits, the ground conductor shall be connected to the equipment grounding facilities and to the source ground bus. Where a ground conductor is not included with the phase conductors, the equipment shall be grounded by connecting a separate ground cable to the equipment grounding facilities and to the tray ground cable or source ground bus.

Except where otherwise indicated on the drawings, all equipment ground conductors which are not an integral part of a cable assembly shall be sized in accordance with the requirements of NEC. All ground conductors installed in conduit shall be insulated.

Circuits in the circuit List include an insulated ground conductor to all 6,900 volt, 4,160 volt, 480 volt, and 208 volt loads to satisfy the requirements of the preceding paragraph. This ground conductor is either a separate cable, Type GI, or is contained within the multi-conductor power cable. Power circuits from 120/208 volt power panels contain one additional conductor which is used for grounding smaller devices which require 120-volt power. Additional grounding cables which would duplicate the ground conductors already in the Circuit List are not required.

The Contractor shall design, furnish, and install all equipment grounding cables required in addition to the ground cables contained in the Circuit List. This shall include, but not be limited to, devices which have electrical connections but do not require a power circuit such as junction boxes and control equipment enclosures, any equipment to which the routed ground conductor is not of sufficient size to properly ground the equipment, and any other electrical equipment which is not grounded by means of a conductor in the Circuit List.

Suitable grounding facilities shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

Suitable grounding facilities for electrical equipment not so equipped, but requiring multiple grounding connections, shall include the installation of a bare copper ground bus for the connection of several grounding conductors. This ground bus shall be connected to the equipment frame or enclosure, providing a minimum of joint resistance.

The conduit system is not considered to be a grounding conductor except for itself and for lighting fixtures. No equipment grounding conductor shall be smaller in size than 12 AWG unless it is a part of an acceptable cable assembly.

3.11 Duct Bank One bare copper ground conductor, equal in size to the ground grid conductors, shall be routed with each duct bank as indicated on the drawings. The duct bank ground conductors shall be located at the top of the duct bank and physically separated on each side if two are required. The duct bank ground conductors shall be connected to the ground grid and grids at locations where the duct bank crosses the grids as indicated on the drawings.

3.12 Vault Grounding. A ground conductor, equal in size to the ground grid conductors, shall be grounded at the vault at one end only as indicated on the drawings.

3.13 Fence and Gate Grounding. Use PGE Standard S-140-15 for fence and gate grounding requirements.

3.14 Barb Wire Grounding. Use PGE Standard S-140-16 for barb wire grounding requirements.

3.15 Instrument Transformer Grounding. Use PGE Standard S-140-24 for instrument transformer grounding requirements

3.16 Switch Handle and Operator Grounding. Use PGE Standard S-140-27 for switch handle and operator grounding requirements.

3.17 Power Transformer Grounding. Use PGE Standard S-140-31 for power transformer grounding requirements. The neutral connection to the transformer shall be one continuous connection from the X0 bushing to ground. Power transformer grounding materials and terminations shall comply with requirements as set forth in M1-04-02 (General Transformer Specification), equipment manufacturer specifications, and equipment manufacturer drawings. Contractor shall seek Owner approval of power transformer grounding installation in the event that power transformer equipment grounding requirements are not consistent between equipment manufacturer documents and Owner specifications.

3.18 Capacitor Bank Grounding. Use PGE Standard S-140-09 for capacitor bank grounding requirements.

3.19 Gas Insulated Switchgear (GIS) Grounding. GIS grounding shall be accordance with drawings and manufacturer's recommendation. Refer to manufacturer GIS grounding information document in the attachment.

46. SECTION 6080 YARD LIGHTING

6.1.57 General

6.1.58 Scope

The work covered by this specification includes furnishing of all labor, tools, and equipment necessary to install the yard lighting and convenience receptacles in the substation / switchyard as shown on the drawings and as specified herein.

6.1.59 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified, as well as the applicable codes, standards, and regulations set forth in the BESS Spec. The latest edition of the code or standard shall govern:

NFPA 70 – National Electrical Code

National Electrical Safety Code Section 111

6.1.60 Materials

All materials furnished by the Contractor shall comply with the specifications, the results of the substation lighting study as defined in M1-04-01-General_Electrical_Study_Requirements, and drawings and be approved by the Owner.

Miscellaneous materials provided by the Contractor shall meet the following criteria:

Component	Material
Switches	
Housing and operating levers	Phenolic compound
Device plates	
Finished areas (metal)	Type 430 satin stainless steel
Unfinished areas	Formed sheet steel coated with zinc of cadmium

Weatherproof receptacle and switches	
Plates and lift cover	Cast aluminum
All other metal parts	Stainless steel or Monel metal

The following conductor types for use in the lighting and convenience receptacle circuits shall be provided.

Cable Type	Circuit Use
THHN (Type L2)	For 120 volt circuits in heated areas
XHHW-2 (Type L1)	All 277 volt circuits and all 120 volt circuits in unheated areas
SF-2 (Type SF-2)	For incandescent luminaire connections

The following raceway and raceway fittings for use in lighting and convenience receptacle circuits shall be provided:

Raceway Type	Use
Electrical metallic tubing (EMT)	Installed in indoor non-hazardous areas
Rigid galvanized steel or Rigid aluminum	Outdoors above grade and indoor hazardous areas
Flexible metallic tubing	Luminaire taps in finished areas
Schedule 40 PVC	Area lighting routed underground

6.1.61 EXECUTION

3.1 Lighting units, receptacles and boxes shall be installed on structures and in the control house as shown on the drawings. Installation of conduit, conduit fittings and boxes for yard power system is covered in the "Conduits" section (6060). Contractor shall install all lamps and poles as indicated in the drawings.

3.2 **Wiring:** Contractor shall install insulated wire, of type and sizes shown on the drawings, to connect control house, yard lighting, and convenience receptacles.

All joints in wiring shall be carefully and thoroughly soldered, or pressure type solderless connectors may be used. If connections are soldered, they shall be insulated with electrical plastic tape or rubber tape covered with black friction tape. If connectors are used, they shall be properly capped or taped.

Immediately before energizing a lighting or convenience receptacle circuit, the Contractor shall make the following checks:

- The transformer neutral supplying the source panelboard is solidly connected to ground.
- The phase and neutral conductors to be energized are free from grounds.
- Convenience receptacle polarity is verified and tested.
- Ground fault circuit interrupting (GFCI) devices are tested for proper operation.
- All covers are installed on luminaires, wiring devices, pull boxes, junction boxes, and conduit fittings so exposed conductors will not be energized.
- The ground conductor is solidly grounded.

The Contractor under the supervision of the Owner representative shall test all circuits for continuity, grounds and shorts, and shall correct all faulty or improperly connected circuits to the satisfaction of Owner.

3.3 **Inspection**: All electrical wiring work shall be subject to inspection. This inspection or waiver of inspection by Owner shall not relieve the Contractor from entire responsibility for use, supply, and installation of materials, workmanship, and all other liabilities under the contract.

47. SECTION 6090 EQUIPMENT TESTING AND ENERGIZATION

6.1.62 GENERAL

6.1.63 SCOPE

This section describes and defines general criteria which pertain to the testing and checkout work covered by these specifications. The scope of work extends to all equipment connected and/or installed under these specifications. This work is in addition to testing activities required in other sections of this specification. The Contractor shall be responsible, as part of the base scope, for all labor and materials required to demonstrate that all equipment has been installed correctly and functions properly.

The Contractor test procedures and plans must meet NETA and IEEE standards for testing. The Contractor shall document all testing and inspections

The Contractor shall supply to the Owner their proposed Electrical and Instrumentation Testing procedures for review.

All checkout and testing shall be performed and approved by a Contractor specializing in this type of work. All pre-energization testing shall be completed by Contractor and approved by Owner prior to substation energization.

The cost of all labor, supervision, materials, equipment, vehicles, supplies, and services necessary to provide field tests and adjustments required to demonstrate that electrical systems are correctly installed, tested, and calibrated shall be included in the Contractor’s base lump sum price.

The Contractor is responsible for all costs associated with correcting deficiencies and retesting in the event of a test failure:

The Contractor shall notify Owner of all Subcontractors that will be used for testing during the bid process.

Prior to commencement of substation energization procedures, Contractor shall submit, and Owner shall approve, a substation energization plan that includes, but is not limited to, a step-by-step checklist that verifies changes in equipment status (i.e. circuit breaker open, disconnect switch closed) including lock-out tag-out procedures, safety precautions including a “STOP WORK” authority and an “ALL CLEAR” signal, coordination with the interconnecting switchyard/substation owners to energize the interconnecting switchyard/substation circuit breakers and interconnecting transmission line, and listing of key authorized personnel. This energization plan shall appropriately coordinate with any collection energization plans and procedures.

6.1.64 WORK PERFORMED BY CONTRACTOR

The following activities shall be performed as part of the equipment installation. The Contractor shall perform all mechanical and electrical work required to calibrate, checkout, and make the equipment ready for service as required by these specifications.

- Visual and mechanical inspection of equipment.
- Mechanical adjustment and testing of all electrical equipment, as required, assuring proper mechanical functioning and operation.
- All testing and reconnection necessary to obtain correct operation of the electrical equipment.
- Loop verification of all control and instrumentation circuits, in accordance with the Circuit List, to confirm continuity of conductors and those conductors originate and terminate at the locations designated in the circuit list or on the drawings.
- Contractor shall verify expected relay and SCADA inputs (52a, BFI, control switch inputs to relay, etc.) Interrogating the relays and observing expected inputs. Contractor shall verify and exercise relay outputs contacts with relay commands to ensure proper function of the associated circuits (e.g. trip circuits, close circuits, lockouts, etc.)
- Control wiring shall be confirmed as complete and ready for functional testing prior to starting functional testing.
- Functional testing shall include a demonstration that all equipment installed can be operated in accordance with their specification.
- All equipment labeling shall include type and location information and shall be verified as installed and accurate.
- All mechanical adjustment necessary or recommended by the manufacturer of all Contractor-supplied or Owner-supplied electrical equipment being connected or installed.
- Complete testing of the lighting and receptacle system as applicable.

- All instruments wired and calibrated, even if installed by others.
- The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC)
- Upon acceptance of completion, the Contractor shall provide standby craft labor to correct discrepancies found during initial operation on a time and material basis when requested by the Owner. Such standby craft labor shall not be utilized for completion of Contractor punch list items for work later identified as resulting from Contractor's lack of construction completion or Contractor's warranty work.

6.1.65 Work Performed by PGE

- Protective relaying testing will be performed by Owner.
- Electrical Testing of the transformer will be performed by Owner with assistance provided by the Contractor
    - Testing of the transformer will be performed as soon as possible after the transformer is fully assembled
    - Contractor will provide owner notification 2 weeks in advance of a 3 day window when the Owner may test the transformer.
    - Owner will provide technicians and the required equipment to complete the electrical testing.
    - The Contractor shall provide all other workers required to make adjustments, connect equipment, and correct deficiencies during the testing

6.1.66 Codes and Standards

Testing shall be conducted in accordance with the specified source.

Tests	In Accordance With	Conducted By
Acceptance Testing	IEEE, NETA	Contractor

6.1.67 Materials

The Contractor shall provide all necessary material and equipment required for the functionality testing of all major equipment indicated.

6.1.68 Execution

The Contractor shall inform Owner that specific items, devices, or systems are installed and available for checkout. Documentation of the Inspections and Testing will be done on Testing Checklist for Contractor (TCC). This form will be supplied by Owner.

Inspection. The Contractor shall inspect the installed instrument systems and the installed equipment specified herein prior to starting calibration and checkout and shall report in writing to Owner all deficiencies that could prevent proper checkout of such equipment and systems. Such deficiencies, if caused by or during installation by the Contractor, shall immediately be corrected.

Discrepancy Procedure. The Contractor shall endeavor to promptly discover major discrepancies in equipment, materials, and installation so that corrective procedures can be initiated without delay. When the Contractor discovers equipment with an incorrect rating, damage, not being as specified, or is otherwise unsatisfactory, arrangements will be made for replacement of the equipment. The Contractor shall promptly report to Owner any improper field installations or material usage which the Contractor believes should be corrected. Owner will arrange for corrective action.

Calibration in-Place. All equipment furnished and installed by the Contractor shall be calibrated at the site after installation. The Contractor's technicians performing the calibration shall be experienced in the calibration and adjustment of mechanical equipment. Technicians shall be experienced in working with the necessary diagrams and documents in accordance with the calibration and checkout work assigned to each technician.

Devices and equipment shall be adjusted and calibrated with the equipment normally installed in place. Exceptions to this procedure will be permitted with the concurrence of the Owner for the specific device categories for which in- place calibration is not practical.

3.1 **Minor Corrections.** Equipment and devices furnished by others may require minor correction to ensure correct operation following calibration and checkout. These minor corrections may include the following:

- Minor assembly operations within instruments.
- Removal of factory shunts or jumpers.
- Minor wiring corrections.

The Contractor shall perform minor corrections as part of the work defined by these specifications. In such cases, the Contractor shall include repair of these discrepancies as part of this work.

3.2 **Contractor-Caused Defects.** The Contractor shall promptly repair at no additional cost to Owner any equipment or devices which are damaged by the Contractor's personnel in the course of performing the work. Such defects shall be promptly reported Owner.

3.3 **Manufacturers' Procedures.** Drawings and installation and operating instructions from manufacturers of the equipment appropriate to the work described in these specifications will be made available to the Contractor as required. The Contractor shall follow the manufacturers' instructions in the performance of this work and perform all required and recommended tests, calibrations, and settings identified in these instructions.

3.4 **Personnel.** The Contractor shall provide all personnel required to complete the work in accordance with the project schedule. The Contractor shall provide sufficient staff so that the project schedule is met.

Owner will have the authority to approve and require changes in the Contractor's actual manpower level, including the number of technicians and craft personnel.

The number authorized and required may be above or below the Contractor's planned number.

Personnel not performing efficiently, in the opinion of Owner, shall, upon notification to the Contractor, be immediately removed from the project.

Personnel provided by the Contractor shall include the following classifications.

- **Electrical and Instrumentation Technicians.** The Contractor's technicians shall be experienced in the calibration and adjustment of electrical apparatus, instrumentation, control equipment, and final drive devices. Technicians shall be experienced in working with control electrical schematic and wiring diagrams, electrical one-line diagrams, and electrical three-line diagrams in accordance with the calibration and checkout assignment. The total cost of the technicians shall be included in the base Contract Price.
- **Craft.** Sufficient numbers of craft personnel shall be provided by the Contractor to support completion of the work included under these specifications. The total cost of craft for the level of foreman, journeyman, and apprentice for startup and checkout activities is included in the base Contract Price.

3.5 **Tools and Test Equipment.** The Contractor shall provide all required tools and test equipment to perform the work in accordance with these specifications and the project schedule. The test equipment shall be periodically certified. Any test equipment found out of tolerance during certification shall be replaced or repaired. The Contractor shall include a list of test equipment provided, including manufacturer and model with the proposal. The Contractor shall provide the Owner with a copy of all certifications for test equipment used on the project including any recertification's or replacement certifications.

3.6 **Test Instrument Certification.** The Contractor shall provide and maintain an onsite facility to perform periodic certification of test instruments and equipment. Test instruments subject to drift or nonobvious miscalibration shall be certified at least weekly. The Contractor's QA program shall be capable of providing verification that the certification is being performed.
Certification methods shall follow recommendations of the test instrument manufacturers.

The Contractor's personnel performing certification shall be specially trained in the methods and procedures for carrying out these calibration certifications.

3.7 **Calibration or Testing Certification Sticker.** The Contractor shall furnish and affix a self-adhesive label to each device calibrated or adjusted. The label shall indicate the date and the name of the person performing the calibration or adjustment.

3.8 **Checkout and Test Report Forms.** The Contractor shall complete the Testing Checklist for Contractor (TCC) for all instruments, mechanical devices, and electrical devices that are tested or calibrated. A blank form to be used by the Contractor will be furnished by Owner or alternately, the

Contractor's standard forms may be used if accepted in writing by Owner. No increase in contract price will be allowed for not using the Contractor's standard forms. The completed forms shall be submitted to the Owner as part of the turnover package. The forms submitted shall include but not be limited to the Checkout and Test Report Forms listed at the end of this section.

Forms shall be submitted within 5 calendar days after completion of the activity covered by the Checkout and Test Report Form.

3.9 **Equipment Checks and Calibration**. Preoperational checks and inspections shall be performed on all equipment as specified herein, and in accordance with the equipment manufacturer's recommendations. A representative of the Contractor shall be present during the equipment checks.
The Contractor shall verify in writing that all work and preoperational checkouts have been completed and, when the services of equipment manufacturers' field service representatives are required, the Contractor shall include verification by such representatives that the equipment is ready for operation.

3.10 **Electrical and Instrumentation Checkout.** This article defines the scope of electrical and all instrumentation devices and equipment which shall be calibrated in-place, adjusted, or checked out by the Contractor as part of the work covered by these specifications.
The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC).

The Contractor shall provide all temporary instrumentation and gauging devices required during testing and checkout of the equipment and systems.

3.11 **Equipment Checks**. Preoperational checks and inspections shall be performed on all equipment as specified herein and in accordance with the equipment manufacturers and Owners recommendations. All field tests shall be witnessed by the Owner at the Owner's discretion. The Contractor shall perform all tests described in the TCC.
Preoperational checks shall include, but not necessarily be limited to, the following:

- Safety Equipment. All personnel safety items shall be installed. All bolting shall be securely tightened to the correct torque as recommended by the equipment manufacturer.
- All temporary shipping braces, blocks, or tie rods shall be removed.
- Lighting and Receptacle Checkout. The Contractor shall test, check out, and energize the lights and receptacles furnished and installed under this Contract. Lights shall be energized as soon as circuits are complete to increase the lighting level for construction and checkout. Immediately before energizing a lighting or receptacle circuit, the Contractor shall make the following checks

- The phase and neutral conductors to be energized are free from grounds.
- All covers are on lighting fixtures, pull boxes, and junction boxes so exposed conductors will not be energized.

- The ground conductor (if required) is solidly grounded.
- All metering, including panel meters and transducers, shall be calibrated to within the manufacturer's accuracy.
- Panel instrumentation indicating lights, switches, and relays shall be adjusted and checked out as part of the checkout of the Contractor- installed electrical equipment. Electric metering for volts, watts, amperes, and other electrical quantity functions shall be checked out as described in this article and the TCC.
- Electrical panel instrumentation shall be calibrated.
- Unless specified otherwise, all meters shall be tested and calibrated with equipment of no more than 50 percent of the manufacturer's stated accuracy instrument being tested.
- All meters shall be visually inspected for damage, and wiring connections shall be verified in accordance with the three-line diagrams.
- Every instrument utilizing a plastic lens or window shall be given a static effect check. The static check shall consist of wiping the lens or window vigorously with a dry cloth of a type recommended by the manufacturer which will not harm the surface. If the needle or pointer holds up-scale or below zero set for more than 15 seconds, the surface of the lens or window shall be treated with a clear antistatic compound recommended by the manufacturer.
- The Contractor shall verify that direct grounds do not exist on any dc or 480 volt powered systems. Should a ground be detected, the Contractor shall locate the ground source and inform the Owner.
- Measurement of resistance to ground shall be made of all switchgear, overhead bus and panelboard bus immediately prior to placing in service. Measurement of resistance will be with a line operated tester. Voltage of testing device shall be in accordance with the following table or the equipment manufacturer's recommendation, as directed by the Owner:

Equipment Voltage	**Voltage, dc**	**Test Current, max, mA**
480 volts	1000 volts	3
4.16 kV	2 kV	1
Above 4.16 kV	5 kV	1

- All 5 kV and above power cable shall be tested (hi-pot, VLF, tan=delta, or partial discharge) in accordance with IEEE and ICEA standards, and in accordance with Startup and Testing Specification.
- Complete check of all field wiring shall be made after installation and connection to verify that field wiring is as indicated on the drawings and schematic wiring diagrams. Equipment jumpers as indicated on the

schematics shall be checked.

- Shielded cable ground check should be made after termination is complete using a volt-ohm meter to determine that each is grounded only at the points indicated on the drawings.
- All instrument transformers, including bushing current transformers, shall be tested.
- Ratio and polarity tests shall be performed on all instrument transformers. Current transformer ratio and polarity tests shall be voltage ratio tests using a digital voltmeter or current ratio tests using high current injection test equipment, as directed by the Engineer.
- The external circuit for each current transformer shall be completely tested before the shorting devices are removed from the current transformer secondary terminals. The tests shall include the following:
- Continuity check of the circuit external to the current transformer by application of current.
- Phase check to verify correct phase relationship at each device connected in the current transformer circuit.
- All protective and alarm devices associated with all power transformers with primary voltage of 4160 volts or higher shall be tested for correct operation and adjusted as required according to the manufacturer's recommendations.
- The Contractor shall verify in writing that all work and checkouts have been completed, and when the services of equipment manufacturer's

  field service representatives are specified, the Contractor shall include verification by such representatives that the equipment is ready for trial operation.

3.12 **Corrected Drawings**. Owner will furnish three sets of the substation Issued for construction design drawings to the Contractor for markup purposes:
The Contractor shall neatly and legibly mark each set, in duplicate, including all field corrections performed during calibration and checkout. One copy of each drawing shall be submitted to PGE as a part of the completed forms returned at startup. A second set will be turned over to Owner for use by Startup and Operations during commissioning. Submittal of these two sets to Owner shall be concurrent with completion of the startup. The third copy shall be retained by the Contractor until the conclusion of the project. The Contractor's copies shall be turned over to Owner at the conclusion of the project.

The Contractor shall use the following colors on markups: Red – Additions

Green – Removals Blue – Information

Yellow – Quality Assurance Checks

3.13 **Checkout and Test Form.** The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC) provided with the drawings and documents. The Contractor shall initial and date all tests on this document and turn it over to Owner at the conclusion on the project. Contractor shall use Owner forms where applicable for testing documentation.

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

Table of Contents

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. Once installed, Contractor will turn over all equipment and licenses to Owner for configuration.

a. 1x 4-node Dell VxRail Custer. Each server should be single-socket with a Intel Xeon 6346 or better with 256GB RAM. Storage

should be all-flash with a total usable space of 15TB, with the ability to expand 45TB in the future.

b. 2x Cisco C9300X-48TX (or newer) with C9300X-NM-8Y and stack cables with 5-year DNA license

c. 2x Cisco FPR-1120 (or newer), with 5-Year Malware and Threat licenses

d. 1x 120/240V, 7200VA cabinet UPS

e. 1x 1U Mixed-use (copper & fiber) feed-through patch panel

f. Software and Licenses:

   i. All server cluster fully licensed with vSphere Enterprise Plus and vSAN.

   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 with sufficient licenses for provided system.

B. 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 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 Facilities

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

Portland General Electric

2023 All Source RFP Technical Specifications – Wind Projects

Release / Revision Version: 0

Release / Revision Date: 4/14/2023

Document Status: Published

Content Owner: Craig Armstrong

APPENDIX M – WIND PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

TABLE OF CONTENTS

APPENDIX M2

ATTACHMENT 01

EXHIBIT 01

WIND PLANT SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong

TABLE OF CONTENTS

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)

(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

Table of Contents

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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			

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	**Deliverable:**	**Description:**	**Level A**	**Level B**	**Level C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
		• 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		

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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		

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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		

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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		

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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		

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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

Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	

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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
		• 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	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong

Table of Contents

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

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	15Oct21	Issued for Implementation	DNV-GL	DS	CPA	Craig Armstrong
1	14Apr23	Update from 2021 Version	PGE		CPA	Craig Armstrong

Appendix M1

Attachment 04

Exhibit 02

General Transformer Specification

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

TABLE OF CONTENTS

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

Table of Contents

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. Once installed, Contractor will turn over all equipment and licenses to Owner for configuration.

a. 1x 4-node Dell VxRail Custer. Each server should be single-socket with a Intel Xeon 6346 or better with 256GB RAM. Storage

should be all-flash with a total usable space of 15TB, with the ability to expand 45TB in the future.

b. 2x Cisco C9300X-48TX (or newer) with C9300X-NM-8Y and stack cables with 5-year DNA license

c. 2x Cisco FPR-1120 (or newer), with 5-Year Malware and Threat licenses

d. 1x 120/240V, 7200VA cabinet UPS

e. 1x 1U Mixed-use (copper & fiber) feed-through patch panel

f. Software and Licenses:

    i. All server cluster fully licensed with vSphere Enterprise Plus and vSAN.

    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 with sufficient licenses for provided system.

B. 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 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 Facilities

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 Recongnition

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

PGE