Portland General Electric

2025 All Source RFP Technical Specifications – Solar Projects

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APPENDIX M – SOLAR PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

TABLE OF CONTENTS

M1 General Specifications

M3 Solar Technical Specifications

APPENDIX M1
ATTACHMENT 01
EXHIBIT 02

ENGINEERING DOCUMENTS, DRAWINGS, AND OTHER DELIVERABLES

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong
2	19Jun25	Update from 2023 version	1898 & Co./PGE	PGE	SPF	Sean Flak

TABLE OF CONTENTS

1.0 SUBMITTALS

1.1 GENERAL

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.

All BIM design to create drawings contractor shall provide the BIM project files as part of the deliverables to include native format files and a Navisworks overall file with native file reader links

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 United States Customary 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 2024 format including bound files, XREF files, 3D models (saved out to Autodesk Plant 3D 2022 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. AutoCAD format 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
- Piping & Instrumentation 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
- COMMS Fiber Plant Diagrams
- COMMS Rack Layouts AC/DC Power, Grounding
- MW Tower, Waveguide Diagrams

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 [x] 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%, Issued for Construction (IFC), and As Built design and model reviews for each engineering package / discipline. 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 .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 a secure document management system (SharePoint or other as approved by PGE) 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

1.5.2 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

1.5.3 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

1.5.4 Special Characters

Information NOT to be Included in the Item Description:

1.5.4.1 Manufacturer’s Name

There are places in PGE Owner PeopleSoft and Maximo software systems that are designated to keep this information.

1.5.4.2 Manufacturer’s Model Number

There are places in PGE Owner PeopleSoft and Maximo software systems that are designated to keep this information.

1.5.4.3 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.

1.5.5 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	^

Description	Character	Description	Character
Plus	+	Backslash	\
Underscore	_	Square Brackets	[ ]
Vertical Bar	|	Round Brackets	( )
Grave Accent	`	Curly Brackets	{ }
Tilde	~		

1.5.6 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.

1.5.7 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.

1.5.8 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. This includes inverter manufacturer name, technology type, model data, nameplate ratings, technology type and settings.

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.

1.5.9 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.

1.5.10 Operation

Complete and detailed operating instructions, including safety precautions, startup procedures, shutdown procedures, normal operation procedures, non-standard event procedures, and all regulatory required 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.

1.5.11 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.
- Inverter Based Resource inverter data
- 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.

1.5.12 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 CLOSEOUT DOCUMENTATION

At the conclusion of the Work and prior to Final Completion, the Contractor shall compile and submit a complete Project Closeout Documentation Package. This package shall serve as a comprehensive reference record of the Project and shall include, at a minimum:

- All deliverables required under this Contract and listed in the Deliverables Table (Ref: M1-01-02-01), organized and clearly indexed.
- Any supplemental documentation developed in the course of project execution that is not specifically itemized in the Deliverables Table but is relevant to the Owner’s future operations, maintenance, regulatory compliance, or asset management. This may include:
  - Project correspondence logs or change order records
  - Meeting minutes, submittal logs, and RFIs
  - Lessons learned or post-construction review summaries
  - Final construction photos and progress documentation
  - Any other project execution records beneficial to long-term ownership

The Project Closeout Documentation shall be:

- Delivered in both electronic (searchable, bookmarked PDF and native editable formats) and hard copy format (if requested by Owner),
- Clearly organized by section and labeled for ease of navigation, and
- Submitted to Owner for review and acceptance prior to Final Completion.

This compilation is intended to supplement, not replace, the specific deliverable requirements identified in other sections of the Specifications.

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 certificates	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			1 month prior to start of relay testing	
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			
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	

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	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-constructed 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-constructed 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.			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	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	
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-constructed facility.			X			

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			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
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-constructed 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		
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-constructed facility.			X			

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Design	Substation	30% Design including the following (as applicable): • Substation general arrangement drawing • Main power transformer(s) • Protection equipment and switchgear specifications • LV systems including 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 Civil	30% Design including the following (as applicable): • Geotechnical investigation • Thermal resistivity measurement of soil •topographic or ALTA survey		X		X		
Design	Substation Structural	30% Design Not Applicable						
Design	Substation Oil Containment	30% Design Not Applicable						
Design	Substation Below Grade Electrical	30% Design including the following (as applicable): •Electrical resistivity measurement (soil model) •Conduit Plan		X		X		
Design	Substation Above Grade Electrical	30% Design including the following (as applicable): •General Layout •Future General Layout		X		X		
Design	Substation Control and Protection	30% Design including the following (as applicable): •One line schematic •Network block diagram •station service one line diagram •control enclosure layout •relay rack elevations •list of materials (relay rack items) •pilot scheme diagram		X		X		
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 Civil	60% Design including the following: • An updated version of 30% Design with revisions and additional detail where applicable •Grading plan and details •Foundation Plan and details •Yard surfacing plan and detail •Preliminary calculations • Submittals as required in Appendix M1 Attachment 05 Exhibit 02 – Substation Engineering Specification.		X		X		
Design	Substation Structural	60% Design including the following •Structure ID Plan •Structure drawings •Fire wall design (preliminary)		X		X		
Design	Substation Oil Containment	60% Design including the following •Oil Containment Plan and Details		X		X		

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Design	Substation Below Grade Electrical	60% Design including the following: • An updated version of 30% Design with revisions and additional detail where applicable •Conduit Plan •Conduit and Vault details •Grounding Plan •Grounding details •Grounding Calculations • Submittals as required in Appendix M1 Attachment 05 Exhibit 02 – Substation Engineering Specification.		X		X		
Design	Substation Above Grade Electrical	60% Design including the following: • An updated version of 30% Design with revisions and additional detail where applicable •Plan Views •All elevations and section views (without material callouts) •Bus connection details •Lighting Plan •List of Materials (Major Equipment Only) •Rigid bus calculations •Lighting Calculations • Submittals as required in Appendix M1 Attachment 05 Exhibit 02 – Substation Engineering Specification.		X		X		
Design	Substation Control and Protection	60% Design including the following: • An updated version of 30% Design with revisions and additional detail where applicable •All schematics (including vendor control schematics) •AC/DC panelboard wiring diagrams •List of nameplates (relay racks) •AC/DC station service calculations • Submittals as required in Appendix M1 Attachment 05 Exhibit 02 – Substation Engineering 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 Civil	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •List of materials •Rebar schedule •Anchor bolt schedule •All calculations and reports		X		X		
Design	Substation Structural	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •Structure calculations		X		X		
Design	Substation Oil Containment	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •Oil Containment calculations		X		X		
Design	Substation Below Grade Electrical	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •List of materials •Conduit Schedule •Conduit Fill Calculations		X		X		
Design	Substation Above Grade Electrical	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •List of materials •List of nameplates		X		X		

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Category	**Deliverable:**	**Description:**	**Level A**	**Level B**	**Level C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
Design	Substation Control and Protection	90% Design: An updated version of 60% Design with revisions and additional detail where applicable •Wiring diagrams •List of materials •List of nameplates •Cable Schedule		X		X		
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-constructed 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 analyzed 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		

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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-constructed 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): • 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			

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 • 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)		X		X	3 months after Agreement execution	
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-constructed facility.			X			
Design	Solar electrical BOS specifications 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 fiber-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	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Design	Solar electrical BOS specifications and design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Solar electrical BOS specifications 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 specifications and design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Solar electrical BOS specifications and design drawings	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	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/Gen-Tie lines	15% Deliverable Memorandum (M1-05-05 Section 1.4)		X		X		
Design	Interconnection/Gen-Tie lines	30% Design including the following (if applicable). Reference M1-05-05 and the 230 kV DCD: • Survey, as applicable		X		X	3 months after Agreement execution	
Design	Interconnection/Gen-Tie lines	60% Design. Reference M1-05-05 and the 230 kV DCD:		X		X		
Design	Interconnection/Gen-Tie lines	90% Design including the following (if applicable). Reference M1-05-05 and the 230 kV DCD: • Includes Final Vendor Drawings • Geotechnical Report, as applicable		X		X		
Design	Interconnection/Gen-Tie lines	IFC Design including the following (if applicable). Reference M1-05-05 and the 230 kV DCD:		X		X	6 weeks prior to start of relevant work	
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-constructed facility. Reference M1-05-05 and the 230 kV DCD:			X		6 weeks after Substantial Completion of Work	
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 commissioning activities	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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		30 business days prior to commissioning activities	
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: • SWPP 1200c ~~(NPDES and Sediment and Erosion control)~~ • Building Permit • Development Permit • Zoning Permit • Easements • Property Rights • Land Use Permit • Wastewater Permit • Removal/fill Permit ~~• Septic~~ ~~• WPCF~~		X		X	5 business days upon obtaining	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 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~~ • Hazardous Materials Management Plan • Waste Management Plan • 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 commissioning	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 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	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Plan	Site Specific Safety and Health Plan	Including elements as specified in Appendix M1 • Resumes of Safety Professional •EHS&S Staffing needs •PPE and Safety Equipment •Medical Services/Facilities •Accident Free Process Implementation •Drug/Alcohol Background Screening •Competent Person Process •Project Safety Status Reporting •Division of responsibility •Environmental Control Plan •Staff Security Plan/Needs •Lock-out/Tag-out procedure •Site permit-to-work/hot work permit requirements •Communication plan (site signage, etc.) • Resumes of Safety Professional	X			X	Agreement close	
Plan	Wildfire Mitigation Plan	Including elements as specified in M1-02-01 •Wildfire mitigation through facility design •Inspection of facility components •Vegetation management •Fire weather monitoring •Emergency response				X	Agreement Close	
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	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	
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, relevant calculations, 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 Initial relay calculations/study due at least 6 months prior to start of relay testing	

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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 summarizing 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 • 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	
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			

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 • 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.		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 manufacturer 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 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	

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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: • Flash 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 • Reinforcement specifications and testing, and • Conclusions		X		X	3 months after Agreement execution	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 Certifications 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	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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 annualized 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 • 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		X		X	3 months after Agreement execution	
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 fiber architecture.		X		X	8 months after Agreement execution	

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	
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 tank 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	

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			Level					
Category	**Deliverable:**	**Description:**	**A**	**B**	**C**	**Owner Approval**	**Owner Proposed Schedule**	**Contractor Proposed Schedule**
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. • 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 • 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		X		X	3 months after Agreement execution	
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			

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Category	Deliverable:	Description:	Level A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
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	

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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 • Magnetizing 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 Polymerization (DP) • Inspection and Testing • Shipping	X			X	Agreement close	
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	

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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	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			

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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	Solar electrical specifications	Functional description and preliminary design specifications of proposed electrical systems up to and including the Point of Connection, including: • 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) • Optimization 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.	X			X	Agreement close	
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 specifications	Document demonstrating welding procedure shall meet all requirements of the AWS D1.1 code		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 A	Level B	Level C	Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
Capability to Meet Compliance with PRC-028	Contractor to ensure design of Inverter-Based Resources (IBR) capability to evaluate IBR ride-through performance during System disturbances and to provide data for IBR model validation. This includes the following: • Sequence of Event Recording; circuit breaker position for circuit breakers; When triggered by ride-through operation or tripping of an IBR unit - all fault codes, fault alarms, high and low voltage ride-through mode status and high and low frequency ride-through mode status. • Triggered fault recording data to determine the following electrical quantities for Elements; High-side of the main power transformer FR data; Collector feeder breaker FR data; Shunt dynamic reactive device FR data to show: • Phase-to neutral voltage for each phase; • Each phase current and the residual or neutral current; • Real and or Real and Reactive power expressed on a three-phase basis. • FR data capable of meeting the High-side of the main power transformer data; Collector feeder breaker data; Shunt dynamic reactive device FR data for the following: • A single record or multiple records that include a pre-trigger record length of at least two cycles and a total record length of at least 2.0 seconds for the same trigger point. • A minimum recording rate of 64 samples per cycle • A trigger settings for at least the following: Neutral (residual overcurrent, if applicable; AC phase overvoltage and undervoltage; Overfrequency and underfrequency To have continuous dynamic disturbance recording (DDR) data and storage to determine the following electrical quantities for each main power transformer(s) it owns: • One phase-to neutral or positive sequence voltage on high-side of the main power transformer(s) • The phase current for the same phase at the same voltage corresponding to the voltage list above, or the positive sequency current • Real Power and Reactive Power flows expressed on a three-phase basis corresponding to each main power transformer(s) where current measurements are required • Frequency of any one of the voltage(s) listed above		X			Agreement Close		

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Level B:	Construction Documentation - Documentation to be submitted prior to the commencement of Work on Site or issuing of any completion certificate
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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
	Generator Owner responsible for DDR data listed above, should have DDR data that meet the following: • Input sampling rate of at least 960 samples per second • Output recording rate of electrical quantities of at least 60 times per second							
	Generator Owner should time synchronize all SER, FR, and DDR data to meet the following: • Synchronization to Coordinated Universal Time (UTC) with or without a local time offset • The IBR unit synchronized device clock accuracy with +/- 100 milliseconds of UTC. For all other devices, synchronized device clock accuracy within +/- milliseconds of UTC							
	A Generator Owner shall provide all requested SER, FR and DDR data to its Transmission Planner, Planning Coordinator, Transmission Operator, Balancing Authority, Reliability Coordinator, Regional Entity, or NERC according to the following specs: • Data shall be retrievable for the period of 20 calendar days and should be provided within 15 calendar days of a request, unless an extension is granted • SER data shall be provided in ASCII CSV format • FR and DDR data shall be provided in either CSV format with appropriate headers or in electronic files that are formatted according to C27.111, IEEE Standard Common Format for Transient Data Exchange (COMTRADE), revision C37.111-1999 or later • Data files shall be names to conform with C27.232, IEEE Standard for Common Format for Naming Time Sequence Data Files (COMNAME), rev C37.232-2011 or later							

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
Capability to Meet Compliance with PRC-029	Ensure the design and operation is such that each Inverter-Based Resource meets or exceeds the Ride-through requirements according to the "must Ride-through zone" specified, except in the following conditions:		X			Agreement Close		
	• The IBR needed to electrically disconnect in order to clear a fault: • The voltage at the high-side of the main power transformer went outside an accepted hardware limitation; • The instantaneous positive sequency voltage phase angle change is more than 25 electrical degrees at the high-side of the main power transformer and is initiated by a non-fault switching event on the transmission system, or • The Volts per Hz (V/Hz) at the high-side of the main power transformer exceed 1.1 per unit for longer than 45 seconds or exceed 1.18 per unit for longer than 2 seconds							
	Ensure the design and operation is such that each voltage performance for each IBR adheres to the following during a voltage excursion, unless a documented hardware limitation exists							
	• While the voltage at the high-side of the main power transformer remains within the continuous operation region, each IBR shall Continue to deliver the pre-disturbance level of Real Power or available Real Power, whichever is less Continue to deliver Reactive Rower up to its Reactive Power limit and according to its controller settings Prioritize Real Power or Reactive Power when the voltage is less than 0.95 per unit, the voltage is within the continuous operating region, and the IBR cannot deliver both Real Power and Reactive Power due to a current limit or Reactive Power limit, unless otherwise specified through other mechanisms by an associated Transmission Planner, Planning Coordinator, or Transmission Operator.							
	• While voltage at the high-side of the main power transformer is within the mandatory operation region as specified, ensure IBR shall exchange current, up to the maximum capability to provide voltage support, on the affected phases during both symmetrical and asymmetrical voltage disturbances, either under Reactive Power priority by default; or Real Power priority if required through other mechanisms by an associated Transmission Planner, Planning Coordinator, Reliability Coordinator, or Transmission Operator							

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
	• While voltage at the high-side of the main power transformer is within the permissive operation region as specified, ensure IBR to operate in current blocking mode if necessary to avoid tripping. Each IBR should follow the requirements for the mandatory operation region							
	If an IBR enters current blocking mode, it shall restart current exchange in less than or equal to five cycles of positive sequence voltage returning to a continuous operation region or mandatory operations region							
	• Should have capabilities to restore Real Power output to the pre-disturbance or available level (lesser of) within 1.0 seconds							
	Contractor to ensure the design and operation is capable of IBR meets or exceeds Rid-through requirements during a frequency excursion							
	Contractor to document any known hardware imitations that prevent the IBR from meeting Ride-through criteria							
Capability to meet compliance with PRC-030	Contractor to ensure design is capable of identifying any complete facility loss of output, or changes in Real Power output that are at least 20 MW and at least 10% of the plant's gross nameplate rating occurring within a 4-second period.		X			Agreement Close		
Capability to meet compliance with EOP-012	Contractor to ensure any generating units that begin commercial operation on or after 10/1/2027, and that has a calculated Extreme Cold Weather Temperature at or below 32 degrees Fahrenheit, and that self commits or is required to operate at or below a temperature of 32 degrees Fahrenheit, shall:		X			Agreement Close		
	• Ensure freeze protection measures to protect Generator Cold Weather Critical Components that operate at the Extreme Cold Weather Temperature with sustained concurrent twenty (20) mps wind speed for a period of not less than twelve (12) continuous hours, or the maximum operational duration for intermittent energy resources if less than twelve (12) continuous hours							

APPENDIX M1
ATTACHMENT 01
EXHIBIT 05

PROJECT MANAGEMENT AND CONTROLS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

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
2	19Jun25	Update from 2023 Version	PGE		SPF	Sean Flak

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 cloud-based document management system 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. Site-Specific Environment, health and safety plan
9. Quality Management System plan

10. Management of Owner and other external interfaces
11. Outage Management Plan
12. Change control plan – including change order process
13. Escalation matrix – how and when to escalate issue for resolution
14. Project Transition/Handoff Plan
15. Comprehensive Contruction Plan

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 submit a Level 4 project schedule no later than eight (8) weeks following the issuance of Notice to Proceed (NTP). This schedule shall provide a detailed, resource-loaded breakdown of construction activities to support execution and field coordination of the Work, including task-level durations, sequencing, and logic ties across all scopes of work (e.g., civil, structural, electrical, commissioning).

The Level 4 schedule shall:

- Include crew-level detail sufficient for weekly planning and coordination,
- Clearly identify critical path activities and float,
- Reflect realistic productivity assumptions and any constraints identified to date,
- Incorporate major procurement, subcontractor mobilization, and construction activities
- Include reasonable allowances for normal delays such as inclement weather, holidays, and site access limitations
- Track Substantial Completion dates for each individual Circuit or system

It is understood that certain schedule activities may remain provisional or dependent on external factors such as receipt of environmental permits, completion of required studies, interconnection approvals, or other regulatory authorizations. In such cases, the Contractor shall:

- Clearly identify any pending dependencies within the schedule,
- Use logical placeholders with tentative durations where needed,
- Update and refine affected activities as information becomes available.

The Schedule shall include, but not be limited to, the following:

1. Engineering activities
2. Procurement activities
3. Permitting
4. Material and equipment deliveries
5. Construction activities
6. Tie-ins to existing plant systems
7. Equipment factory tests
8. Interfaces with Owner and other external interfaces
9. Outage windows

10. Major milestones
11. Milestone payments, if applicable
12. Startup and commissioning activities
13. Testing activities
14. Contractor and Subcontractor data submittals and Owner's review cycles
15. Post-Substantial Completion items including as-built drawings and Punchlist items

Along with the detailed Level 4 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
3. Schedule methodology
4. Project work breakdown structure (WBS)

All Functional and Capacity Test activities shall be clearly coded to match the Commissioning Plan and allow progress tracking. The final accepted schedule shall become an Attachment to the Agreement. All schedule submittals shall be delivered in native Primavera P6 format (or other format approved by the Owner), PDF format, and hard copy.

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[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

2. Risk and opportunity analysis
    a. Summarize key risks that could delay the schedule
    b. Summarize strategies to mitigate key risk
3. Major constraints
    a. Key dates and constraints
4. 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. The Contractor shall update their project Schedule monthly, after the Notice to Proceed, as part of the monthly progress reporting. Owner reserves the right to request weekly schedule updates as needed. The Contractor shall prepare, after mobilization, 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. Weekly project schedule updates shall be provided in each weekly meeting. An alternate template may be used upon Owner approval. The monthly report shall be transmitted the Owner (through an approved document management system) by the 5th 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.

1.6.2 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.

1.6.3 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.

1.6.4 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.

1.6.5 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.

1.6.6 Contract Overall Craft History

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.

1.6.7 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.

1.6.8 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 design, 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.

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

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 version	1898 & Co.	PGE	CPA	Craig Armstrong
2	19Jun25	Update from 2023 version	1898 & Co. / PGE	PGE	SPF	Sean Flak

TABLE OF CONTENTS

1.0 GENERAL

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).

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 which is to be approved by the Owner. Contractor shall ensure that the Plan complies with all federal, state and local regulations and any project specific requirements. 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.

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.

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.

Contractor shall immediately notify Owner of any governmental agency (OSHA, Fire Dept., Health Dept., etc.) complaint and/or inspection of the Site. 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.

Contractor shall be responsible for 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.

2.0 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 determine 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 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, offsite backup must be maintained for incident recovery. The offsite backup must be regularly updated, at minimum once per year or after any major software upgrade.

2.1.3 Security Logging

Contractor will provide a log management system capable of collecting, analyzing, and alerting on logs generated by all SCADA system devices.

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 all 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 systems technically capable of LDAP or RADIUS authentication will be configured and connected to the aforementioned domain controller

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 along with justification for each.

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:

1. Domain Controllers
2. SCADA Servers
3. User workstations
4. Controllers/PLCs
5. Auxiliary Systems
6. Monitoring systems
7. Terminal/VPN Servers
8. 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.

To the extent allowable by the SCADA OEM, Contractor will install all SCADA servers in virtualized environment. This virtual environment must tolerate the failure of any single component (Server, SAN Controller, network switch, etc.). The system must also be able to tolerate least 2 simultaneous disks failures (e.g. RAID 6). Contractor shall configure alerts to the operator in the event of any failure.

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:

1. Review of requirements
2. Presentation of hardware and software products to be used.
3. Implementation plan
4. Long term system maintenance, operation, and support requirements
5. 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.

3.0 GENERATION PHYSICAL SECURITY SYSTEM

The physical security scope described herein is intended to define minimum infrastructure and performance standards for generation site protection. Final design will vary depending on site-specific conditions, including facility layout, surrounding land use, permitting constraints, and Owner preference.

Contractor shall include in their proposal a complete physical security system that meets the functional requirements of this specification and assumes a site of typical size and layout for a utility-scale [solar/wind/storage] facility.

The Contractor shall account for the following:

- Variability in perimeter design based on siting (e.g., rural, industrial, or residential adjacency), which may affect fence height, type (e.g., expanded metal vs. CMU), and visual/noise screening.
- Scaling of underground conduit lengths, camera pole quantities, and lighting zones depending on the facility footprint.
- Security provisions for all site access points, buildings, and secured areas as identified in this specification.

All assumptions used in developing the proposed physical security layout and costs shall be clearly identified in the Contractor's proposal. Final scope and quantities will be confirmed during detailed design in coordination with the Owner.

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:

1. Substation Control House – 100% coverage
2. Switchgear building – 100% coverage
3. Communications Room – 100% coverage
4. Control system Room – 100% coverage
5. 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

1. 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
2. Site lighting shall include light fixture, mounting poles, lighting controls, etc., as applicable.
3. Light fixtures shall be suitable for outdoor locations in wet locations. Light fixtures shall be light emitting diode (LED) type.

4. All site lighting equipment shall be UL listed.
5. Lighting control shall consist of a HAND-OFF-AUTO switch. Photocells shall be used for automatic control.
6. Photocells shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness.
7. Photocells shall be rated at 1800 VA, 120 volts ac.
8. Photocells shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.
9. Site lighting fixtures shall be installed in accordance with the equipment manufacturer's installation instructions.
10. Lighting fixtures shall be installed plumb and level and aimed as specified on the drawings, as applicable.
11. For storage projects, other applicable requirements in M1-05-03 (Substation Design and Construction Specification)

3.3 SECURITY FENCING PERIMETER WITH GATES

foot high mini-mesh or expanded metal fencing with 3 barbed wire strands, as specified below or as approved by Owner

1. Fence fabric shall be 1" mesh, #9 gauge wire, Class 2 Zinc-coated steel.
2. End, corner, angular, 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.
3. 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)
4. 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.
5. 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.
6. 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.
7. All emergency egress points at the site need to meet the same physical security requirements as any other door/gate at the site and must have access control card readers and intrusion detection points. These entry/exit points must allow for free egress from the site, but they must be built to not allow the mechanism that allows free egress to be actuated from the non-secure side of the door/gate
8. 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

4.0 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.

5.0 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. 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.

1. **CIP-002-5.1a R1 – BES Cyber System Categorization:** Contractor will provide information, as needed, for Owner to determine BES impact of the Project's generation resources and associated Cyber Systems.
2. **CIP-003-9 R2 – Low Impact Cyber Security Plan:** Contractor will coordinate with Owner to implement controls that ensure low impact BES Cyber Systems are protected according to the following sections of Attachment 1 of the Standard, as applicable:
    a. Section 1: Security Awareness
    b. Section 2: Physical Security Controls
    c. Section 3: Electronic Access Controls
    d. Section 4: Cyber Security Incident Response
    e. Section 5: Transient Cyber Asset and Removable Media Malicious Code Risk Mitigation
    f. Section 6: Vendor Electronic Remote Access Security Controls
3. **EOP-005-3 R4 – System Restoration:** Contractor will coordinate with Owner to ensure any planned BES modifications that would change Owner's System Restoration Plan are reflected in the System Restoration Plan and submitted to RC West for approval prior to commercial operation.
4. **EOP-012-2** – **Extreme Cold Weather Preparedness and Operations:** Contractor to ensure generation units meet the specifications for extreme cold weather requirements. This includes freeze protection measures to protect Generator Cold Weather Critical Components. Any units in commercial operation after October 1, 2027 that have a calculated Extreme Cold Weather Temperature at or below 32 degrees fahrenheit, will be required to operate not less than twelve (12) continuous hours, or the maximum operational duration for intermittent energy resources if less than twelve (12) continuous hours, during times of sustained concurrent twenty (20) mph wind speeds.
5. **FAC-001-4 R1 & FAC-002-4 R2 – Facility Interconnection Requirements** – Contractor will comply with PGE's *Facility Connection Requirements for Generating Resources*.

6. **FAC-008-5 – Facility Ratings:** Contractor to provide facility rating documentation including applicable equipment ratings and facility rating methodology of installed components
7. **IRO-010-5 & TOP-003-6 – Data Specifications & Collection:** Contractor will provide, as requested, information necessary to meet IRO-010 and TOP-003 Data Specifications.
8. **MOD-025-2 R1 and R2 – Real/Reactive Power Verification:** Contractor to perform a staged real and reactive power capability verification within 12 calendar months of commercial operation.
9. **MOD-026-1 R2 and R4 – Excitation System or Volt/Var Model Verification:** Contractor to perform generator excitation control system or plant volt/var control function model verification and provide Owner with verified model within 365 calendar days of commissioning date.
10. **MOD-027-1 R2 and R4 Turbine/Governor, Load Control, and Active Power/Frequency Model Verification:** Contractor to perform turbine/governor and load control or active power/frequency control model verification and provide Owner with verified model within 365 calendar days of commissioning date.
11. **PRC-005-6 R1, R2, R3, R4, and R5 – Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance:** Contractor to perform and document commissioning testing for protection systems (including protective relays, associated communications systems, voltage and current sensing devices, station batteries and DC control circuitry), as well as Sudden Pressure and Automatic Reclosing relaying components prior to commercial operation. Also requires in-service checks on protective relays after energization.
12. **PRC-019-2 R2 – Coordination of Generator Unit or Plant Capabilities:** Contractor to 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.
13. **PRC-024-3 R1 and R2 – Frequency and Voltage Protection Settings:** Contractor to verify and document 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. Once PRC-029 is fully implemented, IBR will be removed and PRC-024 will only include synchronous condensers.
14. **PRC-025-2 R1 – Generator Relay Loadability:** Contractor to verify generator relay settings are in accordance with PRC-025-2 – Attachment 1.
15. **PRC-027-1 – Coordination of Protection Systems for Performance During Faults**: Contractor to develop new settings for BES elements so that the Protection Systems operate in the intended sequence during Faults. Contractor to verify coordination of Protection Systems installed to detect and isolate faults on the BES so that they operate as intended sequence during Faults.
16. **PRC-028-1 – Disturbance Monitoring and Reporting:** Contractor to verify generation units have the necessary disturbance monitoring capabilities to evaluate IBR ride-through performance to meet PRC-028-1 criteria.. This applies to BES IBR’s and Non-BES IBR’s that either have or contribute to an aggregate nameplate capacity of >20 MVA connected to a voltage >60kV.
17. **PRC-029-1 – Frequency and Voltage Ride-through Requirements**: Contractor to verify ride-through and performance requirements for IBRs and the design and operation of the generation units meet PRC-029 criteria. Contractor to provide inverter control system settings capable of ride-through requirements. This applies to BES IBR’s and Non-BES IBR’s that either have or contribute to an aggregate nameplate capacity of >20 MVA connected to a voltage >60kV.

18. **PRC-030-1 – Unexpected Inverter-Based Resource Event Mitigation**: Contractor to verify generation units have the capabilities to identify unexpected IBR change of power output. This applies to BES IBR’s and Non-BES IBR’s that either have or contribute to an aggregate nameplate capacity of >20 MVA connected to a voltage >60kV.
19. **VAR-001-5 E.A. 15 and E.A. 17 – Voltage and Reactive Control:** Contractor to verify that generating equipment uses voltage set point, and complies with external voltage control loop specification established by these requirements.
20. **VAR-002-4.1 (All) – Generator Operation for Maintaining Network Voltage Schedules:** Contractor to comply with operation and notification requirements during testing and upon initial commercial operation.
21. **VAR-501-WECC-4 (All) – Power System Stabilizer (PSS)**: Contractor to comply with all PSS settings, testing, and operational requirements established by this Standard.

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

2025

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
2	19Jun25	Update from 2023 version	1898 & Co./PGE	PGE	SPF	Sean Flak

APPENDIX M1
ATTACHMENT 02
EXHIBIT 01

GENERAL CIVIL REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	15Dec23	Update from 14Apr23 rev	PGE	PGE	CPA	Craig Armstrong
2	19Jun25	Update from 2023 version	1898 & Co./PGE	PGE	SPF	Sean Flak

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.

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

1. A document review shall be conducted consisting of available geotechnical and geologic documentation, which at a minimum includes the following:
2. Historical and current aerial imagery
3. Regional geologic maps
4. Soil survey reports
5. Groundwater hydrology data and maps
6. Landslide hazard maps (as applicable)
7. Karst hazard (sinkhole) maps (as applicable)
8. Mine subsidence maps (as applicable)
9. Seismic hazard maps
10. Field photographs
11. Other geologic/geotechnical hazard maps (as applicable)
12. 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 M4-01-01 (Energy Storage Technical Documents). . 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 (Minimum Compaction: 95% of the maximum dry density as determined by ASTM D698. Moisture Content: Within ±2% of the optimum moisture content determined by the same test – or as approved by Owner).
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 <u>CIVIL WORKS</u>

2.1 GENERAL

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 M4-01-01 (Energy Storage Technical Documents).

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 requirements in M4-01-01 (Energy Storage Technical Documents).

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.

2.2 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.

2.3 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.

2.4 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.

2.5 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.

2.6 UNDERGROUND CABLE RUNS

Underground conduit and 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, conduits shall be laid during access road construction in order to avoid disturbing reinstated ground. All underground cable must be contained within conduit, except for bare grounding conductors. Direct buried cable is not allowed.

Possible surface reduction from future road maintenance shall be considered when selecting the cable burial depth at road crossings.

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.

2.7 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).

2.8 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

2.9 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.

2.10 RECLAMATION, RESTORATION, AND LANDSCAPING

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. A site specific Landscaping Plan must be submitted to the owner for review and approval in which after the landscaping work is complete, the contractor is required to maintain the project site landscaping in accordance to the approved plan until final site acceptance by PGE and project completion.

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.

3.0 WILDFIRE MITIGATION PLAN

3.1 WILDFIRE MITIGATION PLAN PRIOR TO CONSTRUCTION (PRE)

3.1.1 Update Applicable Sections of Construction WMP

To finalize this Construction WMP prior to construction of the facility, the following sections will be updated:

- Update Section 3.1 based on final facility design including a brief description of areas within the site that are subject to high wildfire risk, fire prevention features at the site, such as roads dimensions, setbacks, fire breaks, entry/exit locations, location of water truck(s) and fire protection equipment locations.
- Update Section 3.2 and include in this WMP the facility site maps described in Section 3.2.
- Update Section 3.3 with fire department, Contractor, and operational manager contact information and emergency response procedures.
- Update section 3.6 to describe vegetation management and areas that will be managed to be vegetation-free, noncombustible space, or gravel surface.

3.2 DEVELOP DRAFT OPERATIONS WMP

Prior to construction of the facility, a Draft Operations WMP will be developed to address wildfire risk at the site during operations of the facility. The Draft Operations WMP would be finalized prior to operations of the facility based on the as-built facility layout. Coordination of the Draft Operations WMP shall be the responsibility of the contractor to facilitate with sign-off by Portland General Electric prior to facility commissioning. The Operations WMP will include a description of wildfire risk at the site and will identify wildfire mitigation measures including:

- Wildfire mitigation through facility design
- Inspection of facility components
- Vegetation management
- Fire weather monitoring
- Emergency response

3.3 PRIOR TO CONSTRUCTION TASK LIST (PRE)

Prior to construction of the facility, the activities in Sections 2.1 and 2.2 will be completed.

3.4 TRAINING (PRE):

The Contractor will organize and hold an on-site training that includes the Certificate Holder, contractors and construction personnel, inviting specialty contractors, local fire department(s), participating and adjacent landowners, emergency management office personnel, ODOE, and any other emergency management agency. The training will cover:

- Description of construction phasing;
- The type, location, and proper use of fire protection equipment;
- Fire protection equipment usage and maintenance requirements;
- The location(s) of water source(s) and proper usage, storing and maintenance for the pump, hose nozzle; and water hose;
- Overview of smoking policy and locations;

- Overview of procedures and restrictions of construction maintenance activities during Fire Season and Red Flag Warnings designated in this Plan;
- Rescue, Alarm, Contain and Extinguish RACE procedures including:
  - Rescue anyone in danger (if safe to do so);
  - Alarm – call the control room, who will then determine if 911 should be alerted;
  - Contain the fire (if safe to do so); and
  - Extinguish the incipient fire stage (if safe to do so).
- Provide information and encourage attendees to sign up for the County's emergency management notification system.

3.5 SOLAR MICROSITING OR WIND TURBINE AREA SITE MAP(S) SUBMISSION (PRE)

The Contractor will update site maps from Section 3.1 and concurrently submit to local fire departments and Portland General Electric.

- Construction Wildfire Mitigation Plan (CON)
- Summary of Solar Component or Wind Turbine Description with Design Features and Location of Fire Protection Equipment

<u>Construction Phasing</u>

The Contractor(s) will maintain vegetation within the Solar Micrositing or Wind Turbine Area and will also maintain a defensible space clearance along Facility features. Defensible space will be free of combustible vegetation or other materials. Roads and parking areas will be maintained to be free of vegetation tall enough to contact the undercarriage of the vehicle.

- During construction clearing, grubbing, and grading, the contractor will create noncombustible space for at least 10 feet within the fence line and another minimum 10-foot limits of disturbance buffer outside the fence line for a total of a minimum of 20 feet of noncombustible buffer around the perimeter of the site. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- Smoking shall only be allowed in designated smoking areas at the Facility.

<u>Facility Site Map(s):</u>

The Construction WMP includes facility site maps that identify:

- The phasing for construction of facility features and components;
- Location and dimensions of facility roads;
- Location of vegetation free, noncombustible, defensible spaces;
- The location of facility access points;
- A description and the location of emergency access procedures, including how emergency responders and/or adjacent landowners may access site for fire protection equipment or to extinguish an on-site fire when personnel will not be onsite;
- The type and location of fire protection equipment on site;
- The location(s) of water source(s) that will be on-site during construction.

The facility site maps shall include the proposed Solar Micrositing or Wind Turbine Area, access roads, gen-tie line, BESS, laydown yards, project substation, and inverter locations, if in scope. As discussed above, locations of specific access points and gates will depend on final configuration of the solar areas and related infrastructure.

The final Construction WMP will include a site map detailing specific access points, location of fire protection equipment, and location of water sources.

3.6 SPECIFICATIONS FOR FIRE PROTECTION EQUIPMENT

The following fire suppression equipment will be carried in vehicles conducting maintenance activities and stored on-site at the O&M building at all times:

- Fire Extinguisher: Dry chemical. 2A:10BC (5 pound), properly mounted or secured;
- Pulaski;
- Hand Shovel: Round point. 26 to 28 in "D" Handle, blade - 12 inches long and 10 inches wide;
- Collapsible Pail or Backpack Pump: 5-gallon capacity;
- During fire season (designated Fire Season or June to October each year) water truck(s)/water source, water buffalo, or tank with minimum 500-gallon capacity must be on site, per Portland General Electric's review. The water truck or water supply shall include the following, unless approved by PGE:
- Pump should be maintained ready to operate and capable to provide a discharge of not less than 20 gallons per minute at 115 psi at pump level. Note: Volume pumps will not produce the necessary pressure to effectively attack a fire start. Pressure pumps are recommended.
- Provide enough hose (500 feet minimum) not less than 3/4" inside diameter to reach areas where power driven machinery has worked.
- Water supply, pump, and at least 250 feet of hose with nozzle must be maintained as a connected, operating unit ready for immediate use.

All internal combustion engines must be equipped with exhaust systems, mufflers and screens, or include an appropriate spark arrestor; and must be kept in good operating condition. All combustion engines (including but not limited to off road vehicles, chainsaws, and generators) will be equipped with a spark arrester that meets U.S. Forest Service Standard 5100-1.

All power-driven machinery will be kept free of excess flammable material which may create a risk of fire.

3.7 CONTACT INFORMATION AND EMERGENCY RESPONSE PROCEDURES

The Contractor shall secure and document local fire department and county emergency management contact information, as required. The Contractor shall document fire department response times to the site.

Contractor primary contact and contact of construction contractor manager(s) shall be provided to Portland General Electric at beginning of project or if there is any change in Project Management.

Construction contractor manager(s) contact information will be provided in the final Construction WMP.

Contact 911 in the event of:

- A fire or emergency on-site that cannot be addressed by personnel on-site and requires the assistance of fire or emergency medical personnel;
- A fire ignition on-site that spreads out of the fence line;
- Any fire off-site that does not have emergency responders on site.

- To the extent that construction personnel can safely assist and/or provide equipment to help extinguish off-site fires until emergency responders are on site, it is encouraged to do so to assist in the spread of the fire, loss of life, property and damage to the environment.

3.8 USE OF VEHICLES AND POWER-DRIVEN MACHINERY AT SITE

The following best management practices (BMPs) to minimize fire risk from vehicle travel, equipment use, and fueling activities will be implemented at the site during construction:

- The movement of vehicles will be planned and managed to minimize fire risk.
- The contractor(s) will be responsible for identifying and marking paths for all off-road vehicle travel. All off-road vehicle travel will be required to stay on the identified paths. No off-road vehicle travel will be permitted while working alone. Travel off road or parking in vegetated areas will be restricted during fire season as designated in this Plan.
- Areas with grass that are as tall or taller than the exhaust system of a vehicle must be wetted or mowed before vehicles travel through it.
- Workers will be instructed to shut off the engine of any vehicle that gets stuck, and periodically inspect the area adjacent to the exhaust system for evidence of ignition of vegetation. Stuck vehicles will be pulled out rather than “rocked” free and the area will be inspected again after the vehicle has been moved.
- The contractor(s) will designate a location for field fueling operations at the temporary construction yards. Any fueling of generators, pumps, etc. shall take place at this location only.
- Fuel containers, if used, shall remain in a vehicle or equipment trailer, parked at a designated location alongside a county right-of-way. No fuel containers shall be in the vehicles that exit the right-of-way except the five-gallon container that is required for the water truck pump.
- All power-driven machinery will be kept free of excess flammable material which may create a risk of fire.

3.9 FIRE WEATHER MONITORING AND RESTRICTIONS DURING FIRE SEASON

Definitions:

Non-Fire Season – Approximately October - May

Fire Season – Approximately June-September, formally designated by the Oregon Department of Forestry (ODF). Under ORS 478.960 (4), a Fire Chief can establish Fire Season within a Fire District when ODF, under ORS 477.505, declares Fire Season. Begins seasonal restrictions for public and industry.

Fire Weather Watch - A fire weather watch is issued when there is a high potential for the development of a red flag event. A watch is issued 18 to 96 hours in advance of the expected onset of criteria. Intent of a fire weather watch is to alert forecast users at least a day in advance for the purposes of resource allocation and fire fighter safety. A watch means critical fire weather conditions are possible but not imminent or occurring.

Red Flag Weather Warning - A red flag warning is used to warn of impending or occurring red flag conditions. Its issuance denotes a high degree of confidence that weather and fuel conditions consistent with local red flag event criteria will occur in 48 hours or less. Specific Red Flag criteria differ for each situation and district in Oregon. Be extremely careful with open flames and other activities that emit sparks.

Hot Work - Any cutting, grinding, welding, or other activity that creates spark or open flame.

Fire Watch Service -

Fire watch shall:

- Be physically capable and experienced to operate firefighting equipment.
- Have facilities for transportation and communications to summon assistance.
- Observe portions of the facility where equipment activity occurred during the day.

Upon discovery of a fire, fire watch personnel must: First report the fire, summon any necessary firefighting assistance, describe intended fire suppression activities; then, after determining a safety zone and an escape route that will not be cut off if the fire increases or changes direction, immediately proceed to control and extinguish the fire, consistent with firefighting training and safety.

Fire-Prevention Measures and Restrictions Associated with Fire Season:

Certificate holder shall maintain a log when construction activities are impacted by Fire Restrictions during Fire Season as designed in this Section. The log will include:

- The date;
- Industrial Fire Precaution Level (IFPL);
- Description of actions taken, including if any measures were taken to reduce wildfire risk that are not identified in this Plan.

Non-Fire Season

- All hot work must be conducted on roads or on non-combustible surfaces.
- Smoking in designated areas only.
- Fire Season
- All hot work (any cutting, welding, or other activity that creates spark or open flame) must be conducted on roads or on non-combustible surfaces.
- Federal and State IFPL restrictions need to be followed during construction, if applicable.
  - IFPL waivers can be requested and the restrictions within the waivers need to be followed.
- Water source meeting specifications in this Plan will be on site during fire season.
- Following the completion of hot work, the Certificate Holder or contractor(s) must maintain a fire watch for 60 minutes to monitor for potential ignition.
- Fire watch shall be on duty during any breaks and for one hour after all power-driven machinery used by the operator has been shut down for the day.
- Smoking in designated areas only.

Fire Weather Watch

- No hot work permitted.
- Driving and parking only permitted on graveled surfaces.
- Fire watch shall be on duty during any breaks and for one hour after all power-driven machinery used by the operator has been shut down for the day.
- No smoking on site.

Red Flag Weather Warning

- No hot work permitted.
- On-site personnel must be aware of Red Flag Warning.
- Driving and parking only permitted on graveled or paved (non-combustible) surfaces.
- Fire watch shall be on duty during any breaks and for one hour after all power-driven machinery used by the operator has been shut down for the day.
- No smoking on site.

Table 1: Fire Prevention Measures During Fire Season Summary

Requirement	Non-Fire Season	Fire Season	Fire Weather Watch	Red Flag Warning
Fire weather advisory	Not required	Not required	Not required	On-site personnel must be aware of Red Flag Warning.
On-site water source	N/A	As specified in Section 4.2	As specified in Section 4.2 and 4.3.	As specified in Section 4.2 and 4.3.
Hot work	Only permitted on roads or on non-combustible surfaces.	Only permitted on roads or on non-combustible surfaces; fire watch required for 60 minutes after completion	Not Permitted	Not Permitted
Fire Watch Service	Not required	During breaks and for 60 minutes after all power-driven machinery has been shut down for the day.	During breaks and for 60 minutes after all power-driven machinery has been shut down for the day.	During breaks and for 60 minutes after all power-driven machinery has been shut down for the day.
Driving and Parking	As described in Section 4.5.	As described in Section 4.5.	Only permitted on roads or on non-combustible surfaces and Section 4.5.	Only permitted on roads or on non-combustible surfaces and Section 4.5.
Smoking	Designated areas only	Designated areas only	Not permitted	Not permitted

3.10 VEGETATION MANAGEMENT

3.10.1 Vegetation-free, Noncombustible Space, and Vegetation Standards

Vegetation within the fence line and below the solar arrays will be maintained in accordance with the approved Revegetation and Reclamation Plan for the facility.

- Vegetation will be limited to a height of 3-12" inches during the rainy season (November-May) and cut down and cleared to a minimum 3” during the dry season (June-October), with a minimum clearance of 12 inches from electrical equipment.

- Vegetation near, at, or taller than the maximum height shall be removed or mowed.
  - Mowing must be done in advance of fire season or in accordance to any fire restrictions.
- At no point shall vegetation come in contact with electrical equipment.
- Any vegetation removed from the site will be disposed of and not stored onsite.
- Certificate Holder and contractors will prevent the accumulation of combustible “burn piles” on site.

The following areas will be managed to be vegetation-free, noncombustible space, or gravel surface:

- 16 foot wide service roads within solar fence line - all weather compacted soil or graveled
- 20 feet of noncombustible buffer around the perimeter of the site
- Fenced areas around the collector substation, operations and maintenance structure, and meteorological stations will be graveled, with no vegetation present
- Mnimum 3 foot buffer of non-combustable material between vegetation and electrical equipment outside the fence line.
- All newly constructed roads will be graded and graveled to meet load requirements for all equipment
- Vegetation along service roads will be managed by mowing or other vegetation removal to a minimum vegetation clearance of 10-ft on either side of the service road with a height of 10-12" during the rainy season (November-May) and 1-3" during the dry season (June-October).

Vegetation in these areas will be managed by the following techniques:

- Mowing
- Clearing

4.0 CONSTRUCTION TRAINING(S)

4.1.1 Safety Training

Once a year after construction begins, organize and hold an on-site training with certificate holder and construction personnel, inviting equipment manufacturers, specialty contractors, local fire department(s), participating and adjacent landowners, emergency management office personnel, ODOE, and any other emergency management agency that covers:

- The location of electrical facility components and the fire safety measures associated with each component that have been constructed;
- Description of remaining construction phasing;
- The type, location, and proper use of fire protection equipment;
- Fire protection equipment usage and maintenance requirements;
- The location(s) of water source(s) and proper usage, storing and maintenance for the pump, hose nozzle; and water hose;
- Overview of smoking policy and locations;
- Overview of procedures and restrictions of construction activities during Fire Season, Fire Weather Watches, and Red Flag Warnings designated in this Plan;
- Rescue, Alarm, Contain and Extinguish (RACE) procedures including:

    - Rescue anyone in danger (if safe to do so);
    - Alarm – call the control room, who will then determine if 911 should be alerted;
    - Contain the fire (if safe to do so); and
    - Extinguish the incipient fire stage (if safe to do so).
- Provide information and encourage attendees County’s emergency management notification system.

APPENDIX M1
ATTACHMENT 04
EXHIBIT 01

GENERAL ELECTRICAL STUDY REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	19Jun25	Update from 2023 version	1898 & Co./PGE	PGE	SPF	Sean Flak

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) 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 (Contractor shall confirm acceptable software version with Owner). Contractor shall follow Owner's modeling and naming conventions. 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. Modeling of inverter-based generation as a synchronous generator is not permitted.
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.

In addition, Contractor shall provide RMS power flow and transient stability models in PSS/E or PSLF format and EMT models in PSCAD format.

3.0 DESIGN CALCULATIONS

3.1 ELECTRICAL STUDIES

3.1.1 Load Flow

Prepare a load flow study in PowerWorld to determine the steady state loading profile of the project electrical system. Alternatively, PSS/E or PSLF formatted files can be provided.

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

3.1.7 Coordination Study

The Contractor shall provide a selective coordination study using Aspen OneLiner for any elements considered part of the Bulk Electric System (BES) or Easypower (if preferred) for non-BES and auxiliary power elements (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, as well as a review of the short-circuit model data for the BES elements, and review of the developed settings to 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

3.1.8 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 Arc Flash Hazard Study in ArcPro or ASPEN (as supported) for all BES and collector circuit elements, or Easypower (if preferred, for supported balance-of-plant/auxiliary elements only) as identified. Arc flash calculations for equipment operating between 208 VAC and 15kVAC shall be conducted 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

3.1.9 Insulation Coordination

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.

3.1.10 Transformer Sizing

Transformer sizing calculations, including medium-voltage and main power transformers, shall be provided prior to procurement of any power transformer.

3.1.11 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

3.1.12 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.

3.1.13 Harmonics Study (if required)

A harmonics study shall confirm that the generation plant harmonics output does not exceed limits required by generator interconnection requirements, IEEE 2800, and IEEE 519. This study shall provide recommendations for the use of harmonic filters, equipment, and methods as necessary to meet these requirements and provide the Total Rated Distortion (TRD). A pre-construction harmonic analysis report (performed at 90 percent design) and an as-built harmonic analysis report, respectively, shall be submitted.

3.1.14 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).

3.1.15 Effectively Grounded Study

An effectively grounded study shall confirm that the project is considered effectively grounded, as defined in IEEE C62.92.1.

3.1.16 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.

3.1.17 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.

3.1.18 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.

3.1.19 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.

3.1.20 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.

3.1.21 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 NERC COMPLIANCE

The project shall be designed to comply with all applicable NERC requirements, including provision of the studies and criteria 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 REPORTS AND DELIVERABLES

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. 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 reports being signed and sealed.

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

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	6/17/2025	Updated for 2025 Version	PGE	PGE	PNK	Paul Kruger

TABLE OF CONTENTS

1.0 GENERAL

This specification covers the general design, construction, and operating requirements for oil-immersed outdoor station type power transformers, Wind turbine pad-mounted step-up transformers and ground reference transformers.

2.0 POWER TRANSFOMERS

Main Power Transformers (MPT) and Generator Step Up Transformers (GSU) shall follow, to the greatest extent possible, the requirements outlined in PGE Standard:

- SDS-M010 (in Section M1-04-02-01 via secure website)
- SDS-M011 (in Section M1-04-02-02 via secure website)

PGE Standards referenced in this specification will be made available to bidders via a secure website following execution of the RFP Non-Disclosure Agreement (NDA).

The Contractor shall submit their transformer specification to the Owner for review and approval before purchasing a power transformer.

For Main Power Transformers associated with collector stations, interconnecting at 230kV, the following specifications are preferred:

- (HV, MV) Continuous MVA Ratings: 96/128/160MVA (full tapping range)
- Tertiary winding MVA Ratings: The tertiary windings shall be rated at least 35% of the main HV & MV windings’ ONAN / ONAF / ONAF MVA ratings.
- Number of Windings: 2 (HV, MV) + 1 (13.8kV) Stabilizing TV Winding
- Winding Connection (HV/LV/TV): Ynynd1 (Wye-gnd/Wye-gnd/Delta corner ground)

3.0 WIND TURBINE PAD-MOUNTED STEP-UP TRANSFORMERS

Pad-mount transformers associated with wind turbines shall follow the requirements outlined in "Wind Farm Electrical Technical Specification for Wind Pad Mount Transformers."

4.0 GROUND REFERENCE TRANSFORMERS (GRT)

The “GROUND REFERENCE TRANSFORMER (GRT) SPECIFICATION” is included as part of the specification for reference. The Contractor should utilities this when developing specifications for this class of transformer.

APPENDIX M1
ATTACHMENT 05
EXHIBIT 02

SUBSTATION ENGINEERING SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	6/17/25	Issued for Implementation 2025	PGE	PGE	PNK	Paul Kruger

TABLE OF CONTENTS

1.0 GENERAL INFORMATION

In the event of any conflict or discrepancy between this exhibit (including any attachments hereto) and any other Requirement, the more stringent or higher quality Requirement shall take precedence over the less stringent or lesser quality Requirement at Portland General Electric's discretion.

1.1 OVERALL SCOPE OF ENGINEERING

Contractor shall supply all engineering design services required for the XXXX Project unless otherwise noted in this specification. The engineering design shall comply with all documents in the Contract, including this specification, all provided Owner standards, and meet or exceed all applicable Industry Standards. The Owner standards are provided in XXXX and a list of Industry Standards is listed below in *Section 1.1*.

This Engineering Specification describes the minimum requirements for the Substation design. It is the Contractor's responsibility to ensure that all necessary drawings and calculations are developed to accurately represent and support the design. Contractor shall also develop all drawings and calculations necessary to support the permitting for this Project.

All engineering drawings shall be developed in AutoCAD using Owner provided Drafting Standards.

Contractor shall supply all required engineering calculations and studies for Owner review and Approval as required in this specification. In addition, any Contractor identified calculations necessary for the engineering design of the Substation shall also be submitted for Owner review and Approval. Calculations must clearly state all assumptions used to support the results. All submitted calculations shall use the software described in *Section 1.3* or elsewhere in this specification. When not specified, software used to support engineering calculations shall be Contractor choice with written Owner Approval.

The Substation Engineering Specification shall be used for developing the Substation design, however does not comprise the full scope of services required by the Contractor. The full extents of these additional services are described in the EPC Administrative Requirements specification.

1.2 STANDARDS AND APPLICABLE LAWS

1.2.1 PGE Standards, Practices, and Design Masters

Consultant shall supply all engineering design services based on the most updated versions of the PGE standards and design masters at the start of design. The current version of the standards have been provided with this Specification.

1.2.2 Industry Standards and Applicable Laws

The following industry standards published by the following industry organizations, associations or groups are part of the Project requirements and when referred to by title or basic designation only are applicable to the extent indicated by the specific reference.

Reference to (a) Industry Standards or (b) Applicable Laws shall mean the standards or laws adopted and published as of the release date unless specifically stated otherwise.

The Industry Standards or Applicable Laws referenced (including addenda, amendments, and errata) shall govern in all cases where references thereto are made except where they conflict with the requirements of the Project. A conflict shall be brought to Owner's attention for an Owner decision on which standard(s) or law(s) will govern.

If the Contractor becomes aware after the release date of a change in an Industry Standard or Applicable Law affecting the design or work to be performed, the Contractor shall promptly advise Owner of such change.

Reference Abbreviation	Name
AA	Aluminum Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
AISE	Association of Iron and Steel Engineers
ANSI	American National Standards Institute
API	American Petroleum Institute
AREMA	American Railway Engineering and Maintenance Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Nondestructive Testing
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CMAA	Crane Manufacturer Association of America
CRSI	Concrete Reinforcing Steel Institute
EIA	Electronic Industries Alliance
EPA	Environmental Protection Agency
HMI	Hoist Manufacturer's Institute
IBC	International Building Code
ICEA	Insulated Cable Engineers Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISA	Instrument Society of America
ISO	The International Organization for Standardization
NACE	National Association of Corrosion Engineers
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NERC	North American Electric Reliability Corporation
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
OSSC	Oregon Structural Specialty Code
SAE	Society of Automotive Engineers
SDI	Steel Deck Institute
SSPC	Structural Steel Painting Council
TIA	Telecommunications Industry Association
UL	Underwriters Laboratories, Inc

Contractor shall use ANSI standard units of measure on all submittals to Owner. Vendor drawings that contain other systems of measurement are acceptable if they also provide the equivalent ANSI units of measure.

1.2.3 List of Standards

In addition to Owner provided standards, the following table is a list of standards to be utilized throughout this Project. The latest edition of each standard is to be utilized unless otherwise noted.

Standard Reference	Title
ACI 318	Building Code Requirements for Reinforced Concrete
ACI 336.3R	Suggested Design and Construction Procedures for Pier Foundations
ACI/MSJC 530	Building Code Requirements for Masonry Structures
AISC 360	Specification for Structural Steel Buildings
ANSI/ASCE 7	Minimum Design Loads for Buildings and Other Structures
ASCE 113	Substation Structure Design Guide
ANSI/IEEE 525	Guide for the Design and Installation of Cable Systems in Substations
ANSI/IEEE 80	Guide for Safety in AC Substation Grounding
ANSI/IEEE C2	NESC National Electrical Safety Code
ANSI C37.2	Standard Electrical Power System Device Function Numbers, Acronyms and Contact Designations
ANSI/IEEE C37.21	Standard for Control Switchboards
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel
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 A325	Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A385	Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip)
ASTM F436	Standard Specification for Hardened Steel Washers
ASTM A500	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A615	Standard Specification for Deformed and Plain Billet Steel for Concrete Reinforcement
ASTM A780	Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992	Standard Specification for Structural Steel Shapes
ASTM F1554	Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ICEA S-94-649	Extruded Insulation Power Cables Rated 5 kV though 46kV
ICEA S-108-720	Extruded Insulation Power Cables Rated Above 46 kV through 345 kV
AEIC CS8	Specification for Extruded Insulation Power Cables and Their Accessories Rated 5 kV Through 46kV
AEIC CS9	Specification for Extruded Insulation Power Cables and Their Accessories Rated Above 46 kV Through 345kV
IEEE 1300	Cable Connections for Gas Insulated Substations
IEEE 1264	Guide for Animal Deterrents for Electrical Power Supply Substations
IEEE 1818	Guide for the Design of Low-Voltage Auxiliary Systems for Electric Power Substations

Standard Reference	Title
IEEE 367	Recommended Practice for Determining the Electric Power Station Ground Potential Rise and Induced Voltage from a Power Fault
IEEE 450	Recommended Practice for Maintenance, Testing and Replacement of Large Lead Storage Batteries for Generating Stations and Substations
IEEE 484	Recommended Practice for Installation Design and Installation of Large Lead Storage Batteries for Generating Stations and Substations
IEEE 485	Recommended Practice for Sizing Large Lead Storage Batteries for Generating Stations and Substations
IEEE 605	Guide for Design of Substation Rigid-Bus Structures
IEEE 693	Recommended Practice for Seismic Design of Substations
IEEE 81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
IEEE 979	Guide for Substation Fire Protection
IEEE C37.99	Guide for the Protection of Shunt Capacitor Banks
IEEE C57.13	Requirements for Instrument Transformers
IEEE C57.13.3	Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases
NEMA 250	Enclosures for Electrical Equipment
NFPA 70	National Electrical Code

1.3 DESIGN SOFTWARE

The following table is a list of required design software for this Project. See the individual sections for further explanation for the use of each software package. Any other software packages and must be Approved by Owner prior to their use. Contractor shall coordinate with Owner for which versions of each software package are acceptable. In general, the latest version available is preferred.

Software Function	Software Name
Word processing	Microsoft Word
Spreadsheets	Microsoft Excel
Database	Microsoft Access
Design Drawings	AutoCAD
Grading Design	AutoCAD Civil 3D
Drilled Piers Foundation Design	Ensoft Lpile
Structural Design	RISA 3D
Vehicular Access	AutoTURN
Cable Ampacity	CYMCAP
Cable Pulling	Pull-Planner
Grounding Analysis	CDEGS
Lighting Analysis	Visual Lighting
Sag-Tension Calculations	SAG10

1.4 SUBMITTAL REQUIREMENTS

Contractor shall follow the Owner's submittal process described in M1-01-02.

1.4.1 Record Drawings

During Construction, Contractor shall keep accurate written records of all design changes that deviate from the Issued for Construction drawings, referred to as As-Builts (or Redlines). All changes shall be marked on the Issue for Construction drawing set as designated by the Contractor for this purpose. These drawings and documents must always remain on site. Supplemental detailed sketches may be included with this set when there is insufficient space to document in the drawing.

Prior to Project Substantial Completion, Contractor shall supply scans of all final As-Builts to the Owner for their use. The scans must be sufficient quality, so the field marks are legible to the Owner. Contractor shall be readily available to respond to any questions from the Owner to clarify any As-Builts. The original As-Builts shall be left in the Control Enclosure in one stack, in drawing number order, and clearly designated as the As-Builts set for the Owner.

Contractor shall update and resubmit any models, studies, or calculations that are affected by the As-Builts changes.

Owner shall update all other drawings and documents for incorporating the As-Builts.

Contractor shall verify Owner has copies of all final versions of CAD drawings, Calculations, and Studies submitted by the Contractor prior to Project Substantial Completion.

2.0 MAJOR SUBSTATION EQUIPMENT

2.1 GENERAL

Contractor shall specify and procure all major substation equipment using PGE approved Vendors.

Contractor shall review each Major Equipment manufacturer's design, and provide comments and recommendations to ensure apparatus conforms to the Substation engineering design. All recommendations shall be coordinated with and Approved by the Owner. Owner shall be provided all design reviews for an opportunity to review.

The Contractor shall be responsible for attending the Factory Acceptance Testing (FAT) for all the equipment procured. The Owner may also attend at their discretion. Contractor shall coordinate with Owner for the FAT schedule.

2.1.1 Transformers

Transformers shall comply with Owner Specification M1-04-02.

2.1.2 Circuit Breakers

2.1.2.1 General

The interrupting and continuous duty of the breakers shall not exceed 85% of their rating

2.1.2.2 High Voltage Circuit Breakers

High voltage circuit breakers shall comply with Owner Specification SDS-M030

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

2.1.2.3 Medium Voltage Circuit Breakers

High voltage circuit breakers shall comply with Owner Specification SDS-M036

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

The low voltage compartment shall contain the protective relays, controls, and meters for the circuit breaker.

2.1.3 Circuit Switchers

High voltage circuit switchers shall comply with Owner Specification SDS-M034.

2.1.4 Disconnect Switches

Disconnect switches shall comply with Owner Specification SDS-M050

The substation shall include the use of 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 group-operated.

2.1.5 Switchgear

Switchgear shall comply with Owner Specification SDS-M047

2.1.6 Instrument Transformers

Instrument transformers shall comply with Owner provided detailed specifications and ratings at time of contract award.

2.1.7 Control Enclosures

Control enclosures shall comply with Owner Specification SDS-M025

Any exposed wall within 50’ and line of site to a power transformer shall be two-hour fire rated per the National Fire Protection Associate (NFPA) guidelines.

Contractor shall be responsible for acquiring all Control Enclosure permits.

Contractor shall be responsible for coordinating delivery and installation of the Control Enclosure per the instructions of the Vendor.

For drawing submittal requirements, refer to Section 1.4.

Relay racks shall comply with PGE Design Master Drawing, MSTR-4800.

2.1.8 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).

2.2 SUBSTATION ELECTRICAL ARRANGEMENT

The Contractor shall be responsible for the Substation design based on the performance standards laid out in the RFP. This will, at minimum, require verification of compliance with Owner and Industry Standards and Construction Specifications, as well as incorporation of all final Major Equipment drawings.

The electrical clearances for the air-insulated equipment within the Substation shall comply with Owner Standard S-130-04 and IEEE 1427.

The Contractor shall verify the clearances of live parts to grounded metal objects and designated roadways within the Substation. The Substation electrical arrangement shall consider personnel and vehicular accessibility and safety. For recommended electrical working clearances, refer to Owner Standard S-130-04.

In addition to the requirements in the previous paragraph, any overhead bus tie between Switchgear shall allow for drive access of Owner vehicles for maintenance. There shall be a large span between the rated distribution voltage bus supports for this purpose. The height of the bus shall be 21 feet in order to maintain electrical clearances for maintenance vehicles and allow for Owner standard bus support structures to be used. If there are compelling engineering reasons to increase the bus height, Contractor shall provide justification to Owner for Approval, but the height of the bus shall not be less than 21 feet.

Contractor shall ensure the equipment layout design can be safely installed while the existing Substation is energized, if applicable. Contractor shall be responsible for coordinating temporary design modifications required to accommodate the construction sequencing.

The electrical phasing within the Substation shall be dictated by the primary bushing orientation of the power transformer(s). The H1 bushing of the power transformer(s) shall be designated A-phase, H2 as B-phase, and H3 as C-phase. Contractor shall coordinate and ensure incoming transmission lines are the proper phasing.

2.3 RIGID BUS AND CONDUCTOR

The Contractor shall be responsible for designing all electrical connections between major electrical equipment, including any overhead bus tie between switchgear and underground capacitor bank circuits. The electrical clearances of all equipment, rigid bus, and flexible conductors shall comply with Owner Standard S-130-04.

Mechanical loading for rigid bus shall comply with the latest version of IEEE 605. Fault ratings used for bus calculations shall use maximum single line to ground and three phase faults using values provided by Owner. Contractor is responsible for requesting fault ratings in a timely manner that will not cause a delay to the agreed upon schedule. In addition to IEEE 605, the vertical deflection of bus shall be limited as follow:

3” maximum, with design ice & wind on ice.

1.5” maximum, with design wind.

Contractor shall prepare a full set of bus span calculations and submit to Owner as described in *Section 1.4*.

All rigid bus shall be 3” or 5” IPS tubular aluminum, Schedule 40, 6063-T6 or 6061-T6 aluminum alloy, and shall comply with Owner Standard S-131-06. All bus terminal fittings and splices shall be welded. However, fixed and slip rigid bus supports may be either bolted DMC “PLK” or welded hook-type fittings.

Contractor shall use flexible conductor connections between high and low rigid bus runs. Welded A-frames or rigid bus transitions shall not be used.

Elevation changes in the bus to account for grade changes shall be done using flexible jumpers. Bus bends shall not be used without Owner Approval.

Design of overhead strain bus exceeding 40’ in length shall be based on Owner Standard S-130-10. Strain bus spans shall be designed with consideration to vehicular access and equipment maintenance. All spans of strain bus shall be analyzed using SAG10, with worst-case sag conditions shown in graphic and tabular forms within the Substation drawings.

Fittings shall develop the full strength of the conductor and shall be capable of carrying the full current capacity of the conductor.

All Aluminum Conductor (AAC) shall be used for all bare current-carrying flexible conductors within the Substation. Aluminum Conductor Steel Reinforced (ACSR) conductor may be used for connections to instrument transformers, surge arresters, and for smaller conductor sizes that may benefit from the additional reinforcement found in the steel core.

The ampacity of flexible conductor connections shall be at least equal to the equipment being connected. At no point shall the flexible connections be the constraint within the current-carrying path. For tapped positions such as transformers, it is acceptable to size flexible conductor connections according to 150% of the full-load current. The ampacity of flexible conductor connections shall be determined based on Owner Standard S-131-15.

For electrical equipment energized at the nominal transmission and distribution operating voltage, the following flexible conductor arrangements shall meet these minimum requirements:

Required Ampacity	Conductor Arrangement
1200 Amps	1-1590 AAC “Coreopsis” per phase
2000 Amps	2-1590 AAC “Coreopsis” per phase
3000 Amps	2-2250 AAC “Sagebrush” per phase
< 900 Amps (Voltage Transformers, Surge Arresters, etc for voltages greater than 115kV)	1-795 AAC “Arbutus” per phase
< 500 Amps (Voltage Transformers, Surge Arresters, etc. for voltages 115kV and below)	1-336.4 ACSR “Linnet” per phase

Aluminum swage fittings shall be used for AAC and ACSR cable connections. Bolted cable terminals are shall not be used for current carrying conductors on the transmission system (57 kV or greater). They may be used for non-current carrying connections on the transmission system and connections to 13 kV breakers (open air).

All flexible conductor connections shall be designed with seismic considerations. Electrical connections to all major equipment terminals shall be made with flexible jumpers and designed with sufficient slack to allow for seismic movement. Alternative designs including connections made with rigid bus, laminated expansion bands, or expansion terminals shall not be used without written Owner Approval.

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.

For bolting hardware requirements, refer to MSTR-9090-1.

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.

Contractor shall provide electrical connection details for all rigid bus, conductor, and major electrical equipment connections within the Substation Above Grade drawing set.

2.4 CONDUIT AND VAULTS WITHIN SUBSTATION

Contractor shall develop a conduit and cable trench system based on the Conceptual General Layout, Owner Standard S-146-00, and guidelines specified below. Considerations to the planned future site expansion, if applicable, shall be incorporated into the design and construction. Contractor shall consider equipment maintenance access and minimize road crossings when developing the cable raceway design. Conduit shall not be routed under equipment foundations.

All installed cable trench and conduit shall be sized for planned future Substation yard expansion. Spare conduits from cable vaults shall be stubbed, capped, and clearly marked in the field and on the drawings for future construction. In addition to these, Contractor shall also supply spare conduits between cable vaults that are being installed.

If applicable, GIS foundation will have cast-in-place cable trench for GIS cabling and shall be effectively coordinated with the Vendor’s requirements. A cable vault shall be installed to interface with the conduit duct bank and GIS trench system. The cast-in-pace trench shall include:

- Drainage

- Embedded ground pads in the sidewall
- Turnouts for the premade cables supplied by Vendor

Conduit for the distribution feeders shall be designed to interface with distribution vaults located outside of the Substation. Contractor shall be responsible for conduit installation inside the Substation and up to five (5) feet beyond the fence. Contractor shall stub, cap and clearly mark these conduits in the field and on the drawings for Owner use.

Distribution vaults and distribution duct banks located outside of the Substation to be designed by others. Additional information shall be provided by Owner after award of Contract. The conduit design shall not impede installation of planned future switchgear and other equipment. Underground medium voltage cable crossings shall be minimized as much as possible. Conduits shall not cross under any foundations.

Fiberglass sweeps and couplers shall be utilized for applications requiring conduits greater than four (4) inches.

Contractor shall be responsible for supplying conduit with pull rop or mule tape for Owner's Communications and Security designs within the Substation.

Conduits on the Conduit Plan shall be indicated with Quantity, Size, and Material (e.g. 2-3" PVC). All conduits shall have a unique number assigned and listed in the Conduit Schedule. Contractor shall create a conduit schedule for all conduits within the Substation using Owner CCS database. See Supporting Documentation in Section 7 for more details.

Conduit penetrations of the foundations shall not be used without written Owner Approval. When required, they shall be clearly defined in the Conduit Detail and Foundation detail drawings.

Contractor shall provide conduits for control and power cables to each of the Major Equipment based on the following minimum requirements:

Equipment	Conduit Arrangement
Transmission Gas Circuit Breaker	2- 3" PVC
Gas Circuit Switcher	1- 3" PVC
Power Transformer	3- 3" PVC
Transmission & Distribution Capacitor Banks	1- 2" PVC
Instrument Transformers (VT, CT)	1- 2" PVC

All Communications fiber optic cables shall be installed inside innerduct using 4" PVC conduit. Conduits with innerduct tubing for fiber optic cables shall not contain any other types of cables, but may include 3-1" innerducts if doing so does not exceed Industry Standard installation practices.

13 kV and 34.5 kV Underground Distribution Duct Banks

- Refer to Section 2.5 for details

Contractor shall provide conduit details for all Major Equipment. Any required conduit details shall be created by the Contractor.

2.5 SUBSTATION GROUNDING

Contractor shall be responsible for developing the Grounding Plan based on the General Layout and future expansion of the Substation. A grounding analysis must be conducted using CDEGS software to verify the performance requirements of the ground grid. All design methods and calculations shall comply with or exceed the requirements of the latest version of IEEE 80 and Owner Standard S-140-00.Contractor shall also evaluate the impact of the ground grid design on any other nearby utilities such as sewer and water.

Contractor shall be responsible for performing resistivity measurements following the requirements outlined in Owner Standard S-140-50 and verifying the accuracy of the results. Owner to provide fault data and specify the safety margin used for the specific analysis.

Contractor Shall perform a current injection continuity check of the ground mat following installation. 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.

The Below Grade ground grid conductor size shall be 250 kcmil soft drawn copper with 19-#9 copper-clad steel stingers used for equipment grounding. All Below Grade grounding connections shall be copper swage fittings. Ground rods shall be ¾" diameter copper-clad steel, and of 8' length. 16' lengths (two coupled 8' rods) are acceptable if required for IEEE 80 compliance. The use of exothermic grounding connections shall not be used without prior written Owner Approval. Above Grade grounding connections to structures and equipment may be made with compression or bolted fittings.

Contractor shall provide grounding details for all Major equipment within the Substation Design Drawings. Refer to the Design Masters for Owner grounding detail standards. Any required grounding connection details shall be created by the Contractor.

2.6 13 KV AND 34.5 KV UNDERGROUND DISTRIBUTION CABLES

Contractor shall be responsible for designing and installing the conduits and duct banks for the Medium Voltage (MV) underground cables within the substation. For the distribution feeder duct banks, the Contractor design shall extend to five (5) feet beyond the Substation fence. Contractor shall stub, cap and clearly mark these conduits in the field and on the drawings.

The duct bank and conduit design must consider the operating parameters of the cable, cable bending radius limitations, pulling tensions, sidewall pressures, and coordination of other underground facilities and foundations within the Substation. Minimum conduit size shall be 6" PVC schedule 40. Fiberglass conduit may be used if PVC does not meet the engineering requirements. Contractor shall supply section views of the duct bank design with sufficient detail to be able to adequately review.

Conduit fill shall meet the recommendations of IEEE 525.

Contractor shall be responsible for installing and procuring materials for all MV cable terminations inside the Substation. All terminations shall be 3M cold shrink type and with weather sheds for outdoor terminations.

Medium Voltage cables and terminations shall comply with Owner Standards LD32020 ,LD32021, LD32023, and LD32024.

2.7 UNDERGROUND MEDIUM VOLTAGE SWITCHGEAR BUS TIE

For projects with a planned or installed underground switchgear bus tie, the Contractor shall verify the current buildout will not impede the ability to install the Underground Bus Tie. Contractor shall provide a proof of concept design that adequately demonstrates that any future Underground Bus Tie between switchgear can be installed without the use of extraordinary construction methods.

The Contractor shall perform a thermal modeling and ampacity study for all distribution ties within the Substation. This model and an accompanying analysis report shall be submitted for review with the 60% and 90% Below Grade Design. Analysis report shall provide thermal concrete and thermal backfill specifications if applicable.

Contractor shall provide all engineering drawings and supporting calculations required to adequately demonstrate the construction of the Underground Bus Tie and ability to meet all specification requirements. These shall include but are not limited to:

- Above Grade Elevations and Construction Details
- Bus Tie Termination Structure and Foundation(s) design
- Cross section views of the Duct Bank detailing feeder spacing, depth and dimensions with respect to the Substation Baselines and/or other foundations.
- Thermal Concrete and Thermal Backfill specifications
- Vault details (if applicable)
- Pulling Tension Calculations
- Cable Ampacity Calculations
- Medium Voltage Cable Material specification

2.8 ANIMAL MITIGATION

Contractor shall install animal mitigation using Owner Approved materials per Owner Standard S-130-50

All post insulators used to support 13 kV bus and other 13 kV connections shall be rated for 34.5 kV minimum.

The metalclad switchgear Equipment Specification includes Owner standard animal mitigation requirements for the rooftop supports and entrance bushings. These ratings shall not be modified by the Contractor.

2.9 LIGHTNING PROTECTION

Lightning protection shall be designed in accordance with IEEE 998.

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.

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.

- 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.
- 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 two (2) based on the allowable

3.0 SURVEY

3.1 SURVEY

The Contractor shall perform a topographical survey of the substation site extending 100 feet in all directions beyond the proposed site boundary. The survey shall be represented on a single continuous map with one (1)-foot contour intervals. All data shall be supplied in state plane coordinates per the applicable local datum.

Establish the baseline monuments and gather all planimetric data within the impact zone of the substation. Locate section and/or quarter corners and property corners that lie within or adjacent to the site and can be located after a reasonable search. Monument property corners for use by construction Contractor in establishing locations for construction.

Plot and identify the substation baselines and baseline monuments. Show all planimetric features within the substation boundary as identified in the topographic survey. Include the location of roads, fences, trees, drainage features, railroads, canals, buildings, foundation remains, existing power and/or communication lines (all structures), and other permanent features. All points shall conform to the provided feature code list.

Perform subsurface utility survey to tie in underground facilities that parallel or cross the proposed property and distribution centerline. Request and coordinate underground utility locations. Obtain, review and incorporate the underground electric, telephone and other communications, water, sewer, gas, storm drain and other underground facility maps into the final survey. Locate subsurface utilities using soft digs to expose and identify the location of subsurface facilities in critical areas, where apparent conflicts exist with the proposed project.

The Contractor shall provide an option for ground based LIDAR for surveying the Substation site, as well as the area for the distribution circuits. This shall be provided as an optional item with complete scope of work and deliverables clearly defined. Contractor shall coordinate with PGE prior to utilizing this method to conduct the survey.

The Contractor shall supply the following to PGE as part of this project:

- Technical specification for PGE’s review and comment prior to commencing the work.
- Final survey drawings stamped and certified by a Professional Land Surveyor licensed in the state of Oregon.
- Compile all planimetric mapping and survey data into one (1) electronic AutoCAD plan view drawing file.
- Provide one (1) AutoCAD topographic survey file georeferenced to the planimetric mapping.
- Prepare XYZ feature coded points file in comma delimited ASCII text format, suitable for upload into CAD software.

3.2 GEOTECHNICAL INVESTIGATION

The Contractor shall be responsible for performing all necessary field investigations and laboratory testing to prepare a geotechnical report for the substation development as well as any necessary investigations for the distribution system. The Contractor is also responsible for preparing a site-specific scope of work and technical specification for this activity and providing it to PGE for their review and comment prior to commencing the work.

The geotechnical investigation is to include at a minimum:

- Site grading recommendations

- Cut/fill material and installation recommendations
- Infiltration rate information
- Foundation design recommendations
    - Including Lpile parameters
- Chemical reactivity information
- Retaining wall recommendations
- Electrical resistivity measurements
- Thermal resistivity properties
    - Including dry-out curves determined through laboratory testing

The report shall be stamped and certified by a PE licensed in the state of Oregon and two (2) hard copies, as well as an electronic (.pdf) file, shall be provided to PGE for record keeping purposes. All field activities shall also be under the direction of a PE.

3.3 PERMITTING

The site development design shall comply with the local governing jurisdiction's permitting requirements.

3.4 SITE DEVELOPMENT

Contractor shall perform the necessary design functions to properly prepare a site development design that meets the approved local governing jurisdiction's Land Use Permit).

The design shall incorporate all necessary Federal, State and local development codes and standards that pertain to the site. General site design parameters include:

- Design shall meet the recommendations of the Geotechnical Report prepared specifically for the Substation. This includes (at a minimum) fill material and compaction, excavation and disposal recommendations, retaining wall design parameters, recommended cut and fill slopes, stormwater design parameters, and pavement design.
- Design shall utilize the Owner provided Survey.
- Consider cut-and-fill quantities and balance, if possible.
- Substation grade and all access roadways shall be designed to AASHTO HS-20 loading requirements and the subgrade shall be per the geotechnical recommendations.
- Substation finish grade slope shall be between 0.5-2%.
- Preferred design shall be sheet flow across the Substation grade and discharged per approved jurisdictional requirements.
- Show details for the drainage facilities such as drainage ditches, water diversions, culverts, and other significant drainage control features.
- All piping materials, if required, shall be non-metallic (e.g., reinforced concrete pipe, high-density polyethylene (HDPE)).
- All collection and treatment structures and devices shall meet jurisdictional requirements.

- All vehicle access shall be coordinated with Substation General Layout and the Contractor shall verify and provide evidence that accessibility is maintained to the Substation equipment as well as ingress and egress to the Substation. An access exhibit shall be prepared utilizing AutoTURN®. Contractor shall provide vehicle model for written Owner approval to be used during the analysis. The Owner shall provide the appropriate sized vehicle to use in this analysis after award of Contract.

Contractor shall prepare all required site design calculations (e.g., retention/detention, discharge rates and volumes, piping, infiltration) required to support the design.

Landscaping and Irrigation design and construction shall be as required by local jurisdiction and Owner approval.

Contractor to coordinate construction schedule of activities with the Owner and receive approval prior to beginning construction of any of the Site Development activities.

3.5 YARD SURFACING

The finished grade yard surfacing shall consist of either Yard Finish Rock or Road Finish Rock except as required for Land Use Permits and/or the Oil Containment.

Yard Finish Rock is defined as the surfacing rock installed as part of the grounding system for the protection against touch potential hazards.

Road Finish Rock is defined as the surfacing rock intended for use in drive areas and sections outside of areas where touch potential hazards may exist.

Contractor shall follow the minimum requirements described in Owner Design Master Standard MSTR-0160-1.

Contractor shall also follow all step and touch potential mitigation requirements and recommendations as described in the Grounding Analysis Report. See *Section 2.4* for additional details on the Grounding Analysis.

Contractor shall follow material and compaction requirements in Owner Construction Specifications Section 2160, Section 2170, and Section 2120.

Contractor shall immediately notify Owner of any conflicts between these requirements and shall work with the Owner to reach a resolution.

3.6 FENCE AND GATES

3.6.1 Fence

Fence and gates shall be 8’-0” tall of either chain-link or expanded metal fabric with an additional 1’-0” of barbed wire unless shown otherwise on drawings provided by Owner.

Design shall adhere to the requirements described in Owner Design Masters MSTR-0150 series drawings. For barbed wire and grounding details, Contractor shall follow the guidelines in MSTR-9240-1.

3.6.2 Gate

Gates shall be 30’ wide. Gate swing shall be toward the Substation. Note that the Grounding Design shall be compliant for a 30’ gate that swings outward toward the access road in case the gate is ever changed in the future. See *Section 2.4* for additional details on the Grounding Design.

Design shall adhere to the requirements described in MSTR-0150 series drawings. For barbed wire and grounding details, Contractor shall reference MSTR-9240-1.

3.6.3 Gate and Fence Signs

Contractor shall procure and install appropriate gate and fence signs per Owner Design Masters MSTR-9800 series.

3.7 FOUNDATIONS

All foundations shall be designed and detailed in accordance with Owner standards and applicable design codes (e.g., Oregon Structural Specialty Code, ACI 318). For specific loading requirements see Owner Standard S-123-10. Coordinate alternative requirements with Owner as necessary where locally adopted codes are newer than the referenced standard. Foundation design shall adhere to all geotechnical recommendations and properly take into account construction feasibility for site specific requirements and factors of safety.

Owner preferred foundation systems are slab on grade (mat), drilled piers or spread footings for equipment support structures and slab on grade (mat) foundation for the Substation equipment (e.g., switchgear, transformer, GIS). No other foundation types shall be used without prior Owner written approval. All foundations shall be coordinated with the necessary conduit, cabling and grounding requirements for each piece of equipment. Special care shall be taken when detailing the foundations to ensure proper fit-up and clearance is achieved and coordinated with the Vendor specific information.

Drilled pier design shall be per ACI 336 and utilizing Lpile by Ensoft, Inc., latest version. Spread footing and slab on grade design shall follow ACI 318 requirements. All foundation design shall incorporate the specific equipment Vendor requirements and tolerances. All loading requirements supplied by the Vendors shall be utilized to ensure conformance with delivery terms of the equipment.

Foundations shall be designed to meet the required strength considerations for both concrete capacity and soil strength. Limit foundation deflections as required by the Vendor for the supported equipment. Maximum allowable deflections are:

- Drilled Piers = ½” (top of pier)
- Slab on grade = 1” max vertical settlement, ½” max differential settlement
- Spread Footings = 1” max vertical settlement and ½” horizontal deflection at the top of stem

All equipment anchorage installed shall conform to the design requirements of ACI 318-11; Appendix D, or the equivalent code section where newer codes have been adopted. Vendor loading shall be utilized when available to determine anchorage system. The anchorage system can be cast-in-place, post installed adhesive or welded, and shall meet the recommendations of the Vendor when provided. Post-installed mechanical anchors may only be used in applications where water can drain from the anchor hole to avoid issues with freezing. Contactor shall coordinate with Owner and justify system used.

Contractor shall provide a Foundation Plan indicating the location of each foundation. Dimensions shall be provided to the center of the foundation on at least two sides. Tops of Concrete and Foundation Schedule shall also be *included on the Foundation Plan*.

Each unique foundation shall have a detail(s) and assigned drawing numbers following the guidelines in MSTR-0000-2

If project required existing foundation removals, Contractor shall develop a Foundation Removal Plan adequately documenting all existing foundations to be removed.

Transformer foundation design shall be coordinated with the necessary oil containment system. See *Section 3.8* for oil containment information.

All doorway entrances to the Control Enclosure shall require stair entrance foundation. Adjacent door entrances may share a double stair foundation. The stair foundation shall be large enough to install a galvanized or stainless steel guardrail and allow for the doors to be opened to at least 105 degrees. For additional guardrail details, refer to the Structural *Section 3.7*.

Foundation design shall comply with governing jurisdiction.

Contractor shall prepare a full set of calculations stamped and certified and certified by an Oregon licensed Professional Engineer (PE) to the Owner for their use.

3.8 STRUCTURAL

All equipment support structures shall be designed and detailed per the requirements the Oregon Specialty Code, latest edition, and all other necessary design codes (e.g. AISC, ACI, NESC, etc.). Design shall also meet the minimum requirements of ASCE 113. Contractor shall take into account the specific loading produced by each equipment type and adhere to the specific requirements to ensure serviceability is maintained.

Contractor shall comply with Owner Standard S-125-10 for specific loading combinations and deflection requirements. Equipment support structures shall be constructed of structural steel in accordance with AISC 360. Foundations shall be comprised of reinforced concrete in accordance with ACI 318. All structures shall be detailed for fit to ensure ease of installation.

Preferred material for the equipment support structures is HSS sections designed per AISC 360. Any deviations shall require written Owner approval.

Contractor may use an Owner standard structure when feasible for the application. Refer to MSTR-0500 through MSTR-599 for all available standard structures. If none of the standards are suitable for the application, Contractor shall design a new structure(s) with similar level of detail as the standards utilizing all Owner preferences. Each unique structure shall have its own drawing number assigned for the structural details.

Contractor shall also provide a Structural Location Plan indicating the location of each structure based on a modified version of the Foundation Plan. Each structure shall be identified on the plan and in the legend based on the drawing number assigned for the structural details. Drawing numbers are typically assigned based on the type of structure following the guidelines in MSTR-0000-2.

Contractor shall coordinate with Owner to ensure Line Termination Structure, or “Dead-End”, supports the tension loads of the incoming transmission lines.

All stairway entrances to the Control Enclosure shall include guardrails meeting the design and detailing requirements of the International Building Code and ASCE 7.

Contractor shall prepare a full set of calculations stamped and certified by an Oregon licensed Professional Engineer (PE) to the Owner for their use.

3.9 OIL CONTAINMENT

All oil filled equipment (OFE) having a volume greater than fifty-five (55) gallons shall have an oil containment system installed to satisfy all regulatory requirements.

The Contractor shall use a non-permeable liner surrounding each OFE with a separation fabric for durability and perimeter berm. Refer to the “Shield Area” on Owner Design Standard MSTR-0400. The Shield Area(s) shall drain to a containment pit with an oil/water separator sized to contain a minimum of 110% of the largest single OFE within the Substation (see “Pit Area” on MSTR-0400). The Shield Area shall be sized and sloped to provide adequate containment around the OFE using the distances from equipment on MSTR-0400 as minimum values. The site-specific Shield Area size will vary by layout and equipment size and should be coordinated with the Owner.

Pipes connecting the Shield Area to the Pit Area and pipes discharging from Pit Area shall be sized and sloped to provide adequate drainage. Refer to MSTR-0401 for standard details. Final discharge piping shall daylight above grade.

If the Owner standard oil containment system is not feasible for this Project, Contractor shall coordinate with Owner for alternative solutions.

The Contractor shall ensure all environmental regulations and requirements are met for this project. Any discharge from the site shall be per governing jurisdiction. Adequate erosion control measures shall be provided at any discharge points (e.g. drainage trench as shown on MSTR-0401, Sheet 2, Detail “D”, or rip-rap as required).

3.10 FIRE WALLS

Firewalls between multiple power transformers, and between power transformers and other protected equipment, shall be required as recommended in the National Fire Protection Association (NFPA) 850.

Fire ratings for fire walls shall be as recommended by NFPA 850. The composition of the wall shall be such that they are removable for maintenance operations, and when re-installed shall maintain the necessary fire rating. Owner’s preferred product is TruFireWalls by Oldcastle Infrastructure. Contractor shall seek Owner approval for alternate vendors.

Fire wall design shall incorporate the physical arrangement of the Substation and support, if needed, any bus work or any other equipment. The structural design of the wall and foundations shall satisfy the necessary design codes for the site (i.e., Oregon Structural Specialty Code).

The minimum physical dimensions of the fire wall shall be one (1) foot beyond any oil containing parts and shall break line of sight between protected equipment. This requirement is for both vertical and horizontal dimensioning.

Space shall be allocated in the design to accommodate future equipment and firewall installation.

Contractor shall prepare a full set of drawings and calculations (or provide vendor drawings and calculations) stamped and certified by a PE licensed engineer in the state of Oregon to Owner for their use.

4.0 STATION SERVICE

4.1 AC STATION SERVICE

Contractor shall determine the Substation AC load requirements for the initial buildout of the Substation loads as well as account for planned future loads. Contractor shall install all equipment and materials necessary to complete the AC station service unless otherwise noted.

Contractor shall calculate the AC Substation Load including estimated loads for planned future expansion for determining the size of the Normal and Alternate Station Service Transformers. These calculations shall be submitted for review with the 60% and 90% Control and Protection design.

Minimum station service transformer size for both Normal and Alternate sources shall be 25kVA. Typical transformer sizes used by Owner are 25kVA, 50kVA, 75kVA, 100kVA, and 167kVA.

The high size fuse protection for each station service transformer shall be coordinated and sized appropriately by the Contractor.

The station service transformer for the Normal source shall be one of the following:

- A single phase, 120/240V secondary, transformer sourced from the main distribution bus. If determined that the station service transformer size is 50 kVA or less, this may be provided by the switchgear Vendor, if applicable, inside the Auxiliary cubicle. If it is greater than 50kVA, it shall be a padmount located near the Control Enclosure or an overhead can mounted near the distribution bus. Switchgear Vendor shall then provide means for Kirk Key interlock system and a location to terminate a medium voltage power cable.
- A single phase, 120/240 V secondary, double bushing, overhead transformer can sourced from the tertiary of one of the power transformers.

The station service transformer for the Alternate source shall be single phase, 120/240V secondary, transformer and sourced from a local distribution line as determined by the Owner. If the determined station service transformer size is 50kVA or less, the source may be pole mount located by the distribution line source, although voltage drop needs to be considered as part of this decision. If it is greater than 50kVA, the station service transformer must be padmount and located near Control Enclosure.

Pad mount station service transformers shall meet the Owner Specification L10003 except that the primary terminals shall not include loop-feed terminations as referenced in the specification Part 4.4.1.

Contractor shall make all efforts to limit underground station service cable crossing with medium voltage distribution feeders.

Both Normal and Alternate sources shall connect to an automatic transfer switch (ATS) located inside the Control Enclosure. Each source shall first terminate on a service disconnect switch located on the exterior of the Control Enclosure. The switches shall be located as close as possible to the ATS. Contractor shall provide the rating requirements for the ATS and disconnect switches to the Control Enclosure Vendor in the Equipment Specification.

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.

For AC station service equipment located inside or mounted on the outside of the Control Enclosure, Contractor shall follow equipment rating and manufacturer guidelines specified below . Contractor shall verify all equipment ratings and adjust the Equipment Specification as needed for a functional AC distribution system.

Contractor shall be responsible for specifying the number of AC panelboards required and providing wiring diagrams that show all Substation loads and breaker ratings, while making provisions for future loads and spares. Breaker ratings shall meet the coordination and fault interrupting requirements as determined by a system study and NEC requirements. Refer to MSTR-5501-1 for typical layout drawing.

Rating Requirements

- 600 VAC
- Minimum 225A continuous frame rating
- Minimum 22 KAIC interrupting main and branch circuit breakers. Contractor shall verify Short Circuit Fault rating is adequate with the AC Station Service Calculations.
- Solid Neutral
- 120/240V single phase three wire (240V) or two wire (120V)
- UL 50 & 60, NEMA PB-1 compliant
- All panelboards must have Main Breakers.
- Minimum 42 pole branches
- ACP1 shall be bottom fed. Other AC Panelboards may be top fed or bottom fed
- Shall be accessible to cable tray system
- NEMA 1

The number of panelboards must accommodate all installed and planned future Substation AC loads. The Control Enclosure AC panelboards must also include the following spare branch circuits: six (6) 2-pole 30A, four (4) 1-pole 20A branch circuits. No poles shall be left blank. In other words, each pole shall be connected to a 2-pole or 1-pole branch breaker. Branch circuit cables designed and/or installed by Contractor shall be minimum #10 AWG.

Each AC Panelboard shall be drawn on its own drawing number per Owner standard. Contractor shall not use Vendor provided panelboard drawings for the Control Enclosure but may use the switchgear Vendor provided panelboard drawings. The drawing number assigned for the AC panelboards are described in MSTR-0000-1.

The AC Panelboard drawings are wiring diagrams and shall show full connection details, but there are no corresponding schematics for these drawings. Therefore, any Control and Protection schematic that references an AC panelboard shall reference the wiring diagram numbers.

On the main AC panelboard drawing, ACP1, wiring shall also be shown for the ATS, Normal and Alternate disconnect switches, and Normal and Alternate station service transformers. If the source of one of the station service transformers comes from the tertiary winding of a power transformer, this would then be shown on a Miscellaneous Three Line Wiring Diagram instead (see MSTR-6800-1).

The main AC panelboard, ACP1, must sub-feed all other AC panelboards in the Substation including the outdoor equipment. ACP1 shall also supply the battery chargers, battery trailer connection panels, and power transformers. Appropriately sized spare branch circuits shall also be supplied for the planned future expansion.

All Control Enclosure AC panelboard branch circuits installed by a Vendor or Contractor shall be shown in the AC Panelboard wiring and directory. Cable numbers must be assigned to all cables designed by Contractor even if it is Vendor installed. Examples would be Emergency Lights, AC power to SCADA rack, etc. If a cable is designed and installed by a Vendor, a cable number does not need to be assigned. Examples would be indoor receptacles, HVAC, exhaust fans, etc.

4.2 DC STATION SERVICE

This Project shall require one or two redundant 125 V DC vented lead acid battery bank systems (Primary and Backup). Contractor will analyze the Substation DC load requirements, including the operation of protective equipment, circuit breakers, motor operated disconnects, etc.

Contractor shall provide Owner calculations following the methods described in the latest version of IEEE 485 and Owner Standard S-135-10 that demonstrates adequate battery sizing, taking into account all planned future loads. These calculations shall be submitted for review with the 60% and 90% Control and Protection design.

DC Station Service System shall be ungrounded.

Contractor shall determine the Substation DC load and install all equipment and materials necessary to complete the DC station service.

Except for the battery banks, the DC station service equipment shall follow equipment rating and manufacturer guidelines specified below and in the Control Enclosure Equipment Specifications. Contractor shall verify all equipment ratings and adjust equipment specifications as needed for a functional DC distribution system.

Each battery bank shall have its own battery charger(s). If battery charger size for a single bank exceeds 50A, then two parallel chargers shall be used to meet the calculated ampacity requirements. For additional details, refer to Owner Standard S-135-10 .

Battery bank rack shall meet the seismic requirements specified in Owner Standard S-135-10.

Each battery bank shall require a minimum 200A, 250 VDC rated fused safety switch mounted on the output of the battery. Contractor shall verify safety switch and enclosure ratings.

The Control Enclosure shall have a separate room for each battery bank from the relay rack area. Each room shall have a single door entrance from the outside.

Contractor shall provide a battery trailer connection panel for each battery bank.

This Project shall have a Group A, B, and C DC distribution and protection system (see also Owner Standard S-135-10).

- Group A
    - DC loads connected to Primary battery bank
    - Transmission breaker Trip Coil 1/Close Coil circuits
    - Primary protective relays for transmission system
    - Every relay scheme, breaker scheme, and Comm racks, if applicable, shall be connected to its own 30A DC branch circuit breaker
    - DC Panelboards shall be named DCP21 (Main), DCP22, etc.
    - If possible, locate the breaker control branch circuits on a separate panelboard from the protective relay branch circuits

- Group B
  - DC Loads connected to Backup battery bank
  - Transmission breaker Trip Coil 2 circuits
  - Backup protectives relay for transmission system
  - Every relay scheme and breaker scheme shall be connected to its own 30A DC branch circuit breaker
  - DC Panelboards shall be named DCP41 (Main), DCP42, etc.
  - If possible, locate the breaker control branch circuits on a separate panelboard from the protective relay branch circuits
- Group C
  - DC loads that can be transferred between either battery bank via DC transfer switch.
  - Any DC powered device or function that does not have a fully redundant primary and backup version (e.g. SCADA, Switchgear Relays, Emergency DC Lights, DC Motor Operators, Transformer DC Control Schematics, etc.)
  - Each relay, device, and/or control scheme shall be connected to its own DC branch circuit breaker
  - Panelboards shall be named DCP61 (Main), DCP62, etc.
  - Transformer DC schemes and Emergency DC Lights shall be supplied from DCP61

DC panelboards shall be provided by Control Enclosure and switchgear Vendors. Contractor shall be responsible for specifying the number of panelboards required and providing wiring diagrams that show all Substation loads and breaker ratings, while making provisions for future loads and spares. Breaker ratings shall meet the coordination and fault interrupting requirements as determined by a system study and NEC requirements. Refer to Owner standard MSTR-5521-1 for typical panelboard layout.

Minimum Panelboard Requirements

- Shall meet Owner Standard S-135-10
- 42 poles with 2-pole branch breakers installed for every available position.
- Minimum 10 KAIC DC interrupting main and branch circuit breakers.
- All Panelboards shall have main breakers.
- May be top fed or bottom fed
- Shall be accessible to cable tray system
- NEMA 1

All non-sub feed DC branch circuits shall be rated for 30A and wiring shall be minimum #10 AWG.

All Main DC panelboards (DCP21, DCP41, and DCP61) located in the Control Enclosure shall include minimum four (4) 100A branch breakers for sub-feeding planned and future DC panelboards. Main DC panelboards shall have a 225A main circuit breaker. All subfed DC panelboards shall have a 100A main circuit breaker.

The DC panelboard drawings are wiring diagrams and shall show full connection details, but there are no corresponding schematics for these drawings. Therefore, any Control and Protection schematic that references a DC panelboard shall reference the wiring diagram drawing numbers.

Wiring diagrams for the battery banks, safety switches, DC junction boxes, battery trailer connection panel and battery chargers shall be shown on the respective main DC panelboard wiring diagram.

4.3 STATION SERVICE ONE LINE SCHEMATIC

Contractor shall be responsible for developing a Station Service One Line Schematic. The diagram shall show connections between major station service equipment along with cable sizes, including but not limited to station service voltage transformers, protective fuses, main breaker ratings, ATS, AC and DC panelboards, battery chargers, battery banks, etc. Branch breakers designated for future AC or DC panelboards shall also be shown.

4.4 YARD LIGHTING

Contractor shall develop a Lighting Plan using Visual™ software based on the General Layout and Owner Standard S-137-10. Lighting shall consist of background lighting automatically controlled by a photocell (controls and photocell provided by Control Enclosure Vendor) and activity lighting that is activated at a gate control switch or the lighting control panel located in the Control Enclosure. The Lighting Plan shall also show lighting cable numbers and the associated control circuit.

Substation lights shall only be LED.

The standard requires each Substation to have a gate controlled light switch per gate. Contractor shall note that the Lighting Control standard (MSTR-4400-2) is designed for two gate switches. The design must be adjusted to allow for appropriate manual control of the yard lights at the gate switch and the Control Enclosure when there is a deviation from Owner standards.

Contractor shall comply with the governing entity regarding requirements for Substation Lighting.

Only fiberglass light poles shall be used for mounting light fixtures. If light poles cannot achieve Owner standard illumination and the requirements of the governing entity, Contractor shall propose alternatives for written Owner approval. Location of luminaires and light fixtures shall not result in requiring any outage to maintain or replace. The determination of whether an outage would be required for maintenance shall be made solely by the Owner.

Lighting control cabinet and photocell control wiring to be provided by the Control Enclosure Vendor. Contractor shall install yard cable interfaces for yard lights and yard lighting control. For a typical lighting control circuit, refer to MSTR-4400-2.

Photocell control shall also include a manual cutout toggle switch and Security System cutout per MSTR-4400-2. Background lights shall also be controllable by the Security System. Contractor shall ensure the lighting control cabinet allows for ease of installation of security wiring.

Cables for LED luminaire power supply shall be shielded and grounded at both ends. For more details refer to Owner Standard S-144-20.

4.5 YARD RECEPTACLES

Contractor shall install 50A 600V Twist-Lock, 3-Pole 4-wire receptacles such that at least one receptacle is within 75 feet of likely parking locations near the equipment. Minimum two (2) shall be installed with each receptacle on its own AC panelboard branch circuit. Additional receptacles may be daisy-chained, with both circuits having equal or near equal number of receptacles on each branch.

Receptacle shall be rated for outdoor use and have a weather proof cover.

For the purposes of the AC Load Analysis, no more than two receptacles shall be in use simultaneously.

5.0 CONTROL AND PROTECTION SCHEMATICS AND WIRING

5.1 GENERAL

Contractor shall be responsible for developing the Control and Protection schematic and wiring design for the Substation.

Reference Section 1.4 for which drawings and documents are required for each submittal.

Contractor shall verify all Schweitzer Engineering Laboratories (SEL) relays furnished are equipped with the correct firmware and Owner standard specifications. When issuing a P.O. for SEL relays, Contractor shall specify Portland General Electric (Owner) is the end user. Contractor shall verify Owner's Special Spec is applied. Owner's Special Spec number is 33.

Contractor shall be responsible for the design and installation of all SCADA and protective relay device settings.

Vendor Drawings:

- Vendor supplied drawings shall not be used in the One Line Schematic, Three Line Schematic, Network Block Diagrams, or Control Enclosure AC/DC panelboard wiring diagrams. These drawings must be created or updated by the Contractor using Owner Design Master and CAD standards. The Vendor supplied version of these drawings shall still be verified by the Contractor for accuracy.
- When Vendor supplied drawings are used, Contractor shall modify as required to show the interconnections to external devices using Owner CAD and design standards. Any revisions to these drawings, including field wiring changes, cable installations, and other modifications are considered drawing revisions and shall be documented according to Owner CAD standards. Contractor shall not utilize vendor designed CAD blocks or styles without Owner approval.
- Drawing references provided by the Vendor shall be updated to reference the Owner drawing numbers as required. These updates shall not be shown as revisions.
- Contractor shall apply standard Owner border and convert to Owner standard CAD platform (as required) for all used Vendor supplied drawings in the Design Drawings.

5.2 METERING

Revenue meters shall be installed at the project substation and downstream plant to account for gross and net generation, as well as station service and auxiliary loads. Each revenue meter shall be sourced from high accuracy, revenue grade current and voltage transformers, and shall comply with the requirements shown in the Interconnection Agreement and any power purchases agreement(s). Actual revenue meter locations and instrument transformer specifications shall be determined by PGE metering personnel.

SCADA meters shall be installed on each medium-voltage (34.5kV) collection system circuit feeder.

5.3 PROTECTIVE RELAYS

Revenue 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.

Relay settings shall, to the extent applicable and possible, follow Owner's standard template and protection practices in effect at the time settings are developed. Contractor shall request the latest standards from Owner prior to starting work.

Contractor will provide Inverter control system settings capable of ride-through requirements.

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.

Owner shall approve the model and firmware version of all relays prior to procurement by Contractor. SEL must be informed that Owner is the end user of the relays to apply Owner's Special Specification requirements, including standard firmware. Model and firmware shall follow the owner's standard in effect at time of purchase. Field firmware updates may be required if a critical service bulletin is released between purchasing and commissioning.

5.3.1 Control and Protection Design Requirements

5.3.1.1 One Line Schematic

Contractor shall prepare the One Line Schematic per Owner Design Master to ensure scheme coordinates effectively with the system and equipment.

One Line Schematic should show equipment identified by standard ANSI device function numbers; instrument transformer and equipment ratings; current transformer (CT) and potential transformer (PT) connections to the protective relaying with solid lines; and protection, control, and metering functions with dashed lines. A legend for the major relay equipment shall also be provided. The appropriate Major Equipment (circuit breakers, transformers, PTs, etc.) should have an associated equipment identification letter for wiring purposes per Owner Standard Position Letter Exclusions. Note – these letter exclusions shall also be followed when developing wiring tags.

5.3.1.2 Three Line Schematic

Contractor shall prepare Three Line Schematic and Schematic Details to show the interconnections of the instrument transformers, metering, relaying, and control circuits per Owner Design Master standards. Layout of the Three Line Schematic should match as closely as possible with the One Line Schematic and General Layout.

5.3.1.3 Protective Relaying Control Schematics

Contractor shall prepare the protective relaying control schematics per Owner Design Master standards to the extent applicable and possible.

Switchgear protective relaying schemes, if applicable, shall be prepared by Vendor and verified by Contractor that they meet Owner Design Master standards and specifications to the extent applicable and possible.

5.3.1.4 Breaker Control Schematics and Wiring

Contractor shall review all breaker Vendor supplied drawings and verify accuracy of drawings and accordance with the Control and Protection design for this Project. In general, all breaker Vendor supplied schematic and wiring diagrams shall be placed in the Design Drawings with Owner standard borders. Contractor shall coordinate with Owner which drawings shall be included in the Design Drawings after approval drawings are received.

5.3.1.5 Transformer Control Schematics and Wiring

Contractor shall review all transformer Vendor supplied drawings and verify accuracy of drawings and accordance with the Control and Protection design for this Project. All transformer Vendor supplied schematic and wiring diagrams, including drawings from the LTC Vendor, shall be placed in the Design Drawings with Owner standard borders. Contractor shall coordinate with Owner which drawings shall be included in the Design Drawings after approval drawings are received.

Transformer alarms are monitored by electronic equipment mounted on the transformer with communication over fiber. For standard transformer alarm and tripping functions, refer to the Owner Standard S-110-30.

5.3.1.6 Capacitor Bank Switch Control Schematics and Wiring

The Capacitor Bank protective relaying schematics shall be provided by the Vendor. Contractor shall verify the design meets Owner Design Master standards and specifications.

Contractor shall design Capacitor Bank control wiring diagrams using Owner provided Design Master or reference to be provided after award of Contract.

5.3.1.7 SCADA

Contractor shall prepare the Network Block Diagram per Owner Design Master for the basis of the Substation SCADA design. Owner utilizes a distributed input/output (IO) system with modules mounted on the relay racks or electrical equipment for device status and alarms. Distributed IO devices, relay communications and Irig-B are connected to gateway and ethernet switch devices located on a main SCADA/HMI rack.

5.3.1.8 Network Block Diagrams

Develop drawings showing all the Substation automation devices. Drawings shall indicate all Substation network connections to relays, meters, IO, and other devices. Other information shall include cable types, communication protocols, and IP addresses.

Ethernet and Irig-B connections for the GIS (if applicable) are not included in the Conceptual Design. Contractor shall update the design per the Vendor supplied drawings and submit with the 60% Control and Protection design for review. If this information is available prior to Contractor start date, these drawings may be updated by Owner and issued as an addendum. Contractor shall still be responsible for verifying the accuracy of these drawings.

IP addresses shall only be listed in the Network Block Diagram. These shall be provided by Owner no later than the 60% design review comments.

5.3.1.9 Pilot Scheme Block Diagram

Develop drawing showing line differential (87L) and MBTT communication paths.

5.3.1.10 SCADA/HMI Control Schematic

Develop schematic showing the DC power connections to all devices located on the main SCADA rack. Contractor shall reference Owner Design Master MSTR-4110-1 for additional details.

5.3.1.11 Relay Alarm and Status Schematics

Schematics for the distributed IO devices shall be included as part of the relay Control and Protection schematics based on the relay rack the device is located on. Refer to the Owner Design Master standards.

IO device schematics located in switchgear and GIS, as applicable, shall be provided by the Vendor and verified by Contractor that they meet Owner Design Master standards and Equipment Specifications. Contractor shall use vendor supplied IO schematics as part of the Control and Protection Design Drawings.

The status alarms for all GIS equipment, as applicable, shall be collected at the GIS IO devices located in the Local Control Cabinets (LCC) instead of the relay rack IO.

IO devices located on the protective relay racks shall still be used for trip and close control functions of the circuit breakers. Only one IO device shall be used for control for each circuit breaker. The breaker controlled shall be the same as the 52CS control switch located on the same rack.

5.3.1.12 Transformer Status and Alarms

Shall be connected by the transformer vendor to digital monitoring device mounted in the transformer control cabinets. Alarms are communicated back to the SCADA via fiber.

Schematic for transformer alarms shall be included in vendor design drawings.

5.3.1.13 Station Service One Line Schematic

Refer to Section 4.1 for additional details

5.3.1.14 Control Enclosure Drawings

- Contractor shall review all Control Enclosure vendor supplied drawings for accuracy of drawings and accordance with the Substation design for this Project. Contractor shall apply the standard Owner drawing border and drawing numbers for vendor supplied Electrical Drawings except for AC and DC Panelboards. Contractor shall modify drawings as required to show the interconnections to external devices.
- Contractor shall ensure all equipment and devices not installed by Control Enclosure Vendor are added to the layout and elevation drawings (e.g. relay racks, comm racks, DC equipment, desk, battery banks, door swing, etc.). All must be properly dimensioned at the appropriate scale.

5.3.1.15 Relay Rack Layouts

Contractor shall provide relay rack and elevation details for relaying shown on the conceptual Single Line Diagram.

All rack mounted devices shall be shown to scale with reference to a list of materials number. Rack layouts should also show a unique nameplate for the rack, major devices and test switches. Drawings shall be set-up logically and coordinate with the Control Enclosure layout. relay rack fabricator shall be responsible for the panel steel and construction drawings. These fabrication drawings do not need to be included in the Design Drawings.

5.3.1.16 Wiring Diagrams and Requirements

Owner Design Masters have been provided for various types of racks. If additional standards are available at time of award, they shall be then provided to Contractor. Contractor may request reference drawings for racks not currently shown in the standards; however, these drawings are not guaranteed to match the project.

5.3.1.17 DC Panelboard Cables

All cables originating from the DC Panelboard to a relay rack shall be terminated at the bottom of terminal block TB2 column as shown in the Engineering References.

All cables originating from the DC Panelboard to a Comm Rack shall reach to the bottom of the rack plus 2 feet. The cables are to be coiled on the cable tray directly above the Comm Rack.

Contractor shall not install additional wires on the same side of the terminal block as the DC panelboard cables.

5.3.1.18 Sliding Link and Knife Disconnect Terminal Blocks

The specified States terminal blocks have sliding links that allow for the isolation of one terminal from another. Some specified Phoenix Contact terminal blocks have a Knife Disconnect that also allow for isolation of one terminal from another.

Maintenance and testing may use this feature to isolate certain circuits without test switches, typically involving Digital Inputs of the protection relays for the States blocks, and SCADA alarms for the Phoenix Contact blocks.

Terminal blocks capable and intended to be used for this type of isolation are represented by a half-shaded square terminal block in the control or relay schematic. The rack wiring design utilizing these terminal blocks must allow for the isolation of the circuits from the DC positive and/or negative source upon operation.

Relay rack terminal blocks without the ability to isolate or are not intended to be used for isolation are represented by a circle with an 'X' inside.

Both terminal block symbols represent States or Phoenix Contact terminal blocks on the relay rack.

Circuits that utilize the States sliding link function shall be wired at the top of the terminal block TB2 column. The primary relay circuits shall located be above the backup relay circuits.

5.3.1.19 Control Wiring

Control wiring shall be connected to the remaining terminal blocks available in TB2.

For Ring Bus relay protection, it is likely there won't be enough terminal blocks for all control and DC cable wiring on terminal block TB2. In this case, Contractor shall use the bottom terminal blocks of TB3 as required.

5.3.1.20 Current Transformer (CT) Wiring

CT circuits terminated on a relay rack shall be connected to the top terminal blocks of TB3.

CT cables in the wiring diagrams shall be shown with a thicker line weight compared to other cables. Refer to Owner CAD standards.

CT neutrals shall be grounded in a single location at the first termination inside the Control Enclosure.

For standalone Current Transformers, all windings and taps shall be wired to the CT junction box. For equipment with bushing CTs or GIS CTs, all CT windings and taps shall be wired to the equipment cabinet or LCCs respectively.

When cables are used, each CT, or set of three phase CT's intended to be grouped for the same function, shall have its own dedicated cable and shall not be combined in the same multiconductor cable as any other circuit.

For multi-ratio CTs, only the tap used shall be wired from the equipment cabinet or CT junction box to the protection equipment.

Unused CTs shall be shorted and grounded at the equipment cabinet or CT junction box.

CT cables shall be at least 4 conductors even for single phase circuits. In the unlikely case that more than four conductors are needed, Contractor shall justify and request approval from Owner. Generally, this is only considered when double conductors are needed to reduce burden.

5.3.1.21 Voltage Transformer (VT) Wiring

VT circuits terminated on a relay rack shall be connected below the CT circuits on TB3.

Contractor may "daisy-chain" VT circuits from rack to rack. If space is available, Contractor shall connect a jumper to another terminal block for continuing the circuit to another rack. In other words, do not connect two cables to the same terminal block as long as space is available.

If there is not enough terminal block space, two VT cables connected to the same terminal block is acceptable.

Secondary winding VT neutrals shall be grounded in a single location at the first termination inside the Control Enclosure. Unused secondary winding VT neutrals shall be grounded at the fuse junction box.

For standalone Voltage Transformers, all windings and taps shall be wired to the fuse junction box. For GIS Voltage Transformers, all windings and taps shall be wired to the LCC.

When cables are used, each VT winding, or set of three phase windings intended to be grouped together, shall have its own dedicated cable and shall not be combined in the same multiconductor cable as any other circuit. When multiple taps on the same winding are used, each tap shall require a dedicated cable per the same requirements.

Only windings and taps used shall be wired from the equipment cabinet or fuse junction box to the protection equipment.

Cables shall be at least 4 conductors even for single phase circuits. In the unlikely case that more than four conductors are needed, Contractor shall justify and request approval from Owner.

5.3.1.22 Wire Names

Wire Names (or Tags) are a unique identifier that represents an electrical node.

In general, each Wire Name should be unique for the entire Substation, though this may not be the case for Vendor supplied equipment

Wire Names shall be shown in both schematics and wiring diagrams. Refer to Owner Design Masters for how that should be depicted in the drawings.

Refer to Owner Standard S-144-60 for how to apply physical labels for cables and switchboard wiring.

5.3.1.23 Conductor Selection

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.

5.3.1.24 AC and DC Panelboard Wiring Diagrams

Refer to Section 4.0 for details.

5.3.1.25 Miscellaneous Three Line Wiring

Shall describe the wiring for standalone Instrument Transformers (Voltage Transformers, Metering CT's, etc.). Refer to additional guidelines provided in MSTR-6800-1.

The Normal and Alternate station service transformer wiring may be shown on this drawing if there is insufficient space on the ACP1 panelboard wiring diagram.

5.3.1.26 Metaclad Switchgear Drawings

Contractor shall review all switchgear Vendor supplied drawings and verify accuracy of drawings and accordance with the Control and Protection and Station Service design for this Project.

Contractor shall organize and update outline drawings, schematics, wiring diagrams, etc. similarly to previous projects. This second digit in the drawing number shall be based on the switchgear number.

5.3.1.27 GIS Circuit Breaker and Motor Operated/Ground Switch Control Schematics and Wiring (if applicable)

Contractor shall review all GIS Vendor supplied drawings and verify accuracy of drawings and accordance with the Control and Protection and Station Service design for this Project.

Contractor shall follow guidelines in Owner Standard MSTR-0000 for GIS drawings to include in the design package and drawing number assignments. Contractor shall propose GIS drawing numbers, drawing titles, and drawing list for Owner review and submit with the 60% and 90% design submittals.

Contractor shall apply Owner Design Master standards for the breaker control schematics as best as possible. Contractor shall seek clarification from Owner for any questions regarding how to apply the standards to GIS equipment.

The Trip 1/Close and Trip 2 circuits shall require separate battery source (Group A and Group B respectively).

The Motor Operator DC control circuits are considered Group C loads (Refer to DC Station Service in Section 4.0, Part 3.0).

All DC circuits shall require its own 30A branch breaker, though the Contractor shall verify each branch breaker meets the load requirements.

All GIS cables from the LCC to Control Enclosure shall be shielded and grounded at both ends unless otherwise required by GIS Vendor. Cables from GIS equipment to LCC should be provided by Vendor. If not, Contractor shall follow requirements by GIS vendor.

All vendor supplied cables shall have a cable number assigned per Owner standard and included in the Cable Schedule.

5.3.1.28 Additional Wiring Requirements

Conductors associated with the Trip Coil 2 and VDC monitoring shall be on a separate multiconductor cable from Trip Coil 1 and Close circuit associated conductors. This applies only for outdoor cables. Rack to rack cables are not required to adhere to this restriction.

Contractor shall supply spare conductors and/or cables to outdoor equipment to account for planned future expansion. Spare conductors on VT, CT, or power supply cables shall not be considered for the purposes of meeting this requirement.

Contractor shall also provide some spare cable conductors to each major outdoor equipment for potential future or replacements for broken wires. An example might be to use a 7/C#10 cable instead of a 4/C#10 cable for one of the equipment cables. Spares for this purpose shall only be added to control cables (i.e. not CT, VT, AC power, or DC power cables). Contractor shall coordinate with Owner before and during the design reviews for an acceptable number of spare conductors.

All spare conductors shall be #10 AWG.

AC Power circuits shall not be combined in the same multiconductor cable as any other type of circuit. All AC power multiconductor cables shall be four conductors for #10 AWG or at least three conductors when larger than #10 AWG.

Two conductor cables shall only be used for DC power circuits from the DC panelboards.

For raceway requirements, refer to Owner Standard S-146-00.

Aluminum conductors shall not be used for any 600V rated cable or conductor. All 600V cables and conductors shall meet the specifications in Owner Standard S-144-20. Refer to Section 6.0 for additional details on cable materials.

All rack to rack cables, except for Network, Irig-B, and communications circuits, shall be multiconductor cables.

5.3.1.29 Supporting Documents

Drawing List, List of Materials, List of Nameplates, and Cable Schedule

5.3.1.30 Studies and Calculations

AC and DC Station Service Calculations and battery sizing.

- Refer to Section 4.0 for additional details

Voltage Drop Calculations

- Contractor shall submit voltage drop calculations that demonstrate no circuits (except Trip and Close coils) exceed 5% voltage drop from station service transformer secondary or battery terminals to the load terminals for steady state loads. For loads with inrush current such as transformers and motors, Contractor shall follow NEC and other applicable industry standards for adequately sizing cables for these loads.
- Alternatively, for steady state voltage drops greater than 5%, Contractor may demonstrate that the terminal voltage is within tolerance of the operating voltage of the device, though Owner still reserves the right to reject this approach and Contractor shall meet the voltage drop requirements stated above.
- Contractor shall demonstrate that the terminal voltage at each breaker Trip and Close coils exceed the minimum operating range during a trip or close event. Contractor shall calculate this assuming lowest possible Battery Bank voltage allowed in the battery bank sizing calculation (typically 105 VDC). Owner reserves the right to request larger cable sizes during the review periods for calculated voltages barely exceeding the minimum requirements.

Conduit Fill Calculations

- Contractor shall demonstrate no conduits exceed maximum fill as defined in the latest version of the National Electric Code (NEC).
- Contractor may use query available in Owner Microsoft Access file template used to generate the Cable and Conduit Schedules for the purposes of this calculation. The template shall be provided after award of Contract.

6.0 MATERIALS

6.1 GENERAL

This section provides guidance on material selection not covered elsewhere in the specification. Regardless of any standard, document, verbal or written communication, etc., it is the Contractor's responsibility to ensure all materials selected meet or exceed their intended function.

When available and suitable for the application, Contractor shall use materials specified in the Owner Standard Design Masters or the Substation Standard Material List. Contractor shall request written Owner Approval for any substitutions.

If required material parts are not within the Design Masters or material database, the contractor shall select a part with a similar form-factor to existing entries within the database and preference to the same vendors. All such materials shall require cutsheets be provided to Owner and written approval from Owner prior to use.

For material submittal requirements, refer to the Supporting Documentation in Section 6.1.

6.2 CABLES AND CONDUCTORS

All insulated control and power cables and conductors rated up to 600V shall follow Owner Standard S-144-20. Insulated medium voltage (1,000-35,000V) cables such as those used for station service transformers and distribution capacitor banks shall comply with T&D Standard LD32020 or LD32023.

In addition to the requirements in Standard S-144-20, multiconductor cables smaller than #10 AWG for Current Transformer, Voltage Transformer, Circuit Breaker Trip and Close, AC Power, and DC power shall not be used in any circumstances. This requirement does not apply to internal rack SIS wires.

Contractor shall appropriately size cables for ampacity per the latest version of the National Electric Code. Contractor shall also size cables to limit voltage drop as described in Section 5.0, Part 3.0(R).

For outdoor installations, all 600V rated multiconductor insulated cables and single conductor cables smaller than 1/0 shall be shielded with shields grounded at both ends. Cables with indoor terminations only are not required to be shielded unless otherwise specified.

All copper Ethernet connections shall use CAT-6 cable. CAT-6 cable shall not be used in underground conduit or trench. The only exception (if applicable) shall be for Ethernet connections between GIS LCC cabinets and the LCC cabinet housing the Network Switch. These shall be Cat-5E, Outdoor, direct burial rated, Commscope #5NF4. This cable shall only be used for this specific application.

All other Ethernet connections located in outdoor conduit and trench systems shall be Multimode Fiber. All fiber optic cables within the Substation shall be installed with 1" orange innerduct tubing. For additional requirements, refer to Owner Standard S-146-00. All fiber cable connectors shall be ST unless otherwise specified.

All outdoor fiber optic cables shall be 2 Pair or 6 pair. Contractor shall supply at least one spare fiber pair for each cable.

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.

Irig-B distribution cable shall be installed per the Conceptual Network Block Diagram. Twisted Shielded Pair cable shall follow Section 4.7 in standard S-144-20.

6.3 STATION POST INSULATORS

Polymer-equivalent ANSI standard strength insulators shall be used for 115 kV and 230 kV Substation bus systems. High strength ANSI station post insulators shall only be used when bus span calculations indicate that the use of standard strength insulators will prohibitively shorten bus spans. Refer to Owner Standard S-131-30 for station post insulator requirements within Owner Substations.

Polymer-equivalent ANSI TR 210 (standard strength) insulators shall be used for Substation bus systems operating at 34.5kV and below. High strength ANSI TR 231 station post insulators shall only be used when bus span calculations indicate that the use of standard strength insulators will prohibitively shorten bus spans.

6.4 UNDERGROUND DUCT SYSTEMS

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.

6.5 LIGHTNING ARRESTERS

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.

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.

7.0 SUPPORTING DOCUMENTATION

7.1 GENERAL

All materials shall adhere to Owner provided standards and requirements set forth in this specification. All materials shall be Approved by Owner.

Contractor may select any software to develop List of Materials but must be submitted as .PDF for all submittals.

Every sheet of the List of Materials shall have the Document Number, Description, and project AWO number listed at the top.

For review submittals, Contractor shall also submit .PDF datasheets for all materials included in the List of Materials, except for Major Equipment, and sorted by Material Identification number. Contractor shall not provide paper copies of these for submittals.

Minor commodity construction materials such as bolts, washers, Unistrut, rigid galvanized steel conduit, etc. do not require material identification and are not required to be included in the List of Materials, but datasheets shall be provided for all such materials that are intended to be used in construction. Datasheet shall be digitally modified to include a description for the intended use of the material and drawing number(s) they apply. Contractor shall seek clarification from Owner if unsure a material is considered a minor commodity item.

7.2 ABOVE GRADE LIST OF MATERIALS (9900)

Format of List of Materials shall include Item Identification number; Quantity listed in Each, Feet, Lot, etc. as applicable; Owner Maximo database number if applicable; Material description with enough information to uniquely identify; Vendor name; Material Part Number.

For Major Equipment (GIS, Transformer, Disconnect Switches, Metalclad Switchgear, Breaker, Control Enclosure, Capacitor Banks and Switches) the material description shall also include the device five-digit Asset Number (to be provided by Owner after award of Contract) and name of the device as described in the One Line Schematic (e.g. WR2, W377, etc.).

Material List shall include:

- Major Equipment
- Material associated with the high voltage and medium voltage equipment installations (rigid tubular bus, flexible jumpers, station service transformers, bus fittings, insulators, cable connectors, junction boxes, medium voltage cables, etc.)
- Lighting
- See also Owner Standard S-146-00

7.3 OUTDOOR ARRANGEMENT LIST OF NAMEPLATES (9902)

Contractor to provide as an Adobe .PDF or Microsoft Word document. Template to be provided by Owner after award of Contract.

Shall include nameplates for all Major Equipment with an equipment number assigned (breakers, transformers, disconnect switches, capacitor banks, etc.), the outdoor control cabinets and junction boxes, and phase labels for the rigid bus spans. Contractor shall be responsible for fabricating and installing these nameplates. Each nameplate shall be assigned a unique number and labelled in a single location in the Design Drawings.

Nameplates shall follow guidelines and specifications detailed in MSTR-9800-1, -2 and MSTR-9801. In addition to the List of Nameplates document, Contractor also shall submit representative examples true to scale and color for Owner Approval.

Contractor shall create and install Asset Number nameplates for Major Equipment.

Contractor shall seek clarification from Owner if there is a question whether a certain nameplate is required.

7.4 CONTROL AND PROTECTION LIST OF MATERIALS (9911)

Format of List of Materials shall include Item Identification number; Quantity listed in Each, Feet, Lot, etc. as applicable; Owner Maximo database number if applicable; Material description with enough information to uniquely identify; Vendor name; Material Part Number; and part location (Rack, Equipment Cabinet, etc.).

Material List shall include:

- Relay rack and all mounted materials
- Battery bank and mounting rack
- 600V Control and Power cables
- Ethernet, Fiber, Innerduct, Coax and other cables used in the SCADA network and Irig-B distribution design
- Any other materials in the Control and Protection design to be installed by Contractor not already included by Major Equipment Vendor or accounted for in the Above Grade or Below Grade List of Materials.
- Contractor shall seek clarification from Owner if unsure which list a material should be included.

7.5 CONTROL AND PROTECTION LIST OF NAMEPLATES (9912)

Contractor to provide as an Adobe .PDF or Microsoft Excel document. Template to be provided by Owner after award of Contract.

Shall include nameplates for all relay rack and front mounted devices. Each nameplate shall be assigned a unique number identifier and labelled in a single location in the Design Drawings, almost always the relay rack layout. If the device is not represented in this drawing, the nameplate identifier shall be listed above the device in the wiring diagram.

Relay rack nameplates are to be fabricated and installed by relay rack Vendor. For projects with Instantaneous Enable/Disable switches (50EN) the Contractor shall adhere to nameplate requirements in MSTR-4803-1 for that device.

Nameplates for switchgear, GIS, Major Equipment cabinets, and Control Enclosure electrical equipment shall be provided by the Vendor except for items described in *Part E* below.

All devices with a SCADA identification must have a nameplate that matches the device name in the Network Block Diagram (e.g. XXXX-W65-11A). Contractor shall verify all such devices have this nameplate as described. If Vendor does not provide this nameplate, Contractor shall fabricate and install.

7.6 BELOW GRADE LIST OF MATERIALS (9920)

Format of List of Materials shall include Item Identification number; Quantity listed in Each, Feet, Lot, etc. as applicable; Owner Maximo database number if applicable; Material description with enough information to uniquely identify; Vendor name; Material Part Number

Material List shall include:

- Conduits
- Ground Mats
- Major Grounding System materials (copper grid, ground rods, DMC ground grid connectors, stingers, etc.)
- Vaults and covers (including for any station service padmount vaults)
- Cable trench if applicable
- Contractor shall seek clarification from Owner if unsure which list a material should be included.
- See also Owner Standard S-146-00

7.7 CABLE AND CONDUIT SCHEDULES (9930 AND 9931)

All Conduit and Conductor (or Cable) schedules shall be developed using Owner Conduit and Conductor Schedule Database. Template of this database to be provided after award of Contract.

Conduit Schedule shall include all conduits within Substation yard, with unique identification number, location, and length. Shall also include all conduits for distribution feeders, security, and communications. Conduits stubbed out for future use shall be stated as such in the Conduit Schedule and described with its designated application if applicable.

Conduit Schedule shall also include a list of all cables in each conduit, including cable size and purpose (control, AC power, SCADA, etc.). Seek clarification from Owner regarding any questions about Cable Purpose.

Cable Schedule shall include all cables, with unique identification number, ‘From’ and ‘To’ locations, drawing numbers for each termination, cable size, quantity, and routing through each conduit or trench. Medium voltage cables are not assigned cable numbers and do not need to be included. Communications cables used for remote communication are also not included.

Cable and Conduit Schedules shall indicate all entries as black if Revision 0. Otherwise, changes or new additions should be indicated in cyan or red and existing as black. Contractor may also use color to differentiate Vendor installed cables and field installed cables. This mainly applies for projects where relay racks are shipped with the Control Enclosure and the vendor has pre-installed some or all rack to rack cables. In this instance, field installed cables should be indicated in cyan and vendor installed cables indicated in black. Contractor shall provide a digital note explaining the color differences at the top of first sheet if this applies.

Note that same Access file is used for both Cable and Conduit schedules. The schedules are produced with built-in queries.

7.8 DRAWING LIST

Contractor shall follow the guidelines in MSTR-0000 Sheets 1 and 2 for drawing number and title selection. All drawing numbers and drawing titles shall be Approved by the Owner.

Contractor shall submit a .PDF Drawing List for each transmittal. Contractor may utilize Microsoft Word or Excel to generate Drawing List, but the format used must follow the example provided in the Conceptual Design. Template from Owner is also available upon request after award of Contract.

Drawing List shall also include all supporting documents with a drawing number (e.g. XXXX-9900).

Each discipline as described in *Section 1.4* shall have its own Drawing List as part of each design transmittal.

For this Project, Contractor shall submit a Void Drawing List with the Issue for Construction transmittal following the same format as the Drawing List. This list will include existing Substation drawings that will no longer be in use. If any existing drawings are carried over to the rebuild design, then Contractor shall coordinate with Owner for assigning an appropriate drawing number and for document management. It is not expected for any existing drawings to be reused for this Project, but Contractor shall notify Owner if it is necessary to include any existing drawings in the new design.

Engineering Calculations, Reports, or Studies should not be included in the Drawing List. These should be listed separately in the Contractor transmittals.

APPENDIX M1
ATTACHMENT 05
EXHIBIT 03

SUBSTATION CONSTRUCTION SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	16Jun25	Updated for 2025 Version	PGE	PGE	PNK	Paul Kruger

TABLE OF CONTENTS

1.0 GENERAL

The purpose of these construction specifications is to summarize the minimum requirements for Contractor, which generally include the complete substation development, procurement, and construction.

The Substation Construction shall follow, to the greatest extent possible, the requirements outlined in the PGE Substation Standards referenced in this specification.

Refer to SECTION 2 for a list of the Substation Construction Specifications

The substation shall be constructed to a high level of reliability and 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 Solar, Wind and Storage Specifications

The Project specific Project Description provides details specific to the Project.

Contractor shall be responsible for obtaining and maintaining all necessary permits and / or easements for the Work. Reference other Sections as applicable.

All access and site work shall comply with other Sections as applicable.

In the event of any conflict or discrepancy between this exhibit (including any attachments hereto) and any other Requirement, the more stringent or higher quality Requirement shall take precedence over the less stringent or lesser quality Requirement at Portland General Electric's discretion. In the event of a discrepancy between Owner versus Contractor responsibility in this exhibit and PGE Substation Specification NO. 6090, this exhibit shall take precedence.

The document is not intended to supersede Portland General Electric's standards.

2.0 TESTING AND ENERGIZATION

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.

The Contractor shall submit a testing plan and schedule to the Owner for review and approval

The Contractor shall follow all requirements listed in the Owner Section 6090 in addition to all the requirements listed below

The Contractor shall submit all final test reports to the owner for review and acceptance.

2.1 WORK PERFORMED BY CONTRACTOR

Wire checkout and associated schematic yellow-lining of all control circuitry and instrumentation circuits, in accordance with the Circuit List, to confirm continuity of conductors and that those conductors originate and terminate at the locations designated in the circuit list or on the drawings.

All CT and PT electrical testing should be performed based on the requirements provided in Owner’s Standard Testing Procedures (STP) per PGE Substation Specification No. 6090, and the completed forms shall be returned to the Owner.

CT and PT circuit loop verification shall be performed via millivolt drop methodology as specified in Owner’s Standard Testing Procedures (STP) per PGE Substation Specification No. 6090. Measurement locations and values shall be documented and returned to Owner.

Functional testing shall include a demonstration that all equipment installed can be operated in accordance with their specification.

Circuit Breaker, Circuit Switcher, and Vacuum Interrupter electrical tests in Owner’s Standard Testing Procedures (STP) per PGE Substation Specification No. 6090. This includes Insulation Resistance, Contact Resistance, and Timing Tests.

Installation of Relay Settings after approval from the Owner.

Installation of SCADA equipment settings (RTU, Substation HMI, substation network switches, etc.) after approval from the Owner.

Perform Protective relaying testing (Acceptance and Functional) and provide the results to Owner for approval. AC Acceptance testing involves verifying all AC inputs of the relay conform to manufacturer’s specification. DC acceptance testing involves verifying relay I/O conform to manufacturer’s specifications. Functional testing involves testing the relay elements and protection and control logic. Temporary settings changes to facilitate functional testing may only be utilized after approval by the Owner.

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.) All circuitry and device input/output checkout shall be documented via yellow-lined as-built schematics. Contractor may have to verify substation data is correctly reported to Owner EMS. Contractor may have to verify Owner EMS substation controls operate as intended (e.g. trip circuits, close circuits, etc.)

2.2 WORK PERFORMED BY OWNER

Owner reserves the right to perform final commissioning of the protective relays.

Contractor shall provide Owner advanced notification of when the relays will be available for testing and a window during which the Owner can complete their final commissioning.

The window for Owner testing shall be after substantial competition but before energization.

The contractor shall inquire with the Owner ahead of testing to determine an appropriate amount of time to allocate for Owner testing.

The Contractor shall provide all other workers required to make adjustments, connect equipment, and correct deficiencies during the testing

End--to--End protection functional testing of the protection scheme on the tie-line or interconnect will be performed by the Owner.

3.0 SPECIFICATION LIST

PGE Standards referenced in this list will be made available to bidders via a secure website following execution of the RFP Non-Disclosure Agreement (NDA).

SPEC NO.	DESCRIPTION
SITE WORK	
2100	Erosion and Sediment Control Plan (ESCP)
2110	Clearing and Grubbing
2120	Site Grading
2130	General Excavation & Backfill
2140	Trench Excavation & Backfill
2150	Aggregate Base Course
2160	Yard Finish Rock
2170	Road Finish Rock
2180	Drain Rock
2190	Geotextiles
2200	Drilled Piers
2210	Asphaltic Concrete Paving
2220	Culverts
2230	Seeding and Erosion Control
2240	Soil Sterilization
CONCRETE	
3000	Reinforced Concrete
3010	Controlled Density Fill
3020	Concrete Repair
FENCING	
4000	Fencing and Gates
METALS	
5100	Structural Steel Fabrication
5110	Anchor Rods
5120	Structural Steel Erection
5130	Painting Structural Steel
5140	Hot Dip Galvanizing
ELECTRICAL	
6000	Station Equipment
6010	Bus, Connectors, and Shield Wires
6040	Control and Power Cable
6050	Pre-Cast Cable Trench & Vaults
6060	Conduits and Duct Banks
6070	Grounding System
6080	Yard Lighting and Power System
6090	Equipment Testing and Energization

APPENDIX M1
ATTACHMENT 05
EXHIBIT 04

COMMUNICATION, SCADA, AND METERING FACILITIES

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	26Oct21	Issued for Implementation	1898 & Co.		JAL	Jared Lathrop
1	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
2	25Aug23	Rev 2, see redline changes throughout	Jeremy Morris	Craig Armstrong	CPA	Craig Armstrong
2	19Jun25	Update from 2023 version	1898 & Co. / PGE	PGE	SPF	Sean Flak

TABLE OF CONTENTS

1.0 GENERAL

1.1 SUMMARY

This Section summarizes the communications systems the Contractor shall provide as part of their proposal. The following specifications include detailed SCADA specification sections:

- M2-01-01 (Wind Plant Specifications)
- M3-01-01 (Solar Photovoltaic Plant Specifications)
- M4-01-01 (Energy Storage Technical Documents)

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

This Section summarizes the communications systems not covered within those specifications.

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. Field Voice Communications System – to support Operations and Maintenance activities, a 2-way radio system should be deployed for voice communications.
3. 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. Contractor to install fiber facilities from interconnection substation to PGE point of interconnection as required by protection schemes. This design shall meet any requirements from the interconnecting utility, the Public Utility Commission, and/or the Independent System Operator for SCADA or Metering and Operations.

4. 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.
5. 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.

1.2 TELECOMMUNICATIONS APPROACH

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.

1.3 TELECOMUNCATIONS FACILITES

The facilities shall consist of the following:

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 10 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.

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. This network shall be constructed such that it supports the following applications:

- Shall support the Real-time control for the operation of the plant.
- Shall support remote monitoring for the Owner to gather operational data from microprocessor- controlled equipment.
- Shall support monitoring of weather information.
- Shall allow the Owner to remotely access remotely configurable equipment to make settings changes and firmware upgrades.
- Shall support the use of Voice at each enclosure, desk, conference room, or security control point.
- Shall support the use of Video where required for security and operations of the plant.
- Shall include Wireless Access Points in Office locations.
- 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.

The network shall be capable of meeting the following specifications:

- Use IP/Ethernet communications over a fiber and copper network.
- 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.
- Category 6 copper shall be used for all connections between switches and equipment within a building.
- Use gigabit Ethernet Interfaces.
- Use VLANS for segmentation of traffic
- Use Quality of Service to Prioritize traffic flows
- Use Rapid Spanning Tree or other advanced ring convergence protocols.
- Support POE where phones or wireless access points are installed.
- Use managed equipment that support the following:
- Centralized authentication via RADIUS or TACACS
- Centralized logging via Syslog
- Use hardened network equipment rated for the environment in which it will be installed.

Interconnection to Bulk Electric Power System:

- 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.
- Build any fiber, microwave, or leased facilities to PGE’s current communication standards in order to tie facility into bulk electric power system.
- Follow Western Electricity Coordinating Council (WECC) teleprotection standards.

PGE Communications Circuits:

- 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	1.5 Mbps	0.5 sec	99.95%	ETHERNET/IP DNP 3.0 AUTOMATIC GENERATION CONTROL AND SCADA
SECONDARY AGC+SCADA	SUBSTATION	PGE WHQ	ETH	1.5 Mbps	0.5 sec	99.95%	ETHERNET/IP DNP 3.0 AUTOMATIC GENERATION CONTROL AND SCADA
METERING	SUBSTATION	PGE WHQ	ETH	64 kbps	0.5 sec	99.90%	METERING DATA
VOIP Phones	SUBSTATION	PGE WHQ	ETH	64 kpbs	.05sec	99%	Site Voice Communications

1.4 OTHER COMMUNICATIONS CIRCUITS/SERVICE

PGE will not be responsible for any Vendor’s long-term ISP or phone system at the site.

1.5 TELECOMMUNICATIONS EQUIPMENT

In each major facility provide space for (4) adjacent Communications racks. For the Plant and Switchyard/Substation facilities, min. (2) adjacent racks with space for third rack, locate the Communications racks in the same room or adjacent to the relay/SCADA 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 and (2) racks for SCADA System-Local Data Collection equipment. 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.

Provide a -48VDC power system capable of supplying the load with an 8- hour reserve time at each major facility.Sites 3hr drive from Portland require 24hr. battery reserve time. 12hrs if tied to emergency generator, and generator has at least 7days fuel.

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.

Provide a SATRAD-G2 satellite phone system with exterior antenna, rack mount equipment, and a dedicated desk phone.

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 FxMP-144 (144ct), with SC/UPC Connectors
7. ADSS Fiber Cable – OFS AT-3BE17NT-144-CMEA/TPDE (144CT SM) Single/Double jacket depending on span lengths. TPDE is not to be used for UG Installation and should be converted on Riser Pole or in vault.
8. OPGW Fiber Cable – AFL DNO-8234 (48-CNT)
9. Splice Cases – Tyco FOSC-450D
10. -48 VDC Fuse Panel – Amphenol GMT Dual Feed 10/10-position 125A
11. -48 VDC Charger Panel – Eltek Flat Pack FPSK591-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 C&D TEL12-XXX series VRLA Rack Mount, East Penn Deka Unigy II (VRLA) w/ one-piece base and interlocking cells, min 8 hours carry time

2.0 SCADA SYSTEM-LOCAL DATA COLLECTION

2.1 GENERAL

Contractor will provide suitable space, power, and environment control to house the PGE equipment necessary to facilitate the collection of plant control system data.

In addition to the Telecommunications, IT Operations, and Physical Security communication racks, Vendor will also provide space for Owner to install (2) 30” x 42” x 84” fully-enclosed, lockable, 4-post network cabinet with venting doors. One being located within the O&M communication room and the other in the Switchyard/Substation.

Cabinets 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.

Vendor shall supply and install fully redundant HVAC systems and humidity control in whatever location the houses the Data Collection Cabinets, with sufficient cooling for all equipment in that location.

Vendor shall provide (2) 30A, 240V circuit to each cabinet.

2.2 SCADA HARDWARE AND SOFTWARE REQUIREMENTS

If Owner will be responsible for day-to-day maintenance or control of the plant, then Owner shall have the final say on the plant SCADA system that is installed and how it is integrated with PGE’s existing systems.

1. If Owner will not be responsible for any day-to-day maintenance, then the Contractor, in coordination with OEM SCADA Vendor, shall:
2. 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.
3. Ensure data values are available in the native resolution in which they were collected, up to 1Hz.
4. Configure the OEM SCADA system to allow Owner’s data collection system to pull all live, historical, and alarm data using one or more of the following methods:

- OPC UA
- OPC DA
- SQL
- Direct queries to controllers using native protocols.

5. All SCADA paths will be commissioned between devices prior to facility operation.

3.0 METERING AND TELEMETRY FACILITES

3.1 GENERAL

PGE requires one owner per Point of Interconnection.

3.2 DIRECT TELEMETRY REQUIREMENTS

PGE requires two communication paths for controlling and operating generation that is settled within its Balancing Authority Area:

- Direct, real-time telemetry (SCADA) from RTU (site) to RTU (PGE control center)

ICCP over WECC Operations Network (WON)

3.3 METERING REQUIREMENTS

Revenue meters shall be installed at the project substation and downstream plant to account for gross and net generation, as well as station service and auxiliary loads. Each revenue meter shall be sourced from high accuracy, revenue grade current and voltage transformers, and shall comply with the requirements shown in the Interconnection Agreement and and any power purchases agreement(s). Actual revenue meter locations and instrument transformer specifications shall be determined by PGE metering personnel.

SCADA meters shall be installed on each medium-voltage (34.5kV) collection system circuit feeder.

4.0 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):

4.1 HYDRO TURBINE

1. Turbine Guide RTD
2. Lower Guide RTD
3. Upper Guide RTD
4. Thrust Bearing RTD
5. Lube Oil Pressure
6. Lube Oil Temperature
7. Gen Turbine Local Ambient Temp
8. Turbine Guide Bearing X VIBR
9. Turbine Guide Bearing Y VIBR
10. Upper Guide Bearing X VIBR
11. Upper Guide Bearing Y VIBR
12. Lower Guide Bearing X VIBR
13. Lower Guide Bearing Y VIBR
14. Wicket Gate Position
15. Wicket Gate Pressure
16. Cooling Water Pressure
17. Cooling Water Temperature
18. Forebay Level
19. Tailrace Level

4.2 WIND TURBINES

1. Pitch - Blade A/B/C Pitch Motor Current
2. Pitch - Blade A/B/C Pitch Motor Voltage
3. Pitch - Blade A/B/C Pitch Position
4. Pitch - Blade A/B/C Hydraulic Oil Accumulator Pressure
5. Pitch - Pitch Pressure Output From Hydraulic Power Unit
6. Pitch - Pitch Oil Temperature - Outlet Hydraulic Power Unit
7. Pitch - Pitch Oil Accumulator Temperature
8. Pitch - Pitch Controller Panel Temperature
9. Pitch - Pitch Bearing A/B/C Vibration
10. Hub - Hub Temperature
11. Hub - Ice Detection System
12. Main Bearing(S) - Main Bearing Temperature
13. Main Bearing(S) - Main Bearing Vibration
14. Main Bearing(S) Oil Lubrication System - In Line Metal Particle Counter
15. Main Bearing(S) Oil Lubrication System - Oil Filter Differential Pressure
16. Main Bearing(S) Oil Lubrication System - Oil Pump Amps

17. Main Bearing(S) Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
18. Main Shaft - Main Shaft Brake Pressure
19. Main Shaft - Main Shaft Brake Accumulator Pressure
20. Main Shaft – Shaft RPM
21. Gearbox – All Bearing Temperatures
22. Gearbox - Gearbox Lube Oil Pressure, Before Filter
23. Gearbox - Gearbox Lube Oil Pressure, After Filter
24. Gearbox - Planetary Vibration
25. Gearbox - High Speed Shaft Vibration
26. Gearbox - Intermediate Speed Shaft Vibration
27. Gearbox - Oil Temperature - Gearbox Sump
28. Gearbox Oil Lubrication System - In Line Metal Particle Counter
29. Gearbox Oil Lubrication System - Oil Filter Differential Pressure
30. Gearbox Oil Lubrication System - Oil Pump Amps
31. Gearbox Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
32. Generator - Winding Temperature 1/2/3
33. Generator - Generator Drive End Bearing Temperature
34. Generator - Generator Non-Drive End Bearing Temperature
35. Generator - Generator Drive End Bearing Vibration
36. Generator - Generator Non-Drive End Bearing Vibration
37. Generator - Phase A/B/C Voltage
38. Generator - Phase A/B/C Current
39. Generator - Power Factor
40. Generator - Heat Exchanger Water Inlet/Outlet Temperatures
41. Generator – Shaft Torque
42. Generator – Frequency (generator side)
43. Generator – Shaft RPM
44. Generator – Active Power
45. Generator – Reactive Power
46. Yaw - Yaw Position
47. Yaw - Yaw Brake Accumulator Pressure
48. Yaw - Yaw Brake Pressure
49. Yaw – Yaw Motor/Gear Temperature
50. Tower - Wind Speed Primary
51. Tower - Wind Speed Secondary
52. Tower - Wind Direction
53. Tower - Nacelle Temperature
54. Tower - Tower Base Temperature
55. Tower - Control Panel(s) Temperature
56. Tower – Converter Inside Compartment Temperature
57. Tower – Converter Coolant Pressure

58. Tower – Converter Coolant Temperature
59. Tower – Frequency (grid side)
60. Tower – Phase A/B/C Voltage (grid side)
61. Tower – Phase A/B/C Current (grid side)
62. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Cooling Media
63. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Panel Air At Cooler
64. Tower - Transformer Temperature MMM. Tower - Ambient Temperature
65. Tower – Air Density
66. Tower - Sway
67. Tower – Error Code(s)
68. Tower – Operational State
69. Main Breaker - Status
70. Main Breaker - Faults
71. Main Breaker - Temperature
72. Main Breaker - Fan Ampere
73. Meteorological Station - Air Temperature
74. Meteorological Station - Cell Temperature
75. Meteorological Station - Relative Humidity
76. Meteorological Station - Wind Speeds At 10 meter, 1/2 Hub Height, and Hub Height
77. Meteorological Station - Barometric Pressure
78. Meteorological Station – Air Density
79. Switchgear - Breaker Phase Currents
80. Switchgear - Breaker Phase Voltages
81. Switchgear - Breaker Status
82. Switchgear - Relay Fault Codes
83. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics
84. Tower – Status Code

4.3 PV FIELD

1. Combiner Box - DC Output Voltage
2. Combiner Box - DC Output Current
3. Combiner Box - DC Current per String
4. Combiner Box - Combiner Box Interior Temperature
5. Inverter - DC Input Voltage
6. Inverter - DC Input Current
7. Inverter - AC Output Voltage
8. Inverter - AC Output Current
9. Inverter - AC Power
10. Inverter - AC Frequency
11. Inverter - AC Reactive Power
12. Inverter - Energy Totalizer

13. Inverter - Inverter Temperatures
14. Inverter - Inverter Status
15. Inverter - Faults/Alarms
16. Inverter - Ground Current
17. Inverter – Operational State
18. Meteorological Station - Air Temperature
19. Meteorological Station - Cell Temperature
20. Meteorological Station - Relative Humidity
21. Meteorological Station - Wind Speed
22. Meteorological Station - Global Irradiance
23. Meteorological Station - Plane of Array Irradiance
24. Meteorological Station - Solar Module Back Panel Temperature(s) - 10% of Modules
25. Switchgear - Breaker Phase Currents
26. Switchgear - Breaker Phase Voltages
27. Switchgear - Breaker Status BB. Switchgear - Relay Fault Codes
28. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

4.4 OIL-COOLED TRANSFORMERS

1. Active Power
2. Reactive Power
3. High Side Amps (by phase)
4. High Side Voltage (by phase)
5. Ground Current
6. Low Side Voltage (by phase)
7. Control Voltage
8. Control Panel Temperature
9. LTC Tap Position
10. Oil Pump Amps
11. Oil Pump Discharge Pressure
12. Fan Bank Amps
13. LTC Tank Oil Temperature
14. Main Tank Oil Temperature
15. Top Oil Temperature
16. High Voltage Winding Temperature
17. Low Voltage Winding Temperature
18. Nitrogen Pressure
19. Local Ambient Temperature
20. Moisture Percentage
21. Gas Analyzer H2
22. Gas Analyzer O2
23. Gas Analyzer N2

24. Gas Analyzer CO
25. Gas Analyzer CO_2
26. Gas Analyzer CH_4
27. Gas Analyzer C_2H_6
28. Gas Analyzer C_2H_4
29. Gas Analyzer C_2H_2
30. Gas Analyzer H_2O
31. Infrared Camera Temperatures

4.5 DRY TRANSFORMERS

1. Active Power
2. Reactive Power
3. High Side Amps (by phase)
4. High Side Voltage (by phase)
5. Ground Current
6. Low Side Voltage
7. Low Side Amps
8. Control Voltage
9. Control Panel Temperature
10. Cooling Fan Amps
11. High Voltage Winding Temperature
12. Low Voltage Winding Temperature
13. Local Ambient Temperature

4.6 SWITCHGEAR / MOTOR CONTROL CENTERS

Control Panel

1. Control Panel Voltage
2. Control Panel Temperature

4160 VAC and Higher Bus

1. Connected Joints Temperature Via Fiber Optic Infrared Measurement

MCC Bucket

1. Load Amps
2. Load Voltage
3. Power Factor
4. Bucket Temperature
5. Cooling Fan Amps

4.7 HEAT EXCHANGERS

1. Inlet/Outlet Temperatures

2. Process Flows

4.8 PUMP / FAN MOTORS GREATER THAN 100 HP

1. Motor Stator Temperature
2. Local Ambient Temperature
3. Motor Amps
4. Motor Power Factor
5. Motor Voltage

APPENDIX M1
ATTACHMENT 05
EXHIBIT 05

GEN-TIE LINE REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	19Jun25	2025 RFP Spec	PGE	SPF	SPF	Sean Flak

1.0 GEN-TIE LINE

This specification defines the requirements for Gen-Tie Line facilities associated with utility-scale generation projects. A Gen-Tie Line, for the purposes of this specification, refers to any portion of the generation interconnection facilities that are owned, operated, or maintained by Portland General Electric (PGE) and are required to support the physical connection between the generation facility and the point of interconnection with the PGE transmission or distribution system. The Gen-Tie line typically begins at the high-voltage terminals of the project's main step-up transformer and terminates at the line-side connection point of the utility-owned disconnect switch at the point of interconnection, with exact start and stop points to be confirmed with the Owner during the design phase as they may vary by project. These requirements apply regardless of whether the Gen-Tie facilities are located on public or private property, and are intended to ensure compatibility with PGE standards, operational practices, and long-term maintenance.

1.1 INTRODUCTION

A. The purpose of this document is to summarize the minimum requirements for Contractor, which generally include the complete development, engineering, procurement, and construction of the overhead generation tie ("Gen-Tie") transmission line.

B. 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 and industry best practices.

C. Expected service life of Gen-Tie line is minimum 50-years.

D. Contractor shall be responsible for obtaining and maintaining all necessary permits and / or easements for the Work.

E. All access and site civil work for the Gen-Tie line shall comply with all local ordinances, Section M1-02-01, and these contract documents as applicable.

F. 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 at Portland General Electric's discretion.

G. The document is not intended to supersede Portland General Electric's standards.

1.2 ENGINEERING

A. Contractor shall receive explicit approval from Owner or Owner's representative(s) of the design of the Gen-Tie line prior to construction. Owner shall have unlimited access to such designs throughout the design process.

B. The following PGE Standards referenced in this specification will be made available to bidders via a secure website following execution of the RFP Non-Disclosure Agreement (NDA).

1. M1-05-05-01 57 and 115 kV PGE Standards
2. M1-05-05-02 Work Practices
3. M1-05-05-03 230 kV DCD
4. M1-05-05-04 Construction Specifications
5. M1-05-05-05 Design Drilled Pier and Direct Embed
6. M1-05-05-06 Geotech Investigation

7. M1-05-05-07 LiDAR57

C. 115 kV Transmission

1. Project shall be designed as per Portland General Electric (PGE) Standards and Work Practices.
2. Reference Attachment M1-05-05-01 for list of PGE Standards.
3. Reference Attachment M1-05-05-02 for list of PGE Work Practices.

D. 230 kV Transmission

1. Project shall be designed as per PGE 230 kV Design Criteria Document (DCD), PGE Standards and Work Practices. Reference Attachment M1-05-05-03 for PGE 230 kV DCD.

E. Drilled Pier and Direct Embed Foundations

1. Reference Attachment M1-05-05-05 for PGE drilled pier and direct embed design standards.

F. Communications

1. Reference Section M1-05-04 for Communications requirements.
2. Gen-Tie will require a minimum of one (1) communications cable. Additional cables may be required depending on NERC CIP or other requirements.
3. 57/115 kV Projects shall use All Dielectric Self Supporting (ADSS) cable(s) for communications.
4. 230 kV Projects may request PGE approval for use of Optical Ground Wire (OPGW) cable(s) for communications.
5. ADSS communications cables shall be designed outside the “Supply Space”. Exception to this requirement will require PGE approval.

G. Miscellaneous

1. 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 within the easement. Electrical field strength shall be calculated for the transmission line and any collocated or adjacent facilities.

1.3 PROCUREMENT

A. Refer to M1-05-07 for an approved vendor list and accompanying material specification(s) as applicable. PGE Standards also identify specific approved parts that shall be used where possible. In the case of conflicts, the stricter of the specifications shall prevail.

B. Conductor

1. Contractor shall utilize a standard PGE conductor for the Project. Reference PGE Standards for list of standard conductors.
2. All ACSS conductors shall use hardware rated for 250oC and clearances shall be designed for 250oC. PGE may choose to relax this requirement for 115 kV framed transmission.

C. 57/115 kV and ADSS Hardware

1. All 57/115 kV and ADSS materials shall be per PGE Standards and current PGE approved parts.
2. Transmission voltages below 115 kV shall be framed as 115 kV.

D. 230 kV and OHSW Hardware

1. All 230 kV assemblies shall be per current approved assemblies. Contractor may propose specific part substitution for PGE review and acceptance, but the general assembly shall stay the same.
2. Contractor is required to complete Project specific electrical design to validate PGE 230 kV assembly.
3. If 230 kV design requires modification to the standard assembly, Contractor shall propose new assembly design for PGE review and acceptance. Contractor shall keep the assembly as close as possible to current approved assemblies.

E. OPGW Hardware

1. If PGE approves OPGW for Gen-Tie Project, Contractor shall provide assembly drawings for PGE review. PGE has limited existing OPGW cable facilities to provide as examples.

F. Material Specification(s) and Vendor Drawings

1. For instances which PGE does not have specifications, Contractor shall prepare material / equipment specifications to define 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 applicable equipment.
2. Contractor shall submit manufacturer’s approval drawings and / or product sheets (material cut sheets) for all permanently installed Gen-Tie line equipment and materials. PGE may elect to waive this requirement for standard materials / equipment procured from approved vendors.

G. Contractor shall provide a complete recommended spare parts list for the Gen-Tie line and include justification. List shall include recommended quantities, part / model numbers, nominal pricing and shelf life.

1.4 DESIGN DELIVERABLES

A. Reference M1-01-02-01 Documents and Deliverables Table for list of deliverables.

B. Contractor shall provide a 15% deliverable memorandum for PGE acceptance. PGE shall have ten (10) business days to review and provide comments. Contents of the memorandum shall include:

1. Proposed project routing and anticipated easement width(s).
2. Project vertical and horizontal datum.
3. Project conductor type; shall be as per PGE standard conductors.
4. Project communications cable type; shall be as per M1-01-05.

5. Project proposed framing; shall match PGE standards for 115 kV. PGE may provide sample framing from past Projects for 230 kV. Framing shall include proposed structure material types and planned foundation types for PGE approval. Framing shall include information on communications cable location.
6. Project proposed hardware assemblies; shall match PGE standards.
7. Engineering milestone schedule so that PGE can plan resources for design review.

C. Upon PGE acceptance of the 15% deliverable memorandum, the design may progress as defined in the 230 kV Design Criteria Document. Section 26 shall apply to overhead Gen-Tie Projects of all voltages.

D. 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 at the deliverable milestones and in final form at the conclusion of the Project.

1.5 CONSTRUCTION

A. Refer to Attachment M1-05-05-04 for applicable construction specifications.

B. Construction of Gen-Tie line and all related facilities shall be performed by a qualified construction contractor who has demonstrated successful completion of similar projects. The contractor shall have verifiable experience in constructing transmission lines of comparable voltage, complexity and scale.

C. Installation of all Gen-Tie facilities shall be per manufacturer requirements and / or recommendations.

1.6 GENERAL

A. Geotechnical Investigation

1. Reference Attachment M1-05-05-06 for PGE geotechnical investigation standard.

B. Survey.

1. Project Datum (design and construction) shall be approved by PGE.
2. Post construction as-built shall include LiDAR survey as noted in Construction Specifications. LiDAR survey shall be as per industry best practices and Attachment M1-05-05-07.

C. Outages. Reference also Section M1-01-05.

D. Contractor shall develop a construction sequencing plan, early in the design process, that reduces the number of outages on PGE system.

1. Contractor shall develop overall Project schedule with consideration for outages.
2. 230 kV outages, with exact dates, shall be submitted for PGE review and approval (120) days ahead of outage.
3. 115 kV outages, with exact dates, shall be submitted for PGE review and approval (60) days ahead of outage.
4. 230 kV outages shall generally be: one (1) circuit, between mid-October and mid-May. If the seasonal restrictions cannot be met, Contractor shall plan on weekend outages only.

5. 115 kV outages shall avoid peak summer / winter months. Outages planned during peak times will be at Contractor's risk. PGE will retain the right to require Contractor to return lines to service during peak months, without compensation for additional work or lost time. Contractor will be provided 24-hour notice for lines that are required to be returned to service.

E. Energization. Reference also Section M1-01-05.

1. Contractor shall prepare construction sequencing plan and identify all outages necessary to complete the Work.
2. Contractor shall test, commission, start-up and place into successful operation the Gen-Tie line, including the electrical and communications infrastructure.
3. 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. Refer to other Sections as applicable. Plans shall include, but not limited to, backfeed plans, soaking plans, testing plans and lock out tag out procedures.
4. Contractor shall expect extensive coordination with PGE.

APPENDIX M1
ATTACHMENT 05
EXHIBIT 06

APPLICABLE STANDARDS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

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REQUEST FOR PROPOSAL

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

1.1 GENERAL REQUIREMENTS

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.

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 implement tation.

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.

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.

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

1.2 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. Americans with Disabilities Act (“ADA”)
7. American Institute of Constructors (“AIC”)
8. American Institute of Steel Construction (“AISC”)
9. American Iron and Steel Institute (“AISI”)
10. Association of Iron and Steel Engineers (“AISE”)
11. Association of Edison Illuminating Companies (“AEIC”)
12. American Gear Manufacturer Association (“AGMA”)
13. American Land and Title Association (“ALTA”)
14. American National Standards Institute (“ANSI”)
15. American Society of Civil Engineers (“ASCE”)
16. American Society of Heating, Refrigeration, and Air Conditioning Engineers (“ASHRAE”)
17. American Society of Mechanical Engineers (“ASME”)
18. American Society of Nondestructive Testing (“ASNT”)
19. American Society of Testing and Materials (“ASTM”)
20. American Water Works Association (“AWWA”)
21. American Welding Society (“AWS”)
22. Avian Power Line Interaction Committee (“APLIC”)
23. Bonneville Power Administration (“BPA”) Master Specifications

24. Clean Air Act and Amendments (“CAA”)
25. Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (“CERCLA”)
26. Code of Federal Regulations (“CFR”)
27. Concrete Reinforcing Steel Institute (“CRSI”)
28. Crane Manufacturer Association of America (“CMAA”)
29. Clean Water Act (“CWA”)
30. Department of Transportation (“DOT”)
31. Det Norske Veritas Germanischer Lloyd (“DNV GL”)
32. Expansion Joint Manufacturer Association (“EJMA”)
33. Electric Power Research Institute (“EPRI”)
34. United States Environmental Protection Agency (“EPA”)
35. Federal Aviation Agency, Department of Transportation (“FAA”)
36. Federal Energy Regulatory Commission (“FERC”)
37. Federal Highway Administration (“FHWA”)
38. Federal Power Act (“FPA”)
39. FM Global (“FM”)
40. Hydraulic Institute (“HI”)
41. IAPMO Uniform Plumbing Code
42. Illuminating Engineering Society (“IES”)
43. Institute of Electrical and Electronic Engineers (“IEEE”)
44. Instrumentation Society of America (“ISA”)
45. Insulated Cable Engineering Association (“ICEA”)
46. International Building Code (“IBC”)
47. International Electrotechnical Commission (“IEC”)
48. International Federation for Structural Concrete (“FIB”)
49. International Fire Code (“IFC”)
50. International Network for Harmonised and Recognized Measurements in Wind Energy (“MEASNET”)
51. International Organization for Standardization (“ISO”)
52. International Society of Automation (“ISA”)
53. Applicable state requirements, including State Department of Transportation
54. Metal Building Manufacturers Association (“MBMA”)
55. Migratory Bird Treaty Act (“MBTA”)
56. MESA – Open Standards for Energy Storage
57. Manufacturer’s Standardization Society of the Valve and Fittings Industry (“MSS”)
58. National Association of Corrosion Engineers (“NACE”)
59. National Electric Code (“NEC”)
60. National Electrical Contractors Association (“NECA”)
61. National Electric Safety Code (“NESC”)
62. National Electrical Manufacturers Association (“NEMA”)

63. National Electrical Testing Association ("NETA")
64. National Fire Protection Association ("NFPA")
65. National Safety Council ("NSC")
66. National Institute of Standards and Technology ("NIST")
67. National Institute of Standards and Technology Internal or Interagency Reports ("NISTIR")
68. North American Electric Reliability Corporation ("NERC")
69. Occupational Safety and Health Administration ("OSHA")
70. Post-Tensioning Institute ("PTI")
71. Pipe Fabrication Institute ("PFI")
72. Resource Conservation and Recovery Act ("RCRA")
73. Scientific Apparatus Makers Association ("SAMA")
74. Safe Drinking Water Act ("SDWA")
75. Sheet Metal and Air Conditioning Contractors National Association ("SMACNA")
76. Solid Waste Disposal Act ("SWDA")
77. Society for Protective Coatings ("SPC")
78. Telecommunications Industry Association/Electronic Industries Association ("TIA/EIA")
79. Thermal Insulation Manufacturer Association ("TIMA")
80. Toxic Substances Control Act ("TSCA")
81. Underwriter's Laboratories ("UL")
82. United States Department of Agriculture ("USDA")
83. Welding Research Council ("WRC")
84. DNV OS C502, Offshore Concrete Structures
85. Electric Tarriff Rule 21 – Generating Facility Interconnections
86. Applicable Standards (Oregon Projects only):
87. Oregon Structural Specialty Code (based on the International Building Code)
88. Oregon Mechanical Specialty Code (based on the International Mechanical Code)
89. Oregon Electrical Specialty Code (based on the National Electrical Code)
90. Oregon Plumbing Specialty Code (based on the Uniform Plumbing Code)
91. Oregon Fire Code (based on the International Fire Code)
92. Oregon State Occupational Safety and Health Act
93. Oregon Health Authority
94. Oregon Occupational Safety and Health Act (OR-OSHA) - 29 CFR 1910, 1926

In addition to the other Applicable Standards noted above, the following shall also apply to all energy storage projects:

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 1815-2012, IEEE Standard for Electric Power Systems Communications— Distributed Network Protocol (DNP3)

4. IEEE 1547-2018, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
5. IEEE 1547.1, Standard Conformance Test Procedure for Equipment Interconnecting Distributed Resources with Electric Power Systems
6. IEEE 1547.2, Interconnecting Distributed Resources with Electric Power Systems
7. IEEE 1547.3, Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
8. ANSI Z535, Product Safety Signs and Labels
9. ANSI C57/IEEE, Transformer Standards, whenever applicable
10. ANSI C37/IEEE, Surge withstand capabilities, whenever applicable
11. UL 1642/IEC 62133, Applicable sections related to battery cell safety, where applicable
12. UL 1741, Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
13. NFPA 704, Standard System for the Identification of the Hazards of Materials for Emergency Response
14. UL 1642, Standard for Lithium Batteries
15. UL 1778, Underwriters Laboratories' Standard for Uninterruptible Power Systems for up to 600 Volts AC
16. UL 1973, Standards for Batteries for Use in Light Electric Rail Applications and Stationary Applications
17. 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
18. Electric Tariff Rule 21, Generating Facility Interconnections
19. NISTIR 7628, Guidelines for Smart Grid Cyber Security
20. IEEE 1881, Standard Glossary of Stationary Battery Terminology
21. IEEE 519, Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
22. IEEE 142, Recommended Practice for Grounding of Industrial and Commercial Power Systems
23. IEEE 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
24. IEEE 2030.3, Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications
25. EPRI 3002009313, Energy Storage Integration Council Energy Storage Test Manual 2016
26. IEEE 1881, Standard Glossary of Stationary Battery Terminology
27. Owner S-76, Below Grade Substation Standards
28. MESA, Open Standards for Energy Storage
29. NFPA 855, Standard for the Installation of Stationary Energy Storage Systems
30. OSSC, 2014 Oregon Structural Specialty Code
31. International Building Code, 2012 International Building Code
32. ACI-318, American Concrete Institute 318-11
33. AWS, American Welding Society D1.1 Structural Welding Code - Steel

34. OFC, 2019 Oregon Fire Code
35. IEEE 2800, IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems

APPENDIX M1
ATTACHMENT 05
EXHIBIT 07

APPROVED VENDORS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	19Jun25	2025 RFP	PGE	SPF	SPF	Sean Flak

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.

Contractor is expected to consider lead time of vendors, including Owner review and approval timeline of drawings and documentation, in their ordering schedule. Exceptions will not be granted because Contractor has failed to do so. All equipment must be designed for, and officially supported in, the United States market.

General Equipment Vendors (applicable to all project types):

1) **Generator Circuit Breaker**
   a) Energy Storage
      i) ABB
      ii) GE Grid Solutions
      iii) Mitsubishi
      iv) Siemens
      v) HVB
   b) Wind
      i) *ABB
      ii) GE Grid Solutions
      iii) Mitsubishi
      iv) Siemens
      v) HVB
   c) Solar
      i) *ABB
      ii) GE Grid Solutions
      iii) Mitsubishi
      iv) Siemens
      v) HVB
2) **Generator Step-up Transformer (Substation Main Power Transformer)**
   a) Energy Storage, Wind, and Solar
      i) Hitachi, Varennes, Canada shop
      ii) Hitachi, Crystal Springs, MS shop
      iii) Hitachi, Bad Honnef, Germany shop

iv) Hitachi, South Boston, Virginia shop
v) Delta Star, Inc, San Carlos, CA shop
vi) Delta Star, Inc., Lynchburg, Virginia shop
vii) HICO, ChangWon, South Korea shop
viii) Hyundai, Montgomery, Alabama shop
ix) Hyundai, Ulsan, South Korea shop
x) Smit, Nijimegen, The Netherlands shop
xi) SPX Waukesha, Waukesha, Wisconsin shop
xii) EFACEC, Arroteia, Portugal shop
xiii) Siemens, Guanajuato, Mexico shop
xiv) GE Prolec, Monterrey, Mexico shop
xv) Shihlin, Taipei, Taiwan shop

3) Ground Reference Transformers

a) Energy Storage
i) ABB
ii) Cooper Power Systems
iii) GE
iv) Virginia Transformer

b) Wind
i) ABB
ii) Cooper Power Systems
iii) GE
iv) Virginia Transformer

c) Solar
i) ABB
ii) Cooper Power Systems
iii) GE
iv) Virginia Transformer

4) GSU Pad-mount Transformers

a) Energy Storage
i) ABB
ii) General Electric
iii) Cooper Power Systems
iv) Siemens
v) WEG

b) Wind
i) ABB
ii) General Electric
iii) Cooper Power Systems
iv) Siemens
v) WEG

c) Solar

5) Instrument Transformers

a) All Technologies
i) Hitachi
ii) ABB (Except for MV Potential Transformers)
iii) Trench Ltd
iv) GE/Alstom
v) Arteche

6) Load Center Unit Substations

a) Energy Storage

- i) ABB
- ii) Eaton
- iii) General Electric
- iv) Powell Manufacturing
- v) Schneider Electric / Square D
- vi) Siemens Power T&D

b) Wind
- i) ABB
- ii) Eaton
- iii) General Electric
- iv) Powell Manufacturing
- v) Schneider Electric / Square D
- vi) Siemens Power T&D

c) Solar
- i) ABB
- ii) Eaton
- iii) General Electric
- iv) Powell Manufacturing
- v) Schneider Electric / Square D
- vi) Siemens Power T&D

7) LV Motor Control Centers

a) Energy Storage
- i) *Eaton
- ii) ABB
- iii) Allen Bradley
- iv) General Electric
- v) Powell Manufacturing
- vi) Schneider Electric / Square D
- vii) Siemens Power T&D

b) Wind
- i) *Eaton
- ii) ABB
- iii) Allen Bradley
- iv) General Electric
- v) Powell Manufacturing
- vi) Schneider Electric / Square D
- vii) Siemens Power T&D

c) Solar
- i) *Eaton
- ii) ABB
- iii) Allen Bradley
- iv) General Electric
- v) Powell Manufacturing
- vi) Schneider Electric / Square D
- vii) Siemens Power T&D

8) Medium Voltage Switchgear, Starters and Controllers

a) Energy Storage
- i) Powercon
- ii) Siemens Power T&D
- iii) ABB
- iv) Eaton

        v) General Electric
        vi) Powell Manufacturing
        vii) Schneider Electric / Square D
    b) Wind
        i) Powercon
        ii) Siemens Power T&D
        iii) ABB
        iv) Eaton
        v) General Electric
        vi) Powell Manufacturing
        vii) Schneider Electric / Square D
    c) Solar
        i) Powercon
        ii) Siemens Power T&D
        iii) ABB
        iv) Eaton
        v) General Electric
        vi) Powell Manufacturing
        vii) Schneider Electric / Square D

9) **Protective Relays**
    a) All Technologies
        i) Schweitzer Engineering Laboratories (SEL)
            (1) Final devices (including part number and firmware) must be compatible with PGE standards and approved by PGE in advance of procurement, final design, and start of construction

10) **Revenue Meters**
    a) Schweitzer Engineering Laboratories (SEL)
        i) Final devices (including part number and firmware) must be compatible with PGE standards and approved by PGE in advance of procurement, final design, and start of construction
    b) Schneider Ion 8650
        i) Final devices (including part number and firmware) must be compatible with PGE standards and approved by PGE in advance of procurement, final design, and start of construction

11) **Relay Panels**
    a) Energy Storage
        i) Electrical Power Products (EP2)
    b) Wind
        i) Electrical Power Products (EP2)
    c) Solar

12) **SF6 Circuit Breakers (High Voltage and Medium Voltage)**
    a) Energy Storage
        i) Siemens
        ii) ABB
        iii) Mitsubishi
        iv) GE/Alstom
        v) Hitachi/HVB (Georgia)
    b) Wind
        i) Siemens
        ii) ABB
        iii) Mitsubishi

iv) GE/Alstom
v) Hitachi/HVB (Georgia)

c) Solar
i) Siemens
ii) ABB
iii) Mitsubishi
iv) GE/Alstom
v) Hitachi/HVB (Georgia)

13) Single Mode Fiber Cable & Attachment Hardware

a) Energy Storage
i) AFL –ADSS and OPGW
ii) OFS –ADSS
iii) Preformed Line Products
iv) Tyco/Commscope FOSC splice cases
v) Anixter

b) Wind
i) AFLADSS and OPGW
ii) OFS-ADSS
iii) Preformed Line Products
iv) Tyco/Commscope FOSC Splice Cases
v) Anixter

c) Solar
i) AFL ADSS and OPGW
ii) OFS ADSS
iii) Preformed Line Products
iv) Tyco/Commscope FOSC Splice Cases
v) Anixter

14) Substation Capacitors

a) Energy Storage
i) Cooper Power Systems
ii) General Electric

b) Wind
i) Cooper Power Systems
ii) General Electric

c) Solar
i) Cooper Power Systems
ii) General Electric

15) Substation Control Enclosure

a) Energy Storage
i) Trachte
ii) AZZ
iii) Systems Control

b) Wind
i) Trachte
ii) AZZ
iii) Systems Control

c) Solar
i) Trachte
ii) AZZ
iii) Systems Control

16) Substation Disconnect Switches (115-230KV)

a) Energy Storage
   i) Pascor
   ii) Cleaveland Price
b) Wind
   i) Pascor
   ii) Cleaveland Price
c) Solar
   i) Pascor
   ii) Cleaveland Price

17) Substation Distribution Metering
a) Energy Storage
   i) Novatech Bitronics M871 (SCADA distribution feeder metering)
   ii) Novatech Bitronics M650 (SCADA distribution transformer metering)
b) Wind
   i) Novatech Bitronics M871 (SCADA distribution feeder metering)
   ii) Novatech Bitronics M650 (SCADA distribution transformer metering)
c) Solar
   i) Novatech Bitronics M871 (SCADA distribution feeder metering)
   ii) Novatech Bitronics M650 (SCADA distribution transformer metering)

18) Substation Human/Machine Interface
a) Energy Storage
   i) Schneider Electric
b) Wind
   i) Schneider Electric
c) Solar
   i) Schneider Electric

19) Substation Remote Terminal Unit
a) Energy Storage
   i) Eaton Cooper Power System
b) Wind
   i) Eaton Cooper Power System
c) Solar
   i) Eaton Cooper Power System

20) Substation SCADA Ethernet Switches and Port Servers
a) Energy Storage
   i) Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports
   ii) Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports
   iii) Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports
   iv) Siemens RuggedCom RS416 – Serial port server, Rack mount, 16 ports
b) Wind
   i) Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports
   ii) Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports
   iii) Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports
   iv) Siemens RuggedCom RS416 – Serial port server, Rack mount, 16 ports
c) Solar
   i) Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports
   ii) Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports
   iii) Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports

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

21) Substation SCADA Gateway
- a) Energy Storage
  - i) Eaton Cooper SMP SG4260
- b) Wind
  - i) Eaton Cooper SMP SG4260
- c) Solar
  - i) Eaton Cooper SMP SG4260

22) Substation SCADA Input/Output Devices
- a) Energy Storage
  - i) Eaton Cooper Power Systems
- b) Wind
  - i) Eaton Cooper Power Systems
- c) Solar
  - i) Eaton Cooper Power Systems

23) Transformer Bushings
- a) Energy Storage
  - i) PCORE
  - ii) Hitachi
- b) Wind
  - i) PCORE
  - ii) ABB
- c) Solar
  - i) PCORE
  - ii) ABB

24) Uninterruptible Power Supply System (UPS)
- a) Energy Storage
  - i) Ametek Solidstate Controls
  - ii) CEG
  - iii) Gutor/Schneider
- b) Wind
  - i) Ametek Solidstate Controls
  - ii) CEG
  - iii) Gutor/Schneider
- c) Solar
  - i) Ametek Solidstate Controls
  - ii) CEG
  - iii) Gutor/Schneider

25) 48 VDC Battery & Charger
- a) Energy Storage
  - i) East Penn Manufacturing
  - ii) C&D Technologies
  - iii) Delta/Eltek
  - iv) SENS
- b) Wind
  - i) East Penn Manufacturing
  - ii) C&D Technologies
  - iii) Delta/Eltek
  - iv) SENS
- c) Solar
  - i) East Penn Manufacturing

ii) C&D Technologies
iii) Delta/Eltek
iv) SENS

26) 125 VDC Chargers
a) Energy Storage
i) *SENS
ii) Ametek Solid State Controls
iii) Cyberex
iv) Hindle Power
b) Wind
i) *SENS
ii) Ametek Solid State Controls
iii) Cyberex
iv) Hindle Power
c) Solar
i) *SENS
ii) Ametek Solid State Controls
iii) Cyberex
iv) Hindle Power

27) 125 VDC Batteries
a) Energy Storage
i) *GNB
ii) BAE
iii) Hoppecke
iv) C&D Technologies
b) Wind
i) *GNB
ii) BAE
iii) Hoppecke
iv) C&D Technologies
c) Solar
i) *GNB
ii) BAE
iii) Hoppecke
iv) C&D Technologies

28) Collection System Cable
a) Energy Storage, Wind, and Solar
i) Southwire
ii) Prysmian Power Cables and Systems
iii) Okonite

Energy Storage Project Equipment Vendors:

1) BESS Suppliers, Batteries (Cells)
a) BYD
b) CATL
c) LG Chem
d) Samsung
e) Panasonic
f) Tesla

2) BESS Suppliers, Inverters

- a) Energy Storage
  - i) Power Electronics
  - ii) SMA
  - iii) Sungrow
  - iv) Tesla
  - v) TMEIC
  - vi) EPC

Wind Project Equipment Vendors:

1) **Climb Assist/Lift System**
   - a) 3S Lift, Climb Auto System
2) **Transmission Line Type Grips**
   - a) *Chicago
   - b) Alcoa Pocket
   - c) Kellum (for stringing operation)
3) **Transmission Tubular Steel Towers**
   - a) Valmont
   - b) Sabre
   - c) TAPP
4) **Transmission Overhead Conductor and Cables**
   - a) Southwire
   - b) Prysmian
   - c) Nehring
5) **Wind Turbine OEM**
   - a) Siemens Gamesa
   - b) Vestas
   - c) General Electric
6) **Rolling Element Bearings**
   - a) Schaeffler/FAG
   - b) SKF
   - c) NSK
   - d) Timken
7) **Gearbox**
   - a) Winergy
   - b) ZF
8) **Pitch Bearings**
   - a) IMO
   - b) Thyssenkrupp/Rothe Erde
   - c) GE O-bearing
   - d) Liebherr
9) **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

Solar Project Equipment Vendors:

1) **SCADA System**
   a) Vertech
   b) Green Power Monitor (GPM)
   c) Norcal Controls
2) **PV Module**
   a) Canadian Solar
   b) First Solar
   c) GCL
   d) Hanwha Q-CELLS
   e) JA Solar
   f) Jinko Solar
   g) LONGi Solar
   h) Trina Solar
   i) Yingli
   j) Tracker
3) **Array Technologies (ATI)**
   a) NEXTracker
   b) DC Combiner Box and/or Load Break Disconnect
   c) Bentek
   d) Shoals
   e) Solar BOS
   f) WTEC
4) **Inverter**
   a) Power Electronics
   b) SMA
   c) Sungrow
   d) TMEIC

APPENDIX M3
ATTACHMENT 01
EXHIBIT 01

SOLAR PHOTOVOLTAIC PLANT SPECIFICTION STATEMENT OF WORK - PV

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
1	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	PGE	SPF	Sean Flak

1.0 GENERAL

1.1 PURPOSE

Without limiting the information summarized herein, the purpose of this document is 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.

- 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.
- PGE Appendix M1, Attachment 01, Exhibit 07: Security and Compliance (“PGE Exhibit M1-01-07”)
- PGE Appendix M1,Attachment 01, Exhibit 09: PGE CAD and Numbering Standards (“PGE Exhibit M1-01-09”)
- PGE Appendix M1, Attachment 04, Exhibit 02: Power Transformer Specification (“PGE Exhibit M1-04-02”)
- 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 this 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 M3-01-05.

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 3.0.

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.

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. 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 M3-01-02 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.

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

I. 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.

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

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

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

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

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

O. 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.

P. 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	
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, ballance of plant equipment, 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 – IX 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 shutdown.

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. Meteorological Instrumentation voltage: 24VDC or 125VDC

F. Communications network: Ethernet via buried fiber optic cable/innerduct 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. Reference Section M1-05-06. 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

A. 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.

B. PV Modules shall be compatible with racking system.

C. PV Modules shall be installed per manufacturer's written instructions.

D. Contractor shall have a documented QA/QC program to ensure module installation meets or exceeds the module manufacturer's installation requirements.

E. Contractor shall make best efforts to distribute modules across site to balance bin classes.

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 designed to be driven galvanized steel and corrosion resistant over the design life of the Project. 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 capabilities. Backtracking to be configured based on module manufacturer's recommendations to maximize energy output.

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.

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

T. All modules shall be a minimum height of twelve (12) inches above finished grade at full tilt. Combiner boxes, disconnect switches, inverter/transformers, and any other electrical equipment shall be a minimum 12” above the 100-year , 24-hour storm event flood level 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 better).

B. Combiner boxes shall be installed at a minimum of 18” above grade or 12” above 100-year flood level, whichever is greater.

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 better).

B. Load Break Disconnects (LBDs) shall be installed a minimum 18” above grade or 12” above 100-year flood level, whichever is greater.

C. Provisions for pad locking in the off position.

D. Completed assemblies shall be UL listed.

E. LBD 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 ambient air temperatures between -20 ºC to 50ºC (-4 ºF to 122ºF). Derates from environmental conditions shall be taken into consideration when determining the quantity of inverters.
    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 at the environmental conditions detailed in table 1-1.
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 0.8 lag to 0.8 lead, unless more stringently defined by Interconnect Agreement.
9. Inverters shall not de-rate while operating within their rated DC voltage range and design temperature. 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). De-rating characteristics shall be submitted to Owner for review.
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 FERC requirements.
    a. Inverter shall be compliant with NERC PRC-029 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.
21. Each electrical equipment enclosure on the ISA shall be labeled with a UV resistant placard.

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, including any environmental derates, shall match ISA combined inverter rating. Impedance shall match inverter manufacturer requirements. Cooling class = KNAN or KNAF

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 color approved by Owner.

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. Valve shall be located external to the high voltage and low voltage compartments in a pad-lockable cover or in gauge cabinet.

P. NEMA 2-hole ground terminal pads.

Q. 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.

R. Transformer insulating/cooling liquid shall be non-hazardous and environmentally friendly such as FR3 or Owner approved equivalent.

S. 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:

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

T. 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. C57.12.28 – Switchgear and Transformers, Pad-Mounted Equipment – Enclosure Integrity.
4. C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers
5. C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
6. C57.159-2016 – IEEE Guide on Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems
7. C57.91 – Oil-immersed transformer temperature monitoring

U. 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 telecoms 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, or path diverse ring fiber network or equivalent.

M. SCADA System

1. 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.
2. 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.
3. IP addressing to be coordinated with Owner.
4. All SCADA and network equipment must be of utility grade substation quality equipment by standard industry grade suppliers.
5. 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.
6. 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 with 2 parallel fibers within the same cable (closed loop).
7. All fiber shall be terminated on bulkheads in weatherproof enclosures or fiber patch panels.
8. All fiber networks shall support 1 Gigabit network architecture.
9. Contractor shall install a minimum of 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.
10. SCADA shall employ Remote I/O to be deployed at major data collections points in the Project. Typical locations for Remote I/O include the ISAs.
11. The Remote I/O shall function as the input/output point for the command-and-control signals.
12. The SCADA system shall be either connected to its own UPS or connected to the substation backup energy system. 8hr run-time required.

13. The SCADA shall be designed with redundancy in mind, i.e. power supplies, network paths, etc. UPS system is required in the Control Room.

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

1. Local operator station (HMI)
2. Owner's centralized remote command center
3. Utility or ISO dispatch commands (such as Automated Dispatch System in CAISO).
4. At a minimum, the following controls capabilities shall be available at the plant level:
   a. Power factor control
   b. Reactive power (VAR) control
   c. Output power curtailment
   d. Power and VAR ramp rate adjustment
   e. Frequency droop control (freq vs. kW)
   f. 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 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.A 144 ct SM fiber cable will connect main communications room to owner POI or Owner LEC interface for transport to owner data center.
3. The Control Room shall also contain the Contractor or owner supplied communications equipment which will transport all SCADA to the Solar Substation control house via min.60ct SM fiber optic cable in a collapsed or ring topology. Telecom transport Network fiber will terminate in the Control Room, and/or O&M building Communicaitons Room. 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 monitored points 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. Rear Plane-of Array Thermopile Pyranometer (Direct & Indirect Irradiance), if applicable
   e. Rainfall Amount
   f. Barometric Pressure
   g. Back of module Temperature (see PV Module Points below)
   h. Anemometer and Wind Vane (Wind Speed and Direction. Wind speed should be ranged for the full design spec of the site.)
   i. Albedo sensor, if applicable
2. ISA Points (per ISA)
   a. Inverter Performance Points: 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. Revenue meters shall be installed at the project substation and downstream plant to account for gross and net generation, as well as station service and auxiliary loads. Each revenue meter shall be sourced from high accuracy, revenue grade current and voltage transformers, and shall comply with the requirements shown in the Interconnection Agreement and any power purchases agreement(s). Actual revenue meter locations and instrument transformer specifications shall be determined by PGE metering personnel.

b. SCADA meters shall be installed on each medium-voltage (34.5kV) collection system circuit feeder.

c. All points required by utility and ISO

4.0 <u>ELECTRICAL INSTALLATION</u>

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 cable management materials shall be impact modified, heat-stabilized, UV resistant Nylon 66 or better. This means their exterior materials shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements.

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.

I. All outdoor enclosures shall be NEMA 3R or better.

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 maximum DC voltage drop between a string and an inverter DC termination is no greater than 2.5% at STC. The average wire loss for all DC circuits shall not exceed 1.5% at STC.

C. All 1500V connections shall be the same make and model as connectors on PV modules. Series string connections between modules will be via locking multi-contact connectors and jumpers factory-supplied with modules.

D. No wiring will be loose and 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. Unless routed in conduit or a CAB system, DC cabling routed below grade from the modules to the DC disconnect shall be rated for direct burial, conforming to NEC Article 310 provisions, and installed a minimum of 30" below grade in a clean fill material free of stones larger than 1-inch in diameter within 12" of cables. Cables shall be laid in the trench such that no cable crosses or rests upon another cable. If there is more than one layer of cable within a trench, a minimum of 4 inches of soil shall separate the layers. A 4-inch-wide marker tape shall be placed 12" below grade continuously over the conductors per NEC Table 300.50.

H. 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.

I. 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.

J. Harnesses or cabling shall be rated to withstand sunlight and extreme heat as defined per table 1-1 and NEC requirements.

K. All DC string or harness wiring shall be factory cable assembled and must be pre-cut to length.

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

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

N. Wiring harnesses and cabling shall be UL listed.

O. 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.

F. When terminating to bus terminal pads, one-hole compression lug for sizes #2/0 and below and two-hole for sizes #3/0 and greater are to be utilized.

G. All control and instrumentation conductors shall be terminated with ring-tongue connectors.

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. Conductors shall be installed below grade. Direct buried conductors shall be rated for direct burial and installed with at depths required per the NEC in a clean fill material free of stones larger than 3/8”-inches in diameter within 4” of conductors. A 4-inch-wide marker tape shall be placed 12” below grade continuously over the conductors.

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

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

H. Conduit sleeves in and out of all transformers shall be provided.

I. 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 may be used where economically efficient in routing power to Solar Substation with minimal losses.

B. Overhead wiring and poles shall be routed 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. All ground conductors shall be stranded copper and may be bare.

B. All electrical Equipment shall be bonded to the grounding system as required by applicable codes and standards. The 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.

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

D. Equipment grounding conductors shall be routed with the phase conductors.

E. Module mounting structure and disconnect boxes shall be grounded per NEC requirements. Where bolts and screws are provided, thread forming screws or equivalent shall not be acceptable.

F. Contractor shall provide a detailed grounding calculation to verify grounding design and conform designs based on results of grounding study.

G. ISAs (inverter(s), transformers, and associated Equipment) shall be bonded to the ground ring.

H. Where applicable, ground equipment per the manufacturer’s requirements.

I. One 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.

J. Contractor shall install supplemental fence grounding or isolation sections where deemed necessary by the grounding study. Perimeter fence grounding shall comply with applicable NESC requirements including official interpretations.

4.7 LABELING AND IDENTIFICATION

A. For diagnostic and troubleshooting purposes, all PV 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 with appropriate safety margin.
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 519 and IEEE 2800 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
6. kg body and no PPE. Fault duration shall be per Protection Coordination Study, or 0.5s if it has not yet been performed.
7. Arc Flash Study: Contractor shall perform an arc flash hazard analysis in accordance with NFPA 70E and (for equipment operating between 208 VAC and 15 kVAC) 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. Permitted software shall be the same as enumerated in M1-04-01, General Electrical Study Requirements.

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

B. General

1. Fire protection during plant construction shall meet the requirements and recommendations of NFPA 10 and 241.
2. All fire protection systems are subject to the review and approval of the local fire department authorities.
3. Locate fire extinguishers where convenient and effective for their intended purpose.
4. Store combustible materials in containers in fire-safe locations.
5. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
6. Provide supervision of welding operations and similar sources of fire ignition.
7. Post warning and instructions at each extinguisher location and instruct construction personnel on proper use of extinguishers and other available facilities at Project Site. Post local fire department telephone number on or near each telephone instrument at Project Site.

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 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.
7. Communications equipment, AC/DC power system, Fiber entrances and termination.

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
14. Fiber Design, one-line, splice diagrams, termination schedules.

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, pole permitting in ROW, 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 consider 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.

F. Contractor shall develop and provide a site layout diagram/map (showing all major features of the proposed project, including access points) and all drawings, diagrams, and documents required for attainment of any/all permits required for the site preparation, and the installation and operation of the solar PV system.

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

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

E. 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 local regulations or the Vegetation Management 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.
2. Owner will provide specific clearing and grubbing restrictions, if any.

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.
2. All vegetation and trees removed from the site shall be disposed of by the Contractor at an Owner approved land fill. Conditioned upon Owner's prior written approval, vegetation and trees may be sold by Contractor or otherwise beneficially used.

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 and meet all permitting requirements. 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.

4. Contractor shall prepare a road use/delivery plan for the proposed deliveries of PV equipment.

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. Reference Section M1-02-01.

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. Design shall consider stormwater management and use low water crossings or culverts to prevent erosion and/or rutting of road.

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 for expected use of large construction vehicles. Minimum inside turning radius shall be 30 feet, with centerline turning radius of not less than 50 feet, unless otherwise approved by the Owner. Tighter radii may be acceptable for limited-access or dead-end service spurs, subject to Owner review and approval
   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

A. 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.

B. Contractor shall coordinate as-built drawing format with Owner.

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:

    c. ASTM A36

    d. Structural Plates and Bars: ASTM A36

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

    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 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 embedment's 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 Contractor’s Geotechnical report.

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. 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

2. 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 (e.g., driven or augered piles) shall be hot-dip galvanized in accordance with ASTM A123 prior to installation. The galvanized coating shall be specified and detailed to withstand abrasion and damage during pile driving or augering. If additional corrosion protection is warranted due to site-specific soil conditions (e.g., high chlorides, sulfates, or low resistivity), the Contractor shall consult a corrosion engineer to recommend supplemental corrosion protection measures. These recommendations shall be submitted to the Owner for review and acceptance. In no case shall bare carbon steel be installed below grade without corrosion protection.

3. 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 <u>COMMISSIONING AND PROJECT ACCEPTANCE TESTING</u>

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 provide an OSHA“competent” and designated safety 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 M3-01-06.

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

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
01	16Jun25	Revision to 2023 Specs	1898 & Co./ PGE	PGE	SPF	Sean Flak

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

O. 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.

P. 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.

Q. 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.

R. Fire protection during construction shall meet the requirements of NFPA241. All fire protection systems shall be subject to the review and approval of the local fire department authorities.

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

T. 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, suchmaterialshall 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 and internet access
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.

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

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

W. Contractor shall provide:

1. Protective Device Coordination Study including time coordination curves and a narrative document explaining relay settings philosophy and calculations.
2. Electronic settings files for insertion to applicable relays.
3. Load Flow Study.
4. Short Circuit Analysis.
5. Facility Rating Report in accordance with FERC and NERC regulations.
6. Grounding System Study (including step and touch potential).
7. Any other studies required by the Interconnection Agreement, Power Purchase Agreement, or by local utility/ISO.
8. 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.

X. 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.

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

Z. Contractor shall furnish and install primary ADSS or 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.

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

BB. 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.

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

DD. Contractor shall provide all water for dust suppression.

EE. 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.

FF. 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. Refer to M1-01-07 (Security and Compliance) for more Owner requirements.

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, if necessary.

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 - Contractor to verify that all sources, including auxiliary and backup sources are in phase at the MV leve]

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. MPT windings 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

D. 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 (the continuous duty shall not be greater than 85% of rating)

G. Rated Current-RMS: Interrupting: [by Contractor] kA (the interrupting duty shall not be greater than 85% of rating)

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 (the continuous duty shall not be greater than 85% of the rating)

G. Rated Current-RMS: Interrupting: [by Contractor] kA (the interrupting duty shall not be greater than 85% of the rating)

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

C. 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.

D. 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

J. Owner shall approve the model and firmware version of all relays prior to procurement by Contractor. SEL must be informed that Owner is the end user of the relays to apply Owner’s Special Specification requirements, including standard firmware. Model and firmware shall follow the owner’s standard in effect at time of purchase.

K. Relay settings shall, to the extent applicable and possible, follow Owner’s standard template in effect at the time settings are developed.

L. Relay settings shall conform to good engineering practice; equipment manufacturer requirements; PRC-027, PRC-025, and PRC-024, as applicable; and, to the extent possible and applicable, Owner’s standard protection practices in effect at the commencement of the Protection Coordination Study. Contractor shall request standards the latest standards from Owner prior to starting work.

M. To the extent possible and applicable, any Solar Plant relay systems shall follow the same design masters and standards as the substation relay systems.

N. All relays protecting auxiliary power circuits used for life safety, fire protection systems, or circuits which are critical for operation of and restoration of the plant shall be fully redundant and powered by the step-up substation DC supply if feasible. If not possible, then the control power to such relays and breakers shall provide reliability and be equipped with monitoring equivalent to the substation DC supply. DC power quality, including excessive ripple and transients, shall not cause protection system misoperations. AC sources to UPSs and battery chargers powering relays shall be connected upstream of any breakers or switches controlled by the relay, or on an independent circuit.

2.14 MAIN POWER TRANSFORMER

A. Contractor shall furnish one (1) or more XXX/34.5kV step-up transformer(s) for

B. 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 collector system.

C. Transformer shall be sized to at least 10% above MVA rating of plant.

D. 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.

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

F. 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:
      - Fault current per project characteristics.
      - 50 kg body weight
      - A fault split factor may be applied.
      - Ground resistivity determined from the Geotechnical Report.
      - 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.
   a. A system model of all Bulk Electric System elements shall be provided in ASPEN One-Liner format. Auxiliary, low voltage, and balance of plant systems may be modeled in Easy Power. Inverters shall be modeled per the manufacturer instructions, and use of synchronous generator models for inverters are not permitted. Contractor shall verify Owner’s version of all software prior to creating any models to ensure consistent results. Contractor shall follow Owner’s ASPEN modeling and naming conventions.
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

d. perpendicular to the bus.

e. 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

4. 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%.

5. 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.

6. 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

- Bare – Soft drawn copper, Class B stranding, ASTM BB.
- 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 <u>MECHANICAL</u>

4.1 GENERAL REQUIREMENTS

A. 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 shutdown.

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.

a. Contractor shall follow all requirements of the SWPPP when removing water from excavations.

b. Contractor shall, at a minimum, check groundwater and stormwater visually and olfactorily (by odor) for contaminants such as oil and grease prior to pumping.

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 <u>STRUCTURAL</u>

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

2. – 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.

3. 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:

   c. ASTM A36

   d. Structural Plates and Bars: ASTM A36

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

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

   g. Pipe: A53, Grade B

4. 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.

5. 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.

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

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

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

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

10. 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 forfuture lateral expansion of theenclosure. 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. Designfor 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/monitoringequipment 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-

B. supporting tubular steel poles (or Owner approved structures), shall begin at

C. the Solar Substation and terminate at the POI or Point of Change of Ownership as defined in the Interconnection Agreement.

D. 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.

E. 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.

F. 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 ADSS/OPGW shall not exceed 20% of the ultimate cable strength.
3. Wire tension limits for design of the conductor, shield wire, and ADSS OPGW shall be based on applicable weather cases (wind, ice, temperature).
4. Vibration Protection.
5. Contractor shall consider and design all wire systems (OPGW,ADSS, 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 48 ~~24~~-fiber OPGW or as specified in the Interconnection Agreement.

H. ADSS fiber will be 144cnt or as specified in the interconnection agreement

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

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

K. 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.

L. All aerial ADSS fiber shall be installed per NESC rule 235.

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

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 04

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION COMMISSIONING

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
1	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	PGE	SPF	Sean Flak

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 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 results 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 commission ability (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 provided to the Owner weekly 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 Commissioning 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:

1. The following PV equipment shall be tested for functionality, operability, and performance:
    a. Solar Modules (IEC 61215 tests and Flash Tests)
    b. DC combining system equipment and assemblies
    c. Inverter Skid Assemblies and components
    d. Solar Substation equipment (as applicable to Contractor scope)
    e. SCADA system & instrumentation
    f. PV Tracking System
2. OWNER and OWNER'S ENGINEER shall be given the opportunity to witness each test and shall be given 15-day advance notice prior to any planned test. The expenses for hosting the test(s) will be paid by the Contractor. Owner and/or OWNER Engineer's travel expense for attending factory acceptance testing will be paid by the Owner.
3. 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. Pre-functional Checklists: Project and equipment-specific pre-functional checklists shall be developed and issued by Contractor to the installing contractors. The pre-functional checklists shall address proper installation methods, manufacturer's 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. Pre-functional checkout 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 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 the manufacturer's recommendations. This will also include observations and punch lists from Contractor's quality control personnel verifying installation that has occurred per their design drawings and specifications.

F. Functional Testing: There are two types of functional testing required:

1. Equipment-specific functional testing.
2. PV Plant Functional Testing.
3. The Contractor shall develop and execute protocols for each of these to address the functionality and safe operation of components and systems. The functional testing protocols shall be detailed to address operation, failure modes, and recovery modes.

4. 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 per tracker and module manufacturer requirements.

    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, Polarity Tests and Grounding Tests.

    c. AC cabling Very Low Frequency (VLF) testing or Partial Discharge (PD) testing.

        - Inspection and testing shall be performed after all splices and cable terminations have been installed. In all cases, the tested sections shall include all cable sizes and shall test the cable insulation, the terminations and the splices (if any) on the cable sections. The test shall be performed after cable terminations have been installed. Other test methods may be used subject to Owner approval, except that DC dielectric withstand testing shall not be used. If partial discharge testing (PD) is required, each of the MV collection system cables shall be tested in accordance with IEEE 400.3 and ICEA S-94-649.
        - Include a documented sensitivity assessment performed in accordance with IEEE 400.3 on every cable system to ensure the test results are comparable with IEEE and manufacturer levels. The design of the cable system shall consider the limitations of the required test methodology.

    d. Proper installation and operation of the Inverter Skid Assemblies.

        - 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 the manufacturer's instructions (Cold commissioning plans).

    e. 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.

f. Perform point to point test from the end of the furthest tracker torque tube in each tracker group to the inverter grounding electrode. Test results shall have no more than 1 ohm of resistance to earth, if the measured ground resistance exceeds this value, the Owner and Owner's Engineer shall be notified and shall assess if the results are acceptable.

g. Perform testing by the fall-of-potential method, in accordance with IEEE-81 and NETA-ATS section 7.13.B.2, at the locations below. Fall-of-Potential tests shall be completed on each ISA ground ring and similar ground rings or rods while such grounding systems are isolated from other grounds and before any underground grounding conductors are installed. Ground rings shall have no more than 5 ohms of resistance to earth and their resistance shall be compared with the values in the grounding study. If the measured ground resistance exceeds the value in the grounding study, the Owner and Owner's Engineer shall be notified and shall assess if the results are acceptable.

- Inverter ground ring.
- Sectionalizing Cabinet ground ring

h. Completion of the pre-functional 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 is required to be performed either in factory or field 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 by the inverter manufacturer.

i. Liquid filled transformers shall be tested per the transformer manufacturers' requirements where integrated into inverter skid. If liquid filled transformer is separate from the integrated inverter skid, following field testing requirements shall be completed:

- Verify nameplate data.
- Coordinate and perform instrument transformer tests on CTs with transformer assembly.
- Winding Tests:
    - TTR at all no-load taps.
    - Megger winding to ground.
    - Megger winding to winding.
- Set high-side voltage taps at positions determined by Engineer of Record.
- Check and measure equipment ground; neutral to grounding grid resistance shall not be more than one ohm.
- DGA:
    - 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.

    - Test oil samples from each transformer with standards in accordance with ASTM D1816.
- Check liquid level in tanks.
- If equipped with cooling fan, check operation of cooling equipment and cooling controls before energizing transformer.
- Check calibration of pressure relief device, top oil temperature gauge.
- Test all gauges including level, temperature, and pressure gauges.

j. Dry type transformers shall be tested per the transformer manufacturer's requirements where integrated into inverter skid. If liquid filled transformers are separate from the integrated inverter skid, the following field-testing requirements shall be met:

- Verify nameplate data.
- Winding tests:
    - TTR at all taps.
    - Megger winding to winding.
    - Megger winding to ground.
    - Winding resistance measurement on center tap
    - Partial discharge measurement
- Check equipment ground to assure continuity of connections. Notify Owner if ground is more than one ohm.
- Check for proper operation of the winding temperature gauge and cooling fans.
- Set high-side voltage taps at positions determined by Engineer.
- Check connections for tightness; clean out dust and other foreign material.

k. Trackers: Verify trackers are fully functional per the manufacturer's requirements. Ensure they operate in unison and adjust angle accurately remaining normal to sun (in the E-W direction) even with clouds and reset to proper angles after stow or night; if required, back-tracking function works properly with no interior shading. Proper tracker stow shall be checked and wind and hail stow shall be verified.

l. 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 PD or VLF testing, and disconnect devices integrity and operability and insulation test on each phase conductor with respect to phase to phase and phase to ground.

m. Test plant controls to verify all control features are fully functional, including reactive power control (PF/VAR/voltage) and power curtailment.

n. All auxiliary systems and devices are installed and functionally tested.

o. 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.

p. Fiber loop feed shall be tested to verify a fully functioning fiber ring. Perform OTDR testing on each fiber strand (including spares).

5. 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 shutdown 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:

- Irradiance
- Ambient Temperature
- Wind speed
- Inverter Voltage, Amperage (both DC and AC)
- Inverter IGBT (measured at heat sink) Temperature
- Power, Voltage, Amperage
- Module Temperatures
- Transformer temperatures and pressures and alarm status
- Tracker angle
- 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. Refer to exhibit M3-01-11 for more information.

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 subcontractors supplied manuals, warranties, and specification sheets.

E. Warranty Review: Contractor shall provide manufacturer equipment warranties that comply with the contract documents. Extended warranty requirements and warranty activation dates shall be documented. Contractor shall provide all warranty information to the Owner and transfer the warranties to the Owner upon transfer of the project.

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

A. Contractor shall be responsible for all standard testing instrumentation. Testing instrumentation should include, but is not limited to:

1. Power meters
2. Voltmeters
3. Clamp-on meters (Amp meters
4. Irradiance meters

5. Power quality test equipment
6. Temperature sensors
7. Met stations: Wind speed sensors, rain gauge, ambient temperature sensors, and all other sensors.
8. IV Curve Tracers
9. PD test equipment
10. Specialized electrical apparatus test equipment.

B. All instrumentation is to be NIST, or approved equivalent, calibrated; calibration certificates shall be current for all instrumentation used by Contractor during testing.

C. All irradiance meters shall be cleaned no less than once per week during testing.

4.0 SAFETY

A. 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:

1. Fall Protection
2. Electrical and Arc Flash Safety
3. Lockout/Tagout

ATTACHMENT 1 – INVERTER TESTING REQUIREMENTS

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.

1.0 SCOPE

The inverter manufacturer shall provide the following documentation from a certified NRTL:

A. UL 1741 Test Report

B. UL 1741 Certification

C. UL 1741 SA and/or SB Test Report

D. UL 1741 SA and/or SB Certification

E. IEEE 1547/519 Harmonics Test Report (including raw test data)

F. Current THD < 3%

G. IEEE 1547/519 Harmonics Certification

H. NERC PRC-024-3 Voltage and Frequency Ride-Through Certification

I. 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).

A. Active Power

  1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the nameplate power rating (including any "overdrive" or 110% functionality).

B. Reactive Power

  1. Inverter manufacturer shall provide test documentation showing the inverter can operate up to the maximum reactive power capabilities.

  2. Minimum Requirement: 0.8 lead/lag in 0.01 intervals, or as required by the interconnection agreement at rated apparent power.

C. Plant Controller Response

  1. Inverter manufacturer shall provide test documentation showing the inverter can receive active and reactive commands from a simulated plant controller interface and as required by the interconnection authority.

2. Inverter manufacturer shall provide test documentation showing the inverter can operate at the maximum and minimum ramp rates for both active and reactive power variation as required by the interconnection authority.

D. Edge-of-Cloud Effects

1. Inverter manufacturer shall provide test documentation showing the inverter can track the PV array maximum power point (MPP) during high DC voltage and current transients.

E. DC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated DC voltage operating range.

2. Inverter manufacturer shall provide active power vs. DC voltage de-rating curves.

F. AC Voltage

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the rated AC voltage operating range.

2. Inverter manufacturer shall provide active power vs. AC voltage de-rating curves from 0.9 to 1.1 p.u. terminal voltage and 0.8 lead/lag.

G. Ambient Temperature

1. Inverter manufacturer shall provide test documentation showing the inverter can operate over the entire ambient temperature range (minimum 4 hours at each test condition).

2. At a minimum, the test documentation must include the following operating conditions:

a. 25°C

b. 45°C

c. Maximum Operating Temperature

d. Minimum Operating Temperature

e. Any “corner points” on ambient temperature de-rating curves

3. Inverter manufacturer shall provide active power vs. ambient temperature de-rating curves.

H. DC/AC Ratio

1. Inverter manufacturer shall provide design calculations and/or test data showing the inverter performance and reliability information at multiple DC/AC ratios including, but not limited to, the maximum and minimum DC/AC ratios specified for the project.

I. Reliability

1. Inverter manufacturer shall provide test documentation summarizing the accelerated life testing (ALT) and highly accelerated life testing (HALT) testing that has been completed.

2. Inverter manufacturer shall provide mean time between failures (MTBF) and mean time to failure (MTTF) rates for critical components such as:

a. IGBTs

b. DC switches/contactors

c. AC contactors/breakers

d. DC link and AC filter capacitors

e. Communications boards

f. Cooling system components (fans, pumps, etc.)

At a minimum, the following tests shall be performed on each inverter during production testing:

A. Calibration of all DC and AC voltage, current, and power circuitry/sensors.

B. UL 1741 production testing such as hi-pot and PE/ground testing

C. GFDI

D. Emergency stop (fast stop)

E. Remote start/stop

F. Burn-in (minimum 4 hours per inverter)

1. Burn-in testing should be completed under elevated ambient temperature and high DC current conditions at maximum rated power.

G. Harmonic content verification (during burn-in tests)

H. Efficiency verification

1. Verify inverter efficiency at multiple DC voltages and power levels which shall be consistent with the levels tested during CEC testing.

a. The official CEC test procedure is not required.

I. Reactive power control (0.95 lead/lag, or as required by the interconnection agreement) at rated apparent power

J. 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 2 – 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:
    a. Megger tests
    b. Instrument transformer tests
    c. Insulating oil tests
    d. Ground testing
    e. Power panel tests, AC and DC
    f. Low voltage automatic transfer switches
    g. Battery chargers
    h. Batteries
    i. Molded-case circuit breaker trip test
    j. High voltage testing
    k. Radio interference tests
    l. Lighting
    m. Hot-spot tests on buses, connectors, and fittings
    n. Miscellaneous tests on other equipment furnished and installed by the Contractor
    o. 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 degreesCelsius 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:

    a. Primary Frequency Response (PFR)

    b. Reactive Power

    c. Automatic Voltage Regulation (AVR)

APPENDIX M3
ATTACHMENT 01
EXHIBIT 05

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION PV CAPACITY TEST

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
1	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	PGE	SPF	Sean Flak

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 the 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 and/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 T0 and W0.

2.0 DEFINITIONS

2.1 AGREEMENT

The Engineering, Procurement and Construction Agreement between Owner and Contractor.[fill in actual final document name/date here]

2.2 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.

2.3 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 guaranteedMinimum 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 have a Facility Performance of 97%. It shall be expressed as a percentage.

2.4 MINIMUM FACILITY CAPACITY

Shall be a Facility Performance of 95%.

2.5 MINIMUM POWER RATING (PMIN)

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.

2.6 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.

2.7 PV POWER PLANT

The PV Power Plant (also referred to as the “Facility”) will consist of XX MWAC 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.

2.8 POINT OF INTERCONNECT (POI)

POI shall mean the point of interconnection of the PV Power Plant.

2.9 POWER RATING (PRC)

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.

2.10 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.

2.11 PRIMARY MEASUREMENT DEVICE

An instrument that provides a measurement or reading that is used in calculating the PV Power Plant Power Rating.

2.12 REPORTING CONDITIONS

This shall be as defined as the reference irradiance (Irr0), the reference temperature (T0), and the reference wind speed (WS0) as determined by the procedures outlined below and referred to in ASTM E2848-13.

2.13 SECONDARY MEASUREMENT DEVICE

An instrument that provides a measurement or reading that is not used in calculating the output power but is used as a check on primary measurements or for further analysis.

2.14 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

The hardware and software installed at the Project Site which is used to control, monitor and collect weather and performance data from the PV Power Plant. This typically consists of programmable logic controllers, data loggers, software, and other network devices.

2.15 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%.

2.16 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 at the POI with calibrated CTs and PTs		+/- 0.2%
Net Power Output (kW)	1 per Inverter	Secondary	Inverter internal power meter		+/- 2%
Ambient Temperature	1 per MET Station	Primary	Part of weather station	-50 – 60°C	+/- 0.3°C
Module Temperature	2 per Met Station	Secondary	Platinum RTD (resistance	-10 - 140°C	+/-0.3°C

			temperature detector) (.00385 TCR DIN B), on back surface of module		
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 as provided by the Contractor.

- 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

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 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 and daily during the test period. 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:

1. Routinely reviewing collected weather and operating data for the PV Power Plant following Substantial Completion.

2. 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 750 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. Contractor shall verify 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.

E. The following acronyms and definitions for the Capacity Test are as follows:

1. PRC is the actual power measured at the Reporting Conditions (RC).

2. PMIN is the guaranteed power at RC.

3. Pass/fail: PRC/PMIN*100 greater than or equal to 97% (to account for test uncertainty). PRC is determined from filtered on-site data (1 min), running multiple regression and calculating PRC from resulting equation with its coefficients, at RC.

4. PMIN is determined by running PVsyst with site weather data (1 hour, averaged from site data) or, if not available, from other sources such as Solar Anywhere, filtering, running the regression, and calculating PMIN at RC.

5. RC is determined from site data (can also use modeled but prefer site data), finding Irradiance Irro to be the mean filtered irradiance above 400 W/m2 +/- 20%, with a distribution skewed no more than 40%/60%. T0 and WS0 will be the average ambient temperatures and wind speeds in the resulting data set.

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.

1. 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).
2. 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:

1. The guidelines and calculations described in ASTM E2848-13 will be followed. All data identified by the applied filters shall be excluded.
2. Any test data points in which the inverter is “clipping” shall also be excluded.
3. 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.

1. 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.
2. There shall be no more than 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.
3. All test data where the irradiance is outside of the range of Irr_0 plus or minus the irradiance band ($Irr_0 \pm 20\%$) shall be excluded. At the agreement of Contractor and Owner, the irradiance band may be increased (not to exceed $Irr_0 \pm 50\%$), to obtain a necessary and reasonable number of data points.
4. The minimum value for consideration as the Irr0 will be calculated by the following equation:

$$Irrmin = (400\ \mathrm{W}/m\text{^}2)\ /\ (1-Irrband) = (400\ \mathrm{W}/m\text{^}2)\ /\ (1-0.2) = 500\ \mathrm{W}/m\text{^}2$$

Where:

Irrmin is the minimum value for Irr0.

Irrband is the size of half the irradiance band expressed as a number, so a band of +/- 20% would mean Irrband = 0.2. For the avoidance of doubt, the full irradiance band would be 0.4.

All irradiance values less than Irrmin shall be excluded from consideration as the Irr0.

5. The maximum irradiance value for consideration of the Irr0 shall be determined by the following equation:

$Irrmax = (Irrhigh) / (1+Irrband)$

Where:

Irrmax is the maximum value for Irr0.

Irrhigh is the highest irradiance value of collected and filtered data set (as determined in section iii above)

All irradiance values greater than Irrhigh shall be excluded from consideration as the Irr0.

6. 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 (iii) above, and it shall have a minimum of one hundred twenty (120) data points.

1. The seven hundred fifty (750) or more data points are under the assumption of a one (1) minute data interval.
2. 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.
3. A wider filter can be applied to irradiance band as mentioned above in section d (iii), if agreed upon by Owner and Contractor.
4. All data points with irradiance less than 400 W/m^2 shall be excluded.

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 (PMIN)

A. The PV Simulation Model, as derived from PVsyst simulations, shall be used to establish the Facility’s expected power output as measured by the inverters and confirmed by the revenue meter.

1. 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) :

1. Date & Time (formatted with Month; Day; Hour in separate columns)
2. POA Irradiance (GlobInc, W/m^2)
3. RPOA Irradiance (GlobBak, W/m^2)
4. Horizontal Irradiance (GlobHor, W/m^2)
5. Ambient Temperature (T Amb, °C)
6. Wind Speed (WindVel, m/s)
7. Near Shadings Beam Loss (ShdBLss, W/m^2)
8. Inverter Loss Due to Low Voltage Maximum Power Point (MPP) Window (IL Vmin, kW)
9. Inverter Loss Due to Power Limitation (i.e., “clipping” loss) (IL Pmax, kW)
10. Available Energy at Inverter Output (EOutInv, kW)
11. 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 sixty (60) days: the thirty (30)-Day period prior to and after the Test start. The Target Period may be extended further than sixty (60) 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:

1. 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)
2. 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.
   d. Exclude data points with POA irradiance < 400 W/m2.
3. 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.

4. 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)

5. 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.

$$PMIN = Irr_0 * (A + B * Irr_0 + C * T_0 + D * WS_0) \quad \text{(Eq. 3)}$$

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 multiplied by the bifaciality factor as illustrated in Equation 1.

5.5 POWER RATING (PRC)

A. The Filtered Measurement Data for the site identified in section 5.3 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:

$$P_{RC} = Irr_0 * (a_1 + a_2 * Irr_0 + a_3 * T_0 + a_4 * WS_0) \quad \text{(Eq.4)}$$

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:

$$\text{Facility Performance} = (P_{RC} / P_{min}) * 100$$

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 met the Guaranteed Capacity, then no further analysis is required.

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

1. Test procedures
2. Instrument calibration sheets/certificates
3. Test data (manual and data acquisition)
4. Test Results uncertainty
5. Field notes
6. Calculations and Results

APPENDIX M3
ATTACHMENT 01
EXHIBIT 06

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION PROJECT SCHEDULE

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
1	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	PGE	SPF	Sean Flak

1.0 GENERAL

Refer to M1-01-05 (Project Management and Controls) for additional Schedule requirements.

2.0 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.

3.0 KEY DATES SCHEDULE

Key Date Schedule shall include major project milestones, including substantial completion of each Circuit, as defined in M3-01-05. Milestones indicated in the Key Date Schedule will be used as a basis for milestone payments.

4.0 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, and shall be sufficiently detailed so that each of the following are included and will be readily apparent:

1. The engineering and detailed design activities necessary to complete design, procurement and construction.
2. Permits required that have not been received by the start of construction.
3. Materials and equipment purchase and deliveries.
4. Subcontractor interfaces and requirements.
5. Construction, by Circuit and system.
6. Dates for the completion of Key Date Items.
7. Contractor and Subcontractor data cycles, and Owner's review cycles.
8. Functional Tests, Commissioning and Capacity Testing.
9. 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.

5.0 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

2025

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1.0 OVERVIEW

1.1 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. The owner will use this energy model for its own financial monitoring and asset management, and the Contractor will use it as the PVsyst model in the Capacity Test calculations.

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, system operational data shall be gathered and recorded by SCADA to update the model with site data.
2. The Project Weather File will be loaded into PVSyst.
3. PVSyst will produce an output based on the Project Weather File, which will then beloaded into the Energy Model File.
4. Calculate any losses not modeled in PVSyst.
5. Add up the contributions from all the Circuits (if modeled separately).
6. The 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

2.1 ASSOCIATED SOFTWARE, FILES, AND REFERENCES

A. Software:

1. Most recent version of PVSyst.
2. Microsoft Excel

2.2 FILES

A. Energy Model File

1. [ ].xls

B. Module Equipment Files for PVSyst

1. [ ].PAN

C. Inverter Equipment File for PVSyst

1. [ ].OND

D. Shading Profile File for PVSyst

1. [ ].SHD

E. Project File, Variant Files by Array Type

1. [ ].PRJ
2. [ ].VC2
3. [ ].VC3

F. PVSYST Output Reports by Array Type or Circuit

1. [ ].xlsx
2. [].pdf

G. Energy prediction Report by Array or Circuit with AC losses excluded

1. [ ].xlsx

2.3 REFERENCES

System design specifying module types, strings per inverter, inverters per Circuit, cable and transformer losses.

3.0 DATA PREPARATION

3.1 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 system at the agreed-upon data time intervals. SCADA recorded 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 used in running the updated Energy Model will include:

A. Measured Meteorological Data (inputs to PVSyst):

1. Albedo (W/ m^2) (If bifacial modules used)
2. Soiling Loss (%)

B. Discussion:

1. The Albedo and Soiling loss are to be recorded during the agreed-upon Capacity Test Period.

C. Data Preparation

1. The raw test data shall be analyzed and reduced to eliminate data points that clearly exhibit a high degree of random error (such as errors caused by faulty instruments).
2. Missing or obviously faulty data due to equipment error shall be discarded or be replaced in accordance with the Acceptance Test Procedures.
3. All methods for data filtering and manipulation shall be agreed upon between Owner and Contractor. A report of all data filtering will be provided.

D. Site-Specific Measurements into PVSyst

1. The resulting measurements will be input requirements for PVSyst and will replace or modify the preliminary values used for the base PVSyst energy model.

4.0 PVSYST SIMULATIONS

4.1 DETERMINE PVSYST SIMULATIONS TO RUN

Each Array or Circuit must be modeled by a single average configuration and single module degradation amount (one PVSyst .VC file per Array or Circuit) Include 8760 data as Attachment B.

Contractor shall fill out and bracketed [ ] values.

4.2 PVSYST PARAMETERS

A. Project Tab

1. Latitude = [ ] deg.
2. Longitude = [ ] deg.
3. Meteo Data File: Solar Anywhere, satellite data, SUNY model - TMY
4. Altitude = [ ] meters
5. Time zone = [ ]
6. Monthly Albedo = [These values assume a one-in-portrait tracker]

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]
October	[ ]
November	[ ]
December	[ ]

B. Orientation Tab

1. See attached input and assumptions for Tracker parameters

C. Horizon Tab

1. As applicable for the site, from Solar Anywhere or other source.

D. Near Shadings Tab

1. 3D model representative of the site layout, including shading objects and as-left terrain.

E. System Tab

1. 3rd-party validated PV Module .PAN file
2. 3rd-party validated Inverter .OND file
3. Nb of inverters. = I[ ]
4. Modules per String = I[ ]

5. Strings per Inverter = This varies by array type. See Attachment A Input and Assumptions System Definition section.

6. Detailed Losses section of System Tab

   a. Uc= [ ]W/m^{2}k

   b. Uv= [ ]W/m^{2}k / m/s

   c. Ohmic Losses = [ ]

      - 1.5% DC loss at STC
      - 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)

- Skid (MV) Transformer [ ]% iron loss, [ ]% resistive/inductive losses at STC.
- Main Power (HV) Transformer: [ ]% iron loss and [ ]% resistive/inductive losses if including GSU transformer.

   d. Module Quality, LID, Mismatch

- [ ]% for LID, per Manufacturer's Datasheet
- [ ] Module Quality loss
- [ ]% Mismatch loss at MPP

   e. Soiling losses:

Month	PVsyst Inputs
January	[ ]
February	[ ]
March	[ ]
April	[ ]
May	[ ]
June	[ ]
July	[ ]
August	[ ]
September	[ ]

October	[ ]
November	[ ]
December	[ ]

f. Average Soiling Losses = [ ]%

g. Incidence angle effect: As per Manufacturer, provided in .PAN file

h. Bifacial System:

- Shed transparent fraction = [ ]%
- Structure shading factor = [ ]%
- Mismatch loss factor = [ ]%

7. Module Layout Tab

a. Not used

8. Hidden Parameters Menu

a. Not used

9. Preferences Menu

a. Physical Model = Perez

4.3 ADDITIONAL LOSS PARAMETERS

Contractor may desire to calculate some of the AC system losses outside of the PVsyst software instead of relying on PVsyst for these losses. If losses are calculated separately from PVsyst, these loss calculations must be completed in Microsoft Excel with all the formulas, constants, and justification available for review by Owner.

4.4 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 should be applied to the Energy Model for predicting the energy output for the Capacity Testing done for each project Phase.

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:

A. In Pvsyst, input a unique output file name for each run/circuit. (not to exceed the number of Circuits).

B. The output parameters will include at least the following variables:

1. Horizontal global irradiation
2. Global incident in coll. Plane
3. Ambient Temperature
4. Average Module temperature
5. Wind velocity

6. Effective energy at the output of the array
7. Available Energy at Inverter Output
8. Energy injected into grid
9. Inverter efficiency (operating)

C. Run the simulation.

D. A .csv file will be created for this simulation and 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/circuit/plant.

E. Copy and paste the output data into the appropriate column in the Energy Model File.

5.2 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 are to be submitted in attachment A, with an explanation for any parameters differing from those given 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)		
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 (%)		

PVsyst Parameter	Value	Comment
Rear Shading Factor (%)		
Module Transparency (%)		
Rear Mismatch Loss (%)		
Monthly Albedo Profile	Jan =	
	Feb =	
	Mar =	
	Apr =	
	May =	
	June =	
	July =	
	Aug =	
	Sep =	
	Oct =	
	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 09

SOLAR PHOTOVOLTAIC PLANT SPECIFICATION FORM OF MONTHLY PROGRESS REPORT

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	14Apr23	Issued for Implementation	1898 & Co.	PGE	CPA	Craig Armstrong
1	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	PGE	SPF	Sean Flak

1.0 GENERAL

The Monthly Progress Report shall summarize the month's project status in engineering, permitting, procurement, construction, safety, quality, schedule and milestones reached, RFIs and open action items, commissioning, and commercial items as applicable

2.0 COVER SHEET AND INDEX

2.1 COVER SHEET

Cover sheet to show the project name, the time span covered and the date of the report.

2.2 PROJECT TEAM

List personnel and functions of team comprising of:

- Contractor
- Subcontractors
- Major suppliers

2.3 EXECUTIVE SUMMARY

Provide high level summary delineating project status, milestones and issues. Limit to 1 page or less.

2.4 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)

2.5 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

2.6 PROJECT SCHEDULE

- Include % complete against time (Engineering Procurement, Construction, Overall)
- Progress curves for planned versus actual (Engineering Procurement, Construction, Overall)
- Overall project status

2.7 PERMITTING PROGRESS

Detail any permitting progress and issues that have continued into construction phase, as applicable: site access, encroachments, building permits, etc.

2.8 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

2.9 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

2.10 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

2.11 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.

3.0 <u>KEY ISSUES AND REMEDIES (AREAS OF CONCERN)</u>

- 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

2025

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1.0 GENERAL REQUIREMENTS

This exhibit M3-01-10 describes 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 the requirements of the Agreement. Contractor shall 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 shall submit their QA/QC procedures for review to Owner prior to the 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

Basic objectives of Contractor's Quality Plan shall be as follows:

- To verify that all work adheres strictly to all requirements of the Agreement and governing agencies where the work is being performed.
- To maintain QC procedures and to verify that tasks performed will comply with the requirements of 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.

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.
- Be present on-site and designate alternate individual(s) to assume responsibilities in case of temporary absence. 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 its various subcontractors and monitor their conformance.
- Inspect existing conditions before 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 work segment to verify compliance with the Agreement. Upon request, Owner may attend such inspections.
- Coordinate required tests, inspections, and demonstrations with Owner or any other authority having jurisdiction.
- Inspect Contractor purchased materials and equipment arriving at the jobsite to verify conformance with the requirements of the Agreement. Prepare and submit documentation as required by the Agreement.
- Inspect material to verify 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 that the 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 verify optimum quality control. Attend meetings as required by Owner.
- Initiate and maintain regular training of the quality team, and construction teams, to verify quality does not falter.

5.0 SUBMITTALS

- Submit 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, form of reports that will be used to document the inspection, and personnel who will witness the inspections. The ITP shall identify witnesses, review, and hold points.
- It shall be the responsibility of Contractor to provide all the above documents to 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 quality inspections shall be adequate to cover all operations, including both on-site and off-site. They shall be aligned with the 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 verify that they conform to accepted shop drawings or submittal data and that all necessary materials and/or equipment are available

As a part of this preparatory work, Contractor's shall 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 confirmation of acceptance by the Contractor's quality control manager (or authorized designee) indicating that they have reviewed the submittal and it conforms to the Agreement Drawings, or showing the required changes.

- Initial Inspection: To be performed as soon as a representative segment of the 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 verify 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.

In addition, Contractor shall provide the following:

- 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 shall have any third party (special) inspections performed as required by the authority having jurisdiction.
- Contractor shall perform tests according to method(s) of testing specified in the Agreement.
- Contractor shall verify that Owner is given sufficient time to witness tests and re- inspect work performed by Contractor.
- Contractor shall verify that all work not complying 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 with proposed corrective action.
- Contractor shall package and prepare all inspection and testing documentation for turnover after construction. Turnover packages are to be developed for each Project system as determined by Owner. Each system package 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

2025

REQUEST FOR PROPOSAL

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1.0 GENERAL

Contractor shall conduct site-specific training for Owner-assigned administrative, operations, technical, and maintenance personnel. Training shall include classroom and field portions, and feature SCADA HMI viewing of the instruction topics. 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. Virtual remote participation 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.

In addition to the classroom based training, operations personnel shall be provided with a minimum of 12 hours of on-the-job, in the field training during start-up and commissioning activities, see 2.1.7 below.

Owner shall advise one month in advance the number of personnel attending the 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 verify 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.

SITE-SPECIFIC TRAINING

This Program will encompass on-site training.

2.0 CONTRACTOR RESPONSIBILITY

Contractor shall be responsible for:

A. Provide training facilities with 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.

B. Preparation of all classroom and training materials.

C. Scheduling and coordination of all classroom-training courses.

D. Provision of instructions, lesson plans, review, and on-the-job training of the students.

E. Coordination of the training schedule with Owner to allow Owner to conduct its own employee training.

F. 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.

G. 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.

2.1 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 training module. The modules will include lesson plans, system descriptions, and power point presentations for the systems. Each trainee shall receive a copy of the classroom materials and other training documentation. Larger scale 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.

Two types of training shall be provided:

1. PV System, Substation, and SCADA System, performed by Contractor's Training Staff.
2. 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 a demonstration of the 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.

2.2 TRAINING TOPICS

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 site's PV system design. The following outline of topics shall typically be covered but not limited to:

A. Introduction

B. PV Systems

  1. During this section, Contractor will describe the process and discuss the principles of operation for the photovoltaic power plant.

C. Substation

D. Commissioning and Startup

E. SCADA Systems

F. Meteorological (MET) Stations

G. Security Systems

2.3 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

2.4 LESSON CONTENT

A. Lesson Objectives

1. 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.

B. Design Basis and List of References

1. The design basis and reference documents shall be presented. The student is expected to learn and retain this information from the lesson.

C. System Overview with Drawings

1. This section shall include a brief description of the intended use of the system.

D. Component Description with Supporting Documentation

1. This section shall include information on the major components in the system. Tables, figures, drawings and design details shall also be provided.

E. Principles of Operation, Including Start-up and Shutdown Procedures

1. The various operational modes of the system and documents shall be presented, including:

    a. Operating Philosophy

    b. Start-up

    c. Normal Operation

    d. Normal and Emergency Shutdown

    e. Understanding and responding to alarms

    f. Recognizing and Handling Abnormal Operating Conditions (Troubleshooting)

2. 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 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

2025

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1.0 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.

2.0 LIMITED WARRANTY

The following main elements shall be addressed in the PV Module Warranty:

A. Warranted Products.
    1. Photovoltaic modules including factory assembled junction box and cables and connectors, and
    2. Mounting products including factory assembled basic hardware, if any,

B. Warranty Descriptions and Durations
    1. Product Warranty
    2. 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%

Year	If the module(s) has a power output less than the percentage below multiplied bythe 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
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%
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%

C. Warranty Start Date

D. Exclusions and Limitations

E. Repair, Replacement or Refund Remedy

F. Rights and Remedies against Third Parties

G. Claims Procedure, Notice Periods, Dispute Resolution, Testing and Verification Procedures

PGE