Portland General Electric

2025 All Source RFP Technical Specifications – Energy Storage Projects

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APPENDIX M3 – ENERGY STORAGE PROJECTS

TECHNICAL SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

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RENEWABLE ENERGY RESOURCES

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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

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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			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Certification	3rd party structural design certificate	Third-party Registered Professional Engineer's Certificate confirming the suitability of all foundation(s) and that they are in accordance with the As-built drawings.			X			
Certification	Acceptance certificates	All completed Acceptance Certificates for Works prior to Substantial Completion milestone			X	X		
Certification	Capacity and Availability test report	Upon satisfactory completion or upon failure of the Capacity and Availability Test, as the case may be, the Contractor will issue an Acceptance Test Certificate to that effect.			X	X		
Certification	Electrical safety 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 electrical scope of Work, including, but not limited to, switchgear, power transformers, instrument transformers, protection relays and revenue metering systems.		X			8 weeks prior to start of relevant site work	
Certification	Factory acceptance test reports for electrical components	FAT certificates to be provided by Contractor shall include, but not necessarily be limited to, the following components: • Transformers, including: o Substation main power MV/HV transformer/s o Auxiliary MV/LV transformer/s o PCS/Inverter skid MV/LV transformers • Instrument transformers (i.e. CTs, VTs) • HV and MV switchgear and switchboards • LV distribution boards (AC and DC) • Cabling (HV, MV, LV and fiber optic) • HV and MV surge arrestors • Protection relays • Metering systems (revenue, check and power quality) • UPS systems • Switchroom batteries and chargers		X			Prior to delivery to Site	
Certification	Performance test report	Report summarizing test as specified. Upon satisfactory completion or upon failure of the Performance Test, the Contractor will issue an Acceptance Test Certificate to that effect.			X	X		
Certification	Permanent on-site buildings	Permanent building designs shall be independently checked and approved by a certified structural engineer		X			6 weeks prior to building work	
Certification	Power Circle Test Report and Certificate	Upon satisfactory completion or upon failure of the Power Circle Test, as the case may be, the Consultant shall issue to Owner a report and a Performance Test Certificate to that effect.			X			
Certification	PRC-028 Records	Event records showing initial energization of plant, from inverters, demonstrating compliance with NERC PRC-028			X		1 week after energization of inverter	
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	Reinforcement specifications and testing certificates	Certificates confirming manufacturers and processors of steel reinforcement hold a valid certificate of approval.		X			6 weeks prior to start of relevant work	
Certification	SCADA system warranty and results	Documentary evidence that the SCADA system is sufficient for recording and analysis of the data for the warranty tests; and confirmation and detailed report of how the SCADA system stores data and provides values to enable availability calculations.		X			6 weeks prior to start of relevant work	
Certification	Communications Fiber Test Results	OTDR & Loss Meter Test results of fiber installed intra-building and inter-site facility per PGEC fiber standards			x		3 weeks after Installation	

KEY

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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
Level C:	As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval:	Must be submitted for the Owner's review and approval prior to equipment purchase or construction

Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Certification	Communications Fiber Permits	Turn over any RR permits or Easements obtained for fiber installation			x		3 weeks after Installation	
Design	Civil works	30% Design including the following: • Buildings and structures • Roads • Site drainage • Earthwork and compaction • 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	Site electrical single-line system	30% Design including the following: • Energy storage system SLD, showing connection to PCS, step-up or isolation MV/LV transformers, all junction boxes, ground reference transformers (if applicable) and battery banks or blocks; protection SLD to be incorporated or provided separately • Earthing drawings		X		X	3 months after Agreement execution	
Design	Site electrical single-line system	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Site electrical single-line system	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Site electrical single-line system	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Site electrical single-line system	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility including the following: • MV Protection Schematics • MV CB Control Schematics • LV Air CB Schematics • UPS Schematic • DC Circuit Schematic • Distribution Board schedules • Cable schedules (HV, MV, LV and Comms) • As-built MV Switchroom GA drawings, including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.			X			

KEY

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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			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Design	Fire Protection System documentations and drawings	Including as a minimum: • Fire Risk Evaluation/Fire Protection Design Basis Document • Fire Protection Control Narrative • 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	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	Battery and PCS block design drawings	30% Design: Includes the general arrangement drawings of the following: • Battery blocks, including racks and modules as appropriate • Inverter Blocks • PCS • Permanent and temporary buildings		X			3 months after Agreement execution	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Design	Battery and PCS block design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Battery and PCS block design drawings	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Battery and PCS block design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Battery and PCS block design drawings	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility.			X			
Design	Substation	30% Design including the following (as applicable): • Substation general arrangement drawing • Main power transformer(s) • Protection equipment and switchgear specifications • LV 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		

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			A	B	C			
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		
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	

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			A	B	C			
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		
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	

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			A	B	C			
Design	SCADA and communications network	60% Design including the following (if applicable): • An updated version of 30% Design with revisions and additional detail where applicable • I/O connections drawings • Network used to communicate (transmission medium, network topology, communication protocols and fault tolerance) • Interfaces • Network layout • Point addressing scheme • Grounding requirements • Redundancy and UPS • Sensor locations and sensor orientations • Remote access • Viewing and display • Data collection and storage • Control • Reporting • Software and licenses • Comprehensive user manual explaining the operation and use of all the functions • Hardware manuals for all hardware and computers systems • Documentation including manuals, quality control, installation, commissioning and testing procedures		X		X		
Design	SCADA and communications network	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	SCADA and communications network	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	SCADA and communications network	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-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): • Battery and PCS layouts • Landowner boundaries • Public roads • Access roads • Cable routes • Laydown areas • Substation • Transmission line • Borrow pits • Permanent and temporary buildings * Fiber Route, vaults, splices, slack loops, pole line, entrances	X			X	Agreement close	

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			A	B	C			
Design	Site layout/plans	30% Design including the following (as applicable): • An updated version of Preliminary Layout with revisions and additional detail where applicable • Junction boxes • Foundations/footings • Drainage and erosion control features • Spares, parts, tools and permanent storage • Temporary utilities, and • Fencing, gate, signage and label details		X		X	3 months after Agreement execution	
Design	Site layout/plans	60% Design: An updated version of 30% Design with revisions and additional detail where applicable		X		X		
Design	Site layout/plans	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Site layout/plans	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Site layout/plans	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility.			X			
Design	Project controls drawings and documentation	30% Design: Operating description document, controls architecture block diagram, control devices specifications details		X		X	3 months after Agreement execution	
Design	Project controls drawings and documentation	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Project controls drawings and documentation	90% Design: An updated version of 60% Design with revisions and additional detail where applicable		X		X	6 weeks prior to start of relevant work	
Design	Project controls drawings and documentation	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		
Design	Project controls drawings and documentation	As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility.			X			
Design	Project auxiliary systems 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: • Switchgear connections, including connection diagram, in addition to individual equipment specifications and compliance certification. • Transformer specifications, including kVA rating, nominal voltage rating, insulating medium, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, corrosion protection, load and no-load loss guarantees, manufacturer and standards compliance. Design drawings, including enclosure. Transformer type test certificate and a fitness for purpose statement (considering Environmental Conditions, corrosion, cyclic loading, harmonics, peak voltages and fire risk). • Auxiliary power systems and associated equipment specifications, including battery and UPS capacities/back-up time • Revenue and power quality meter specifications		X		X	3 months after Agreement execution	
Design	Project auxiliary systems specifications and design drawings	60% Design: An updated version of 30% Design with revisions and additional detail where applicable.		X		X		
Design	Project auxiliary systems 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	Project auxiliary systems specifications and design drawings	IFC Design: An updated version of 90% Design with revisions and additional detail where applicable		X		X		

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			A	B	C			
Design	Project auxiliary systems 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		
Licenses	Software licenses	All licenses, software keys, hardware keys (dongles) and the like for all software included in the Works.			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	
List	Sub-contractors list	List of all sub-contractors to be included as approved sub-contractors.	X			X	Agreement close	
Manuals	O&M Manuals	Draft, comprising Overview and Manuals from key equipment suppliers; equipment maintenance requirements Per M4-01-01, Section 2.5		X		X	Per M4-01-01, Section 2.5	

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			A	B	C			
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 - Startup and Shutdown - Gas Detector and Fire Alarm Investigation • 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 • Emergency Response Plan/Procedures from battery manufacturer			X		Per M4-01-01, Section 2.5	
Manuals	SCADA system documentation	The SCADA system shall be supplied with three sets of comprehensive, complete and up-to-date documentation packages relevant to all the hardware and software supplied. This shall include but not limited to (as applicable): • A comprehensive user manual explaining the operation and use of all the functions • 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			

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			A	B	C			
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	
Plan	Capacity test plan	Method Statement describing the Contractor's proposal to perform Capacity Test and Availability Test in accordance with the requirements set in the Specifications. • Details of the equipment to be used • Any deviations • The methodology for dealing with those deviations • Details of the site calibration procedure		X		X	6 months after Agreement execution	
Plan	Civil works, concrete procedure	A procedure for on-Site concrete batching, including as a minimum: • Source of materials • Transport plan • Quality control If Contractor proposes to utilize a pre-existing off-Site batch plant, details shall be provided on the concrete supplier including: • Quarry materials suppliers and any additives required • How the delivery of concrete to site is to be managed Contractor shall additionally provide a method statement for forming cold joints should concrete supply be disrupted.		X		X	2 months after Agreement execution	
Plan	Critical Lift Plans	Plan shall clearly identify precautions for all critical lifts; coordination plans, including pre-lift meetings, with all participating personnel; and sample documentation/checklists for all critical lifts.		X		X	Prior to mobilizing to Project Site	
Plan	Document control plan	The document control plan shall address how documents are transmitted, named, reviewed, tracked, and edited.		X		X	2 weeks after Agreement execution	
Plan	Emergency response plan	Emergency response procedures and information		X			1 month prior to accessing Site	
Plan	Environment Management Plan	Including, but not limited to: ~~• NPDES permit~~ • 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	

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			A	B	C			
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	
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	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Plan	Project schedule	The Schedule shall include, but not be limited to, the following: • Schedule Basis Memorandum • Engineering activities (i.e. engineering studies, calculations, and designs) • Procurement activities • Material and equipment deliveries • Construction activities • Tie-ins to existing plant systems • Equipment factory tests • Interfaces with Owner and other external interfaces • Major milestones • Milestone payments, if applicable • Startup and commissioning activities • Testing activities		X		X	8 weeks after NTP	
Plan	Site Specific Safety and Health Plan	Including elements as specified in Appendix M1 • 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	Solid Waste Recycling/Recovery plan	Plan for solid waste recycling and recovery.		X		X	1 month prior to accessing Site	
Plan	Storm Water Pollution Prevent Plan (SWPPP) or Sediment and Erosion Control Plan	As required		X		X	1 month prior to accessing Site	
Plan	Testing, inspection and test plans	Proposed testing plan including but not limited to: • Proposed commissioning procedures including but not limited to: o the Commissioning Tests o the Acceptance Tests o the Performance Tests o SCADA • Details of any Tests on Completion that may threaten the safety of the Plant		X		X	2 months prior to start of relevant work	
Plan	Training program	Details of training program required to support the off-site and in-field training of Owner's personnel.	X			X	Agreement close	
Plan	Training program	Hard and electronic copies of all training material.			X			
Plan	Transportation plan	Procedure for delivery to Site for main transformer, inverter stations and other critical equipment and oversize loads		X		X	1 month prior to Site mobilization	
Plan	Transportation plan	Proposed shipping and access routes and major onsite access plan	X			X	Agreement close	
Plan	Work plans	Procedures for execution of all Work including details of number of personnel and vehicles that will be on site at all the different phases of the Project		X		X	2 months prior to start of relevant work	

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			A	B	C			
Report	As left settings	Alarm set points, complete I/O database including description of each I/O			X			
Report	Civil works 3rd party structural design report	Third-party Registered Professional Engineer's Report confirming the suitability of: • 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: • HV/MV substation foundations/footings; • Access roads • Permanent buildings (including structural, architectural, fire rating and hold down details) • Site drainage • Site landscaping • Site restoration		X		X	3 months after Agreement execution	
Report	Document register	Proposal defining the contract drawings and documents in the form of a document register	X			X	Agreement close	
Report	Document register	Update of document register.		X				
Report	Electrical balance of plant power system studies and design calculations reports	Updated Electrical Design Report following any design changes during construction.			X			
Report	Electrical studies	Include Easypower/Aspen software model, relevant calculations, and complete system one line diagram, where applicable. Electrical studies including, but not limited to the following: • Auxiliary power study • Coordination study • Arc flash hazard study • Insulation coordination • Isolation transformer k-factor (or h-factor) calculation • DC/UPS sizing • Grounding calculation • Harmonics study		X		X	Initial relay calculations/coordination study 6 months prior to start of relay testing	
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	List of all equipment		X				
Report	Equipment maintenance records	Maintenance records for equipment			X			
Report	Failure Modes and Effects Analysis	Provide for critical supplied systems and assets: • Known / common failure modes • Potential failure modes and historical/expected mean time between failures • Severity on operation relative to the system provided • Methods of detection based on vendor supplied Preventive Maintenance (PM) or Predictive Maintenance (PdM) Procedures • Improvements due to design modifications, additional PM or PdM measures or optional equipment.		X		X	3 months after Agreement execution	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Report	Final substantial completion test reports	Completed installation and commissioning checklists, including commissioning test results, for the entire Plant electrical Works, including, but not limited to, MV/HV Transformer/s, auxiliary transformers, protection systems and switchgear, transformers and switchgear, MV cables, fiber optic cables, metering, LV equipment, in-line cable joints (if applicable), earthing connections, terminations and joints.			X			
Report	Foundations Civil/Structural design report	Including but not limited to the following: • Design loads for all structural components • Design calculations including all assumptions • Demonstration of suitability of all structural components in extreme wind conditions and over the design life • All partial safety factors • Decision trees • Reinforcement specifications and testing, and • Conclusions		X		X	3 months after Agreement execution	
Report	Geotechnical investigation report	Comprehensive geotechnical investigation, including and as applicable: • MV/HV Substation • Access Roads • Underground Cabling • Soil Resistivity (Electrical and Thermal) Surveys		X		X	2 months after Agreement execution	
Report	Grid connection documentation	Update to all required grid connection documentation.			X			
Report	HSE report	Final HSE report and risk register			X			
Report	HV/MV electrical system design report	Design of proposed electrical systems including, but not limited to: • Single Line Diagrams (SLD) for MV/HV Substation incorporating protection (or provided separately) • Earthing general arrangement (GA) drawings and schematic diagrams • Substation GA drawings, including overall GA drawing, MV switchroom GA drawings (including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.) • Schematic diagrams and distribution board schedules for MV switchroom equipment, LV supplies and metering • Details of equipment redundancy • Electronic copies of all studies, models, rating evaluations, etc. performed for the above requirements. Specific software and version information to be provided by Owner.		X		X	6 months after Agreement execution	
Report	Hydrology and flood study	To confirm the design for flood requirements for a 1 in 100-year flooding event.		X		X	Prior to relevant design work	
Report	Installation and commissioning reports	The results of all inspections, checks and tests carried out, together with any subsequent analysis. Including but not limited to protective relay calibration tests, trial of equipment operation summary, and 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	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Report	Project schedule	Update as monthly progress reporting showing status, variance, constraints, actual versus planned progress.		X	X	X	monthly	
Report	Project status report	Weekly template provided by Owner. Monthly report to include, as a minimum, for that month: • Safety statistics, issues, and events • Summary of events including equipment delivery dates and status • Major activities accomplished during past month and those planned for the coming month • Project schedule update • Milestone payment schedule status • Earned Value Quantities Report (EVQR) • Contract progress S-curves • Contract overall man-hours S-curves • Contract overall staffing histograms • Contract overall craft histograms • Key quantity S-curves • Risks, delays, and quality concerns		X	X	X	monthly and weekly	
Report	Project workbook	List of Project documentation			X		Prior to Final Completion	
Report	Punch list	Documentation listing and detailing any and all minor non-conformances and proposed rectification not required to be completed prior to Substantial Completion.			X			
Report	Quality assurance package	Complete sets of quality assurance documentation for each of the defined construction milestones referenced in the Specifications (commonly recorded via construction job books).			X			
Report	Risk assessment report	Risk Assessment Analysis		X		X	30 days after Agreement execution	
Report	Risk assessment report	Periodic submission of risk report showing updates and control measures		X			As updated	
Report	Special tools and vehicles	List of all the tools, vehicles or voice communications equipment required for the safe and effective operation and maintenance of the Plant stating whether the Employer is required to purchase this equipment or not.	X			X	Agreement close	
Report	Special tools and vehicles	Update to special tools and vehicles list		X			6 months after Agreement execution	
Report	Storage records	Storage records for any equipment, materials, or other work that was previously produced, manufactured, or constructed, per Section 1.5.11 of Attachment M1-01-02.		X		X	Prior to shipment from original storage location	
Report	Test reports	The results of all inspections, checks and tests carried out, together with any subsequent analysis including documentation of all Acceptance, and Performance Tests (if complete) and applicable certifications. The final commissioning test summary shall be prepared and document the results of all commissioning tests. • Any mutually agreed upon deviations from the Commissioning Test Manual procedures • Instrument calibration sheets and certificates • Test data, including corrected test data • 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	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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	Communications Fiber As-Builds	As-build of Fiber Installed OH or UG in Public ROW for Inter facility communications.						
Specifications	Civil works specifications	Where not covered by the Site Layout, an outline of proposed BoP/BOS Civil Works, including but not limited to: • Overview, specifications • Details of reinforcement • Site testing	X			X	Agreement close	
Specifications	Contractor specifications	Including the following: • Standards as identified by Contractor as being relevant to the Work • Equipment suppliers detailing locations, and where major components of the Work shall be manufactured	X				Agreement close	
Specifications	Grid connection documentation	All required information to assist Owner in its application for Grid Connection.	X	X		X	Duration of Agreement	
Specifications	Grid connection documentation	Including: • Generating System Design Data Sheets • Contractor shall supply a completed performance standard template stating the proposed level of compliance to each access standard in accordance with the TSP's GPS		X			Duration of Agreement	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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	Permanent on-site buildings	Functional description and preliminary design specifications including: • Layout • Elevation drawings • Structural • Architectural • Fire rating • Hold down	X			X	Agreement close	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
Specifications	SCADA and communications network	Functional description and preliminary design specifications including: • Information on the communications system, including specifications and drawings, fiber, power, grounding • Information on the SCADA system, including specifications and drawings	X			X	Agreement close	
Specifications	SCADA instrumentation specifications	Copies of calibration sheets for all sensors/transducers as appropriate in accordance with the appropriate calibration standards. Sensors/transducers shall include those mounted on: • Switchgear • Monitored equipment • Statcom equipment, and • Power Quality Metering			X			
Specifications	Substation specifications	Functional description and preliminary design specifications including: • 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	

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
	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							
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: • 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		X			Agreement Close		

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

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Category	Deliverable:	Description:	Level			Owner Approval	Owner Proposed Schedule	Contractor Proposed Schedule
			A	B	C			
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: • 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		X			Agreement Close		

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

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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.

[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
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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

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APPENDIX M1
ATTACHMENT 02
EXHIBIT 01

GENERAL CIVIL REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

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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 CIVIL WORKS

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

Construction Phasing

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.

Facility Site Map(s):

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

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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

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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

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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

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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

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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 CO2
26. Gas Analyzer CH4
27. Gas Analyzer C2H6
28. Gas Analyzer C2H4
29. Gas Analyzer C2H2
30. Gas Analyzer H2O
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

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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

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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

<u>Energy Storage Project Equipment Vendors:</u>

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 M4
ATTACHMENT 01
EXHIBIT 01

ENERGY STORAGE TECHNICAL DOCUMENTS

RENEWABLE ENERGY RESOURCES

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2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
1	26Oct21	Issued for Implementation	1898 & Co.	SC & KW	JAL	Jared Lathrop
2	3Dec21	Rev 2 – correction to 3.2.4 & 3.2.5, replacement of section 3.2.9	Colin Solini	Kevin Whitener	JAL	Jared Lathrop
3	14Apr23	Update from 2021 Version	1898 & Co.	PGE	CPA	Craig Armstrong
4	15Dec23	Rev 4, see redline changes	Kevin Whitener	Craig Armstrong	CPA	Craig Armstrong
5	16Jun25	Revision to 2023 Spec	1898 & Co./ PGE	SPF	SPF	Sean Flak

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ACRONYMS AND ABBREVIATIONS

AC	Alternating Current
ACI	American Concrete Institute
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
BIL	Basic Insulation Level
°C	degrees Celsius
CAD	Computer-aided design
CT	Current Transformer
DART	Days away, restricted or transferred
DC	Direct Current
EMI	Electromagnetic Interference
EMR	Experience Modification Rate
ESS	Energy Storage System
E-Stop	Emergency Stop
ESIC	Energy Storage Integration Council
FAT	Factory Acceptance Testing
HMI	Human Machine Interface
HV	High Voltage
HVAC	Heating, Ventilation, and Air Conditioning
IEEE	Institute of Electrical and Electronic Engineers
IFC	Issued for Construction
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
RPA	Reference Point of Applicability
RTU	Remote Terminal Unit
SAT	Site Acceptance Test
SCADA	Supervisory Control and Data Acquisition
SEC	Site Energy Controller
SOC	State of Charge or Energy: Nominal Energy Remaining / Nominal Full Pack Energy Available
Specification	Project Technical Specification
TRIR	Total Recordable Incident Rate
UL	Underwriters Laboratories
UPS	Uninterruptible Power Supply
VPN	Virtual Private Network

LV	Low Voltage
MV	Medium Voltage
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
PCS	Power Conversion System
PDF	Portable Document Format
PF	Power Factor
POI	Point of Interconnection
psi	pounds per square inch
PT	Potential Transformer

0.0 SCOPE

This Project Technical Specification (Specification), including Appendices, comprise or constitute requirements to design, fabricate, ship, assemble, test, startup, commission, warrant and make ready for service a fully functional energy storage system complete with accessories as required by the Agreement. This Specification defines specific engineering, operating and performance requirements for the Project that is intended for installation on the Owner's electric system. The Project is to be designed to be in a restricted access setting and configured to meet applicable standards required of other Owner equipment with respect to safety, operations, maintenance and environmental impact.

1.0 CONFORMANCE TO SPECIFICATION

1.1 APPLICABLE DOCUMENTS

Except as modified herein, the Project, including the energy storage technology, power conversion system (PCS), and site energy controller (SEC) or plant controller shall be designed, manufactured, and tested in compliance with the latest versions (including any issued revisions) of the applicable standards of American National Standards Institute (ANSI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Code (NEC), National Electrical Manufacturers Association (NEMA), Occupational Safety and Health Administration (OSHA), American Society for Testing and Materials (ASTM), American Society of Mechanical Engineers (ASME), National Fire Protection Association (NFPA), and Owner safety practices. See Appendix A for applicable standards and codes.

1.2 COMMUNICATIONS

Communications systems at the DER interface must comply with IEEE 1815-2012 for DNP3 communications and DNP3 Users Group Application Notes AN2018-001 DNP3 Profile for Communications with DERs

The Customer must be able to directly communicate with each protective relay within the project. This connection will be through an Ethernet port on the relay specifically reserved for this purpose. The customer communicates to these relays using AcSELerator Team software. This interface can alternatively be through a relay serial port with the proper converter.

1.3 CYBERSECURITY

When the Contractor has provided the 30% submittal for the Project network and controls architecture, Customer and Contractor will collaborate to design the Project cybersecurity design.

1.4 DATA

The Customer's primary method of operations and maintenance monitoring of the project is through the Customer's command center. It is acceptable for the Contractor to provide a user interface of their own design, but the Customer will not use that interface for day-to-day operations. For this reason, it is important for the project plant controller to provide data to the Customer to adequately serve this purpose. The Customer will develop graphics, status, command and alarm graphics for their command center and the Contractor will provide data in sufficient detail to facilitate this. This includes data down to the rack level of the DC system, DC contactor positions, cell temperatures (min, max and average within the rack), rack SOC and voltage, and any alarms associated with the rack. The Project Plant Controller shall provide ISP Service to Transport Data to their remote monitoring center.

Contractor will provide a draft data tag list at the time of 30% review of the network and controls architecture submittal.

1.5 <NOT USED>

1.6 CUSTOMER SYSTEM OPERATING VOLTAGES

For purposes of this specification, the Customer's system voltages have been provided as nominal voltages. This is not necessarily the same as the Customer's operating voltages. This can be a critical distinction for design and procurement of Project transformers and for performing electrical studies. It is the Contractor's responsibility to verify with Customer the actual operating voltages of the various interconnections.

1.7 PROTECTIVE RELAY SETTINGS

For all protective relays within the scope of the project, the Contractor will provide the proposed settings and relay logic for review and approval by the Customer.

1.8 SAFETY

A. The Project must be compliant with all applicable provisions of IEEE 1547-2018 or IEEE 2800 depending upon interconnection voltage, Underwriters Laboratories (UL) 1642, UL 1741 Supplement B, UL 1973, UL 9540, UL 9540A and NFPA Codes including NFPA 855. The Project must be able to protect itself from internal failures and utility grid disturbances. As such, the Project must be self-protecting for alternating current (AC) or direct current (DC) component system failures. In addition, the Project must be able to protect itself from various types of external faults and other abnormal operating conditions on the grid.

B. The Project must be designed in compliance with and ultimately meet all applicable federal, state, and local safety standards and regulations regarding construction and potential exposure to chemicals and regarding container or enclosure resistance to hazards such as ruptures and exposure to fire. Prepackaged and pre-engineered energy storage systems shall be UL 9540 listed per large scale fire testing performed at the cell, module, unit, or system level until it passes the criteria specified in UL 9540A. Contractor shall provide documentation of UL 9540A test results with the proposal.

C. All Project systems and equipment must be grounded in accordance with the NEC and adhere to the guidelines in IEEE 80 and IEEE 142. In applicable areas, Owner recommends Contractor follow PGE Substation standard S140-00, Grounding System Design.

D. For all Project equipment, Contractor shall provide information and training to first responders on all known or reasonably foreseeable safety issues related to the equipment, including appropriate responses on how to handle the Project in case of an emergency, such as fires, off-gassing or module ruptures. Contractor shall provide Sequence of Operations document from the PCS and Battery vendors pertaining to life safety and safety devices.

E. The Project must be designed to minimize the risk of injury to the workforce and public during installation, maintenance, and operation.

F. Contractor to provide thermal runaway detection; visual and audible fire alarms and fire alarm panel trouble alarms shall be included as necessary per all applicable fire and life-safety codes. If a fire alarm panel is existing at a site, the Project fire alarm panel will be required to tie into that site panel and therefore must be compatible. Otherwise, if the fire alarm panel is standalone, it must provide its own means for dial-up. Cellular signal strength must be confirmed by Contractor if that is the chosen solution.

G. A physical Emergency Stop (E-Stop) button is required to be installed at all entrances and exits of the buildings or containers. The E-Stop button shall have the ability to open contactors/breakers to the inverter and batteries isolating the DC and AC potential, without affecting the fire protection, monitoring and other safety measures required by the applicable safety standards and regulations. This E-Stop design must be such that no damage is caused to the PCS or any other systems.

H. Cabinet Keying and Locking Requirements: All PCS, battery, and associated control cabinets shall be equipped with lockable doors using a locking mechanism or lock hasp. All cabinets shall be keyed alike, with a keying configuration unique to the project site. Cabinet locks must be accessible from ground level. Where OEM standard keying cannot be customized, Contractor shall notify Owner during design.

I. Contractor shall provide a site specific Fire Protection Control Narrative 3 months after project agreement execution, that aligns with the project needs and with the Owners BESS Emergency Action Plans.

J. The Contractor must submit a copy of its Company Safety Plan and a comprehensive site-specific safety plan (at least 30 days prior to the start of the Work) that the Contractor and all Subcontractors will understand and follow during execution of the Work. The site-specific safety plan shall incorporate, at a minimum, plans and policies that are at least as stringent as federal, state, and Owner safety regulations and policies. (i.e. include reference to Contractor Safety Program and all Owner Safety Plans/Policies).

K. Designated safety personnel during construction of the Project shall have a minimum of five years of safety experience or an equivalent level of skill through a training certification or professional degree. Resumes will be provided to support this requirement.

L. Contractor and all Subcontractors must submit historical safety data for review prior to start of the Work: previous three years of safety stats: Total Recordable Incident Rate (TRIR); Days Away, Restricted or Transferred (DART); Experience Modification Rate (EMR) on official letterhead; and OSHA inspection history and any OSHA citation history. Contractor shall use the following benchmarks for TRIR (less than or equal to 2.0, DART less than or equal to 1.0, EMR less than 1.0) . Inspections and citations should be evaluated on a case-by-case basis. If TRIR, DART, EMR are outside of recommended benchmarks, a risk mitigation plan is required.

M. All enclosures and equipment, including battery containers, PCS, control cabinets, and transformer housings, shall be designed and installed to minimize the risk of pest intrusion. This includes sealed conduit entries, metal mesh screening on all ventilation openings (≤ 1/4” mesh), and barriers to prevent rodent access via cable trays, piping chases, or foundation openings. Pest intrusion control measures shall meet the general environmental protection principles defined in NFPA 855 and enclosure integrity per UL 9540. Where applicable, designs shall follow pest deterrent provisions in accordance with IEEE 1635 and manufacturer recommendations.

N. At minimum, Contractor’s Site-Specific Safety Plan shall include provisions with respect to:

1. Daily job planning
2. Activity Hazards Analysis
3. Analysis of Utility locations (proper mark-out for underground facilities)
4. Incident reporting procedures

5. Project safety statistics tracking and reporting

6. Personal Protective Equipment
7. Emergency Plans to include evacuations and inclement weather
8. Fire Management (i.e. Fire Safety)
9. Excavation plans
10. Sanitation (hand wash/temporary toilets)
11. Demolition activities (if applicable)
12. Procedures for a Regulatory Visit (should one occur)
13. Deficient Project Safety Performance (recovery plan)
14. Site Safety Orientation requirements
15. Security of work zones, material yards, etc.
16. Behavioral Based Safety Plan
17. HAZCOMM
18. OSHA

1.9 ENVIRONMENTAL REQUIREMENTS

A. Contractor and its Subcontractors and vendors engaged in the performance of the Work shall comply with all Applicable Laws and permits.

B. Spill Prevention Control and Counter Measure Plan - Proper site containment when equipment has equal to or greater than 1,320 gallons of liquid.

1. Containment shall include Petro pipe and a lockable drain valve.
2. All containment basins shall include grating as required to access and maintain equipment located in the containment area.

C. The Project shall be designed for proper operation without de-rating for the following conditions and limits:

1. Ambient temperature range as defined in Section 4.3.9.
2. Zero gas emissions during normal operating conditions.
3. Noise produced by any Project operation shall comply with the requirements set forth in Section 4.3.10 herein.
4. The Project must be designed to minimize risk of harm to the environment including land contamination or disturbance (footprint), water contamination or diversion, and air emissions, as required by permitting and best Industry Standards.
5. Contractor must provide sufficient information specific to their product and the Project to facilitate utility personnel training and communications with emergency response and environmental agencies. Safety Data Sheets shall be provided, as applicable.

1.10 SEISMIC

The following seismic design parameters represent the minimum requirements for the Project; actual site-specific values shall be determined by the Developer based on final site location and geotechnical investigation.

A. The structural and nonstructural components of all buildings, Control Shelters/Rooms, free standing structures, structural equipment supports, and all associated foundations and anchorages shall be designed and constructed to withstand the effects of earthquake motions and seismic loading in accordance with the requirements of the most recent versions of the Oregon Structural Specialty Code and ASCE 7 (respectively) with supplements No. 1 and 2 with the following parameters:

1. Risk Category II
2. Seismic Design Category D
3. Site Soil Class D, unless otherwise determined by the Geotechnical Engineer
4. Ip is 1.5

B. All electrical equipment shall be designed to the 'High Seismic Qualification Level' in accordance with IEEE 693 Standard.

C. For all anchors embedded into concrete that resist seismic loading, the cracked concrete provisions of American Concrete Institute (ACI) 318-11, must be considered.

D. Anchor design must be governed by ductile yielding of a steel element (anchor or attachment), unless the exceptions of ACI 318-11 are met.

E. Post-installed anchors installed into hardened concrete must be an International Building Code Compliant Anchor for Seismic Design Category D and shall be designed and installed in accordance with the cracked concrete provisions.

1.11 SPECIFICATION INTERPRETATION

If the Contractor is in doubt as to the meaning of any part of this Specification, or if Contractor finds discrepancies in or omissions in this Specification, the Contractor must submit a request for a written interpretation or correction of the Specification. Any request for a written interpretation shall be made to the Owner Representative.

Any interpretation or correction of the Specification will be given in writing by the Owner Representative.

2.0 GENERAL REQUIREMENTS

2.1 WORKMANSHIP

All Work must be done and completed in a thorough, workmanlike manner by personnel skilled in their various trades, notwithstanding any omission from drawings or this Specification. All parts of the Work shall be constructed accurately to standard gauge so that renewals and repairs may be made when necessary, with the least possible expense.

2.2 DESIGN AND MATERIAL

All materials used in the Project shall be new and of the specified quality. All components and workmanship must be free from physical and electrical flaws and imperfections. The design shall not only be effective in engineering characteristics, but it must also comply with the finish requirements stated herein.

2.3 DOCUMENT SUBMITTALS

The Contractor shall provide all documents and deliverables as set forth in M1-01-02 (Engineering Documents Drawings and Other Deliverables) and M1-01-02-01 (Documents and Deliverables Table). This shall include, but not be limited to, the example documents listed below. In addition, the Contractor shall provide a completed ESIC Energy Storage Technical Specification Template V3.0 at the time of proposal. This template is available from the Electric Power Research Institute.

The preliminary drawings submitted (30% review) shall be accompanied by design memoranda which shall provide, when applicable, all data, calculations, and information necessary for an engineering review and understanding of the proposed design. The 30% review level is defined as drawings and documents that define the design concept. Examples of documents to be submitted at the 30% level include but are not limited to:

- Site Plan Layout
- AC Single-line Drawing(s)
- DC Single–line Drawing(s)
- Phasing Diagrams
- Grounding Plan
- PCS Layout and Details
- Energy Storage Layout and Details
- Architectural Drawings
- Cable Sizing Schedule
- Foundation Plan
- Heating, Ventilation, and Air Conditioning (HVAC) Drawings and Details
- Fire System Drawings and Details
- Grading and Drainage Plan (with stormwater calcs and grading cut/fill quantities, section and details)
- Storm Water Pollution Prevention Plan
- Equipment Specification List
- Control System and Network Architecture Diagrams
- Preliminary Data Tag List
- Communication System Block Diagrams with Proposed Communications Protocols and Communications Media, Owner POI Fiber Route/Design, Splice diagrams and termination schedules.

- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow, Arc-Flash and Short-Circuit Calculations
- Purchase Specs or Data Sheets for Long Lead Items
- Equipment Seismic Qualification Reports
- Geotechnical Investigation Reports
- Enclosure/Building Structural Calculations

The Owner shall have the right to require the Contractor to make design alterations for conformance to the design requirements of the Statement of Work without additional costs to the Owner. The review of such alterations shall not be construed to mean that the drawings have been checked in detail, shall not be accepted as justification for an extension of time, and shall not relieve the Contractor from the responsibility for the correctness of the drawings and compliance to the Statement of Work. The Contractor shall make, at his own expense, any revisions needed to correct the drawings for any errors or omissions which may be found by the Owner.

The Contractor shall submit for review multiple packages of final drawings ready for construction (90% review). Calculations and drawings shall be submitted together. After review, the Contractor shall stamp the final drawings “Issued for Construction”, or IFC, to indicate that these drawings will be the official drawings used for construction activities. Drawings submitted at 90% review shall include, but are not limited to:

- Site Plan Layout
- AC Single-line Drawing
- AC Three-Line Drawings
- DC Single–line Drawing
- Uninterruptible Power Supply (UPS) drawings for black start / islanding systems (if applicable)
- Drawings Grounding Plan and Details
- PCS Layout and Details
- Energy storage Layout and Details
- Building/Enclosure Drawings and Details:
    - Structural
    - Architectural
    - Plumbing
    - Mechanical
    - Electrical
    - Fire Detection
    - Fire Suppression, if required.
    - Gas Detection, Ventilation & explosion mitigation if required
- Grading and Drainage Plan and Details
- Foundation Drawings, Plans and Details
- Raceway Plan and Details
- Storm Water Pollution Prevention Plan, if required

- Equipment and Materials List / Bill of Materials listing major Equipment and Materials
- Control System Diagrams / Logic Diagrams
- Communication System Block Diagrams.
- Fiber to Owner POI Design including all permits to construct. (Pole,ROW, Railroad, easements)
- Access Road Plan, Cross Sections, and Details
- Site Fencing Drawing
- Electrical Load Flow, Arc-Flash and Short-Circuit Calculations
    - Arc-Flash Labels
- Control Input/Output List
- Supervisory Control and Data Acquisition (SCADA) Points List
- Purchase Specs or Data Sheets for All Equipment
- Site Logistics
- Location and content of Labels and Signage
- Section 2.6 Study Reports
- Communication Network Documents
- Communication Network Block Diagrams
- Equipment Seismic Qualification Reports
- Structural Calculations
- Commissioning and Testing Documents
- Operations and Maintenance Documents
- A Separately Packaged and Distinct First responder Training Program

A final set of signed “IFC” drawings for each sub-system shall be available on-site before construction of that sub-system may proceed. To the extent required by Applicable Laws, and/or the Authority Having Jurisdiction (AHJ) over Project permits, construction issue drawings shall be signed and stamped by an Oregon registered professional engineer involved in the Project. Electronic registered professional engineer stamps shall be provided for electronic issues.

The following information shall be shown on each drawing submitted:

- Contractor’s name.
- Owner contract and release number.
- Owner equipment number if indicated in the Agreement or Contractor’s equipment number if not indicated in the Agreement.
- Description of drawings (Title).
- Latest revision and date.

Construction submittals shall be reviewed by Contractors’ registered engineer or architect (as applicable) and, to the extent required by Applicable Laws, and/or the AHJ over Project permits, shall bear review stamp from Contractor’s registered engineer or architect (as applicable), or the registered engineer/architect’s designee, where appropriate. Documentation provided by equipment manufacturers shall not require additional stamp by a registered engineer if those equipment manufacturer documents are included in a 30%, 90% or IFC submittal package. These reviewed submittals shall be submitted to the Owner at a minimum for the following items:

- As-built drawing markups delivered after completion of Work.
- Drilled pier construction work plan (if applicable).
- Backfilling materials.
- Structural concrete mix design and associated material certifications.
- Complete reinforcing bar fabrication, details, and bar setting drawings.
- Anchor bolts.
- Structural steel shop fabrication drawings.
- CMU block including certification of compliance with appropriate design ASTM standards.
- Welding procedure specifications, qualifications, and QC plan.
- Disposal site for exported soil material.
- Masonry mortar mix.
- Grout mix and procedures.
- Roof deck erection drawings.
- Completed manufacturer application for roof guarantee along with shop drawings of the roofs showing all dimensions, penetrations and details. The roof guarantee shall contain all technical information including: Deck types, roof slopes, base sheet and/or insulation assemblies (with method of attachment and fastener type) and manufacturers membrane assembly proposed for installation. The roof guarantee should contain accurate and complete information including: Proper names, addresses, zip codes, and telephone numbers.
- Roof membrane guarantee, 20-year labor and materials membrane / system guarantee.
- Roofing material submittals, product data information and material certifications.
- Layout and attachment of insulation indicating fastener and adhesive patterns per the manufacturer's installation requirements to meet Factory Mutual Global tested wind uplift resistance.
- Certification from roof manufacturer that board insulation materials are acceptable with roof membrane and included in roof manufacturer 20-year system guarantee.
- Copy of manufacturer's warranty and installers warranty for control shelter.
- Doors, frames and hardware.
- Louvers
- Paints
- Sealant
- Cable cut sheets and testing results.
- Transformer testing results.
- Inverter testing results.
- Conductors and grounding rods.
- Exothermic welds and grounding connections.
- Conduit, tray, and conduit fittings.
- Mandrel

- All drawing / document reviews shall comply with the process set forth in M1-01-02 (Engineering Documents Drawings and Other Deliverables).

2.4 RECORD DRAWINGS

The Contractor shall maintain a full-size record drawing set on-site always with clear markings on the drawings indicating it as the record set. The record set shall be available for Owner review always during performance of the Work. The Contractor shall furnish record drawings to reflect any changes including red line drawings made during or after installation and commissioning of the Project. One set of marked-up paper print drawings all with a new revision number shall be forwarded within six weeks from the Substantial Completion Date. A transmittal letter shall accompany the mailing itemizing the revised drawings.

2.5 PROJECT SPECIFIC – OPERATIONS AND MAINTENANCE MANUAL

No later than six weeks from the Substantial Completion Date, the Contractor shall furnish two complete identical set of detailed Operation and Maintenance Manuals as set forth in in M1-01-02 (Engineering Documents Drawings and Other Deliverables) in both print and digital (i.e. PDF) formats for the Project. These manuals shall be accompanied by a letter of transmittal and shall have a table of contents, contain all illustrations, assembly drawings, outline drawings, wiring diagrams, replacement parts list that includes part number identification, a list of recommended spare parts, and instructions necessary for storing, installing, operating and maintaining the Project. The illustrated parts shall be numbered for identification. Additionally, these books shall contain instructions and test procedures for integrating the Project into Owner control and monitoring computer networks. All information contained therein shall apply specifically to the Equipment and Materials furnished and shall not include instructions that are not applicable. All illustrations shall be incorporated within the print of the page and drawings bound into the book form a durable and permanent reference book. Binding holes of all Table of Contents pages, illustrations shall be reinforced with nylon circlets to prevent this information from being torn out of the book.

The Owner will inform the Contractor six weeks after receipt of the Operation and Maintenance Manuals either that there are “No Comments”, “Furnish as Corrected” or “Correction Required”. If there are “No Comments”, the Contractor shall promptly furnish two additional sets identical to the submitted copy. If there are corrections needed, one set will be returned to the Contractor by the Owner. The corrections shall be promptly incorporated in the Operation and Maintenance Manuals and a total of four complete, identical sets of such revised Operation and Maintenance Manuals shall be furnished to the Owner in both print and digital formats. All reference and vendor documents shall be provided in English or should be translated before being sent to PG&E.

One additional, identical Operation and Maintenance Manual shall be kept in control shelter.

2.6 EMERGENCY OPERATIONS PLAN

Emergency Operations Plan (EOP): Contractor shall provide an EOP in accordance with NFPA 855.

2.7 STUDY REPORTS AND CALCULATIONS

The Contractor shall submit all design study, calculations, dynamic modeling simulation, shake table testing, and field test reports to the Owner in a timely manner. All reports and calculations shall be signed by an Oregon registered professional engineer and shall list assumptions, study methods, results, significant findings and conclusions.

The Contractor shall prepare the following study reports and calculations as specified below:

- Hazard Mitigation Analysis (HMA): Contractor shall provide a HMA in accordance with NFPA 855 and the project adopted International Fire Code (IFC).
- Seismic and Wind Loading Calculations: The Contractor shall provide seismic and wind loading calculations for all buildings, structures, nonstructural components, equipment and structural supports, and all associated foundations and anchorages as specified in Section 1.4.

- Seismic Qualification Report: Contractor shall prepare a report demonstrating the Project's compliance with the seismic standards specified in Section 1.4 for the following:
    - Battery racks IEEE-693-2005-Annex J
    - Batteries – IEEE 693-Annex J
    - Switchgear-IEEE 693-Annex M
    - Step-Up Transformer-IEEE 693-Annex D
    - Inverters (including rack mount)-IEEE 693- Annex L
    - Medium Voltage (MV)/High Voltage (HV) Breaker, IEEE 693- Annex C
    - MV/HV Disconnect Switch IEEE 693-Annex E
    - MV/HV Termination and Support Structure, IEEE 693-Annex N
    - Pad-mount Isolation Transformers (Anchorage Only), IEEE 693-Annex D
    - Electronic Devices, Panels, Switchboards, solid-state rectifiers-IEEE 693 Annex L
- Structural Calculations: The Contractor shall provide structural calculations for all structural supports and foundations, the building enclosing the batteries, and shelters, Control Shelters/Rooms, and equipment foundations and all nonstructural components in accordance with Oregon Structural Specialty Code requirements as specified in Section 1.4 of this document.
- Grounding System Study: The Contractor shall use CDEGS to model the grounding system. The Contractor shall perform soil resistivity measurements using the Wenner four-point method and studies as necessary to determine the parameters for the Project's grounding system. Suitable sites for these measurements shall be selected by the Contractor and approved by the Owner.shall. It shall be the Contractor's duty to contact the landowner for permission to take the measurements. Grounding studies shall identify step and touch potentials, as applicable, for each facility where new equipment is added as part of the Project scope. The Project grounding system shall be designed to function independently of the adjacent grounding system. The grounding system for the Project may be connected to the ground grid for the adjoining substation at the discretion of the Owner at Contractor's cost. If connected to the adjoining grounding system, the contractor shall perform a study of the entire connected grounding system to verify that step and touch potentialare within tolerable limits at all points in the connected system. Connections to and routing of ground cables to connect the ground grid of the adjoining grounding system shall be provided by the Contractor.
    - Grounding for all multi-component outdoor structures shall include two (2) or more independent ground connections. The Project grounding system shall also be designed in such a way as to reduce electromagnetic interference (EMI) coupled to the grounding system from power electronic converters, such as through single-point grounding systems. Designs and study shall adhere to IEEE 80, IEEE 81, IEEE 142, and the Project's geotechnical engineering report where applicable.
- Electrical Studies: The Contractor shall provide electrical studies as required to determine control response and settings, including load flow, short-circuit, cable ampacity, arc-flash analysis, lighting study, protection coordination and voltage drop using industry-standard engineering software agreed-upon by the Owner. For the purposes of the system electrical studies, the Contractor shall provide inputs data for an accurate power flow and dynamic simulation model of the Project compatible with the Owner's CYME database and software for projects connected to the Owner's distribution system. Contractor shall perform dynamic simulations.. Plant studies shall be included in the substation studies referenced in M1-04-01 for transmission connected projects, to the extent possible, and provide positive-sequence models in either PSS/E, PSLF, or PowerWorld format, as well as electromagnetic transient models in PSCAD format. Provide lighting study in Visual Lighting software.

- Relay and Control Settings: The Contractor shall provide complete documentation of all protective relay and Project control settings for the Project's batteries, inverters, control systems, and AC systems up to the POI. Such documentation shall include a protection and control criteria document (separate protection and control criteria documents are acceptable), all calculations and time current coordination curves used in the development of the settings.
- Depending upon the scope of the Project, additional studies such as transformer sizing, DCS/UPS sizing, harmonics and auxiliary power studies may be required. Refer to M1-04- 01 for specific requirements of these studies.

2.8 TESTING AND TEST REPORTS

- For those tests described in IEEE 1547.1 under Clause 5 – Type Testing, Contractor shall provide certifications from Nationally Recognized Testing Laboratory (NRTL) for the results of those type tests. NRTL must be registered and authorized in the United States as well as in the country where type testing is performed. Any required type tests lacking documentation from a NRTL must be performed as a part of on-site commissioning and witnessed by the customer.
- The Contractor shall, within 30 days prior to any on-site testing, submit a "Master Test Plan and Procedures" document indicating the order in which the tests will be conducted, and the test method being used along with required instrumentation for Owner approval.
- The Contractor shall furnish, at the Contractor's own expense, necessary facilities, personnel and test equipment for the required tests.
- The Contractor shall notify the Owner not less than two weeks in advance of the day when:
  - Manufacture, fabrication and integration starts for the batteries, inverters, controls and transformers of each major deployment.
  - The batteries, inverters, controls, transformers and other major components allocated for each major deployment are ready for testing and inspection prior to packaging for shipment.
- Should the Owner elect to waive the right of inspection or of witnessing tests and accept certified test reports instead, the Owner will notify Contractor no later than three business days ahead of the scheduled inspection or test.
- Witnessed factory tests shall be made in the presence of Owner personnel or authorized representative. The test procedures shall be subject to review and acceptance by the Owner prior to arrival at testing location, provided that non-acceptance of any part of the procedures is consistent with the Statement of Work. The Contractor shall bear all costs of such testing except for the compensation and expenses of Owner personnel. If scheduling such tests to accommodate the Owner causes schedule delays, then said delays will be accommodated on a day-by-day basis to the extent they negatively impact the critical path.
- One copy of the certified reports of all tests shall be furnished to the Owner in digital and print formats for review. The Owner will inform the Contractor within two weeks after the receipt of the certified test reports either that there are no exceptions noted or that the test results show noncompliance with the Specification. Contractor shall provide the test data for a representative sample of each of the major components.

2.9 FACTORY ACCEPTANCE TESTING REQUIREMENTS

The Contractor shall be responsible for compliance with all standard factory test procedures that check the quality and performance of the Equipment and Materials.

The Contractor shall perform those tests specified below and in other sections of this Specification. The Contractor shall propose additional tests to be conducted if required. Where appropriate, tests should conform to those contained in ANSI, NEMA, ASME, NEC, ASTM, NETA, IEEE and UL standards and guidelines. Where standards are not suitable or applicable, other common industry procedures and mutually acceptable methods shall be used.

If certain tests are performed by firms other than the Contractor, the Contractor shall furnish the test reports and certify that the necessary testing has been performed.

2.9.1 Factory Acceptance Testing of the Battery/Cells

The Contractor shall test and submit test data for the cells designated for use on this Project. At a minimum, the following tests shall be performed:

- Amp hour capacity
- UL 1642 Certificates (if applicable)
- As applicable, maximum noxious and toxic material release rates for same cell design but not necessarily a specific production lot.

The Contractor shall propose a test plan for all required cell tests. Required tests may be proposed as a percentage of the cells in production lots. Test data for production lots other than those being supplied for this Project are not acceptable. The contractor shall submit a detailed template for the FAT test for review. The FAT template shall be approved prior to FAT testing on project units.

2.9.2 Factory Acceptance Testing of the PCS and Control System

The Contractor shall develop and submit for Owner approval a Factory Acceptance Test (FAT) Plan. The FAT Plan shall be in general accordance with Appendix C of this Specification. The Contractor shall work cooperatively with the Owner to develop a formal FAT Plan based on the appendix.

At a minimum, tests shall be conducted to demonstrate that all controls, protective functions and instrumentation perform as designed and adhere to this Specification. Successful tests performed on a scaled-down version of the overall scope of supply will be deemed to meet the intent of this Section provided that the Owner approves the design of the system under test. The PCS FAT testing must be performed using a subset of the exact make and model of the batteries being supplied for the project. Testing does not necessarily have to be performed at the PCS manufacturer's facilities. It can be performed at some location with the means to perform grid-connected and integrated testing. The tests shall demonstrate that the PCS is capable of synchronizing with and operating in conjunction with the utility connection. A report along with applicable graphs of each test and relevant data file(s) including a power quality report will be provided by the Contractor to the Owner upon completion of the FAT. This file should be captured at a minimum of 512 samples per cycle resolution.

Witness test shall demonstrate the following, at a minimum:

- Run at rated power for duration of specified system capabilities
- Normal and failure mode operating sequence and protective functions
- Verification of accuracy of measured input/output voltage and currents
- Verification of response to basic P and Q commands
- Verification of dynamic power factor (PF) control via SCADA system (e.g., Communications Protocol)
- Verification of power curtailment via SCADA system (e.g., Communications Protocol)
- Verification of islanding and black start capabilities

- Verification of power quality and compliance with IEEE power quality requirements through the use of power quality metering equipment with historization and harmonic analysis

2.10 SITE ACCEPTANCE TEST

The Site Acceptance Test shall be in accordance with Appendix F of this Specification, to be provided at a later date by Contractor as an exhibit to the Agreement. Owner will assist Contractor during the Site Acceptance Test process. In addition, the Contractor shall demonstrate that all aspects of the System integrate and coordinate as intended. At a minimum, the Contractor shall demonstrate that all control and management systems, including but not limited to, all levels of energy storage management system, PCS controls, overall site controls, and protective features operate as intended. Other balance-of-plant systems shall be tested in conjunction with the overall system tests (e.g. HVAC, fire alarm, thermal runaway mitigation system operational alarms, etc., lighting, security). Protective systems shall be tested in conformance with all applicable PRC standards. Owner reserves the right to require specific tests on any relay, or to require PRC testing even on non-BES relays.

2.10.1 Actual Operating Experience

It may not be possible due to system constraints to test all facets of the Project function as part of the performance verification tests specified above. The actual operating experience of the Project through Final Completion shall be deemed an extension of the performance verification tests.

Actual operating experience will be documented through Owner-furnished sequence of event recorders, oscillographs, digital fault recorders and other system monitoring equipment capable of identifying system disturbances and associated Project performance. Additional information may be provided by monitoring equipment installed by the Owner at other locations. Operation may also be documented with the Contractor-furnished power quality meters, as determined by the Owner.

2.10.2 Other Compliance Tests

The Contractor is responsible for obtaining both before (or with all equipment de-energized) and after Project installation, measurements to ensure the Project complies with this Specification in the following areas. The Owner reserves the right to perform (or request others to perform), at Owner expense, identical compliance test measurements for the following:

- Broadband frequency signal strength and noise voltage.
- Harmonic voltages and currents adhering to IEEE 519, 1547 and 2800. The proper IEC Class A meter must be used for this testing and a power quality report must be provided showing harmonic content in TRD (not THD) for each harmonic and interharmonic up to the 50^{th} order. Harmonic content must be measured at each of four different PCS operating levels.
- Audible noise measurements adhering to AHJ requirements.

2.11 SPARE PARTS

The Project-specific Operations and Maintenance Manual provided by Contractor shall include a complete list of recommended spare parts based on the equipment manufacturer’s minimum recommended spare parts list and, where applicable, informed by the outcomes of any analysis required by these specifications (such as Failure Modes and Effects Analysis- FMEA, or other). The Contractor shall furnish these spare parts with the Project. Each spare part shall be interchangeable with and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications. Enclosed storage space for spare parts required on site shall be provided by Contractor. If climate- controlled space is required, additional space shall be included in the Control Shelter or energy storage system enclosure(s).

2.12 SPECIAL TOOLS

The Contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the Project. Any accessories normally furnished with this system required for satisfactory operation of the Project, and not specified herein, shall also be furnished by the Contractor. All tools furnished shall be new and plainly marked for identification. One complete set of tools shall be furnished for the Site.

2.13 CLEANING AND PAINTING

All NEMA rated waterproof/water tight enclosures shall be thoroughly cleaned of rust, welding scale, and grease, and shall be treated to affect a bond between the metal and paint which shall prevent the formation of rust under the paint. A priming coat shall be applied immediately after the bonding treatment. The final finish shall consist of two coats of paint of specified color and type. Contractor shall submit painting specifications and procedures for Owner approval.

Waterproofing is the combination of materials or systems that prevent water intrusion into structural elements of the buildings or its finished spaces.

2.14 SHIPPING REQUIREMENTS

The Contractor shall prepare Equipment and Materials for shipment in such a manner as to protect from damage in transit. Each item, box or bundle shall be plainly and individually identifiable for content according to item number, Owner contract number, Contractor's identifying number, and complete shipping address. The Contractor shall pay attention to the proper packaging and bracing of the apparatus to assure its safe arrival.

Systems, equipment, materials and components shall be transportable from the designates port at normal speeds over North American highways and railways and meet all United States Department of Transportation hazardous materials and other requirements. System components may be shipped separately as needed and assembled on-site. Battery shipments shall adhere to the requirements of Title 49 Code of Federal Regulations (CFR) Part 173.185.

Energy storage media shipping containers will each be provided with shipping shock sensors of the appropriate G-rate sensitivity prior to loading at the manufacturer's dock.

Energy storage media shipping containers will each be provided with shipping tilt sensors prior to loading at the manufacturer's dock.

Shipping of storage media shall be via air-ride van or trailer.

A complete itemized bill of lading, which clearly identifies and inventories each assembly, subassembly, carton, package, envelope, etc., shall be furnished and enclosed with each item or items at the time of shipment.

Contractor must conduct a Site Acceptance Test (SAT) for all equipment delivered to site which is to be provided and approved by the Owner.

2.15 INSTALLATION

The Contractor shall be responsible for quality of construction to meet best Industry Standards and design requirements. Equipment shall be installed in accordance with their listing and the manufacturer's instructions.

2.15.1 Civil/Structural

The permanent Project shelters and required foundations, structures, anchoring (including the building or enclosure that will house the batteries), and other civil/structural work shall be designed by and under the supervision of a qualified registered professional engineer and registered architect, in each case in the state where the Project is located. All such work shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification and M1-02-01 (General Civil Requirements).

2.15.2 Geotechnical Testing

The Contractor shall perform geotechnical investigations, and geotechnical report shall be in accordance with the requirements set forth in M1-02-01 (General Civil Requirements), including all information necessary to complete civil/structural and grounding design. Contractor to determine cable thermal ampacity based on geotechnical investigations.

2.15.3 Site Development

The Contractor shall perform all necessary studies and calculations for hydrology and drainage, erosion control, landscaping, NPDES (Stormwater Pollution Prevention Plan) and site grading to comply with local agency regulations. The Contractor shall be responsible for all surveys (e.g. topographic, Dig Alert, potholing) required to attain an accurate design.

Drainage structures and piping within the Project boundaries shall be grounded if constructed of materials capable of conducting electricity.

2.15.4 Excavation

The Contractor shall perform all excavation necessary for installation of all foundations and utilities. All excavation shall be in accordance with OSHA regulations and the geotechnical report performed or to be performed by Contractor. Excavation spoils shall be the Contractor's responsibility and may be used for backfill or embankment if suitable for this application as directed by the project geotechnical report/ engineer. Unsuitable or excess excavated material shall be disposed of properly at a PGE approved location. The Contractor shall verify that earth material exposed in excavations is consistent with those assumed for the Contractor's foundation designs.

2.15.5 Construction Surveying

The Contractor shall furnish all labor, equipment, material and services to perform all surveying and staking required for the completion of the Project in conformance with Contractor's design and the Statement of Work. Survey information shall be included in Project as-builts.

The Contractor shall retain qualified survey crews knowledgeable in proper and up-to-date survey techniques and shall use these qualified survey crews when conducting the survey. Such crews shall be under the supervision of a professional land surveyor licensed in the state where the Project is located.

2.15.6 Fills

Earth fill material adjacent to and below structures shall conform to the design requirements for the structure and the geotechnical report performed or to be performed by Contractor.

Contractor-prepared specifications and drawings shall indicate the types of soil to use for fills and compaction requirements.

2.15.7 Storage

Contractor to provide onsite storage container, if required by selected battery OEM. Contactor to also adhere to additional requirements including but not limited to lighting, grounding, HVAC, etc., as required by the OEM. Fill shall be placed as uniformly as possible on all sides of structural units. Fill placed against green concrete or retaining walls shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly.

2.15.8 Fencing

Site perimeter fencing is required for the Project. Such fencing shall comply with the Owner fence standards as described in M1-01-07. Signage on fencing shall comply with PGE Substation standard S120-20 – Safety Signs. Additional signage may also be required – coordinate with Owner during signage plan development.

2.15.9 Lighting and Convenience Outlets

Lighting shall be provided for all indoor and outdoor areas of the project. The lighting system shall provide personnel with illumination for operation under normal conditions and means of egress under emergency conditions. Luminaries shall be LED type, mounted so they are easily accessible for maintenance and lamp replacement, to the maximum extent practical; for both interior and exterior. Emergency lighting shall be powered from self-contained batteries, with chargers, within a self-contained emergency lighting unit.

The power supply for the lighting system shall generally be from low voltage (LV) lighting panelboards. The emergency egress lighting shall consist of self-contained battery lanterns. Outdoor lighting shall be limited to providing fixtures mounted on building, container, or light standards. Light fixtures shall be Dark Sky compliant to help preserve the night sky from light pollution.

The lighting levels shall be designed in accordance with the Illuminating Engineering Society to provide proper illumination levels recommended. Minimum level in the energy storage system area shall be 30-foot candles (323 lux) at 30 inches (762 millimeters) above plane, when occupied, and adequate levels for illumination for video and security equipment when unoccupied; 3.0-foot candles (22 lux) at 30 inches (762 millimeters). Minimum level in the control room and maintenance area shall be 50-foot candles (538 lux) at 30 inches (762 millimeters) above floor plane.

Follow state and local lighting energy efficiency standards, as applicable. Electric power to light fixtures shall be switched with motion sensors in energy storage system rooms. When unoccupied, sensors shall reduce levels to minimum for security. Motion sensors with built-in override function shall be provided in areas where the light can be completely turned off, such as storerooms, switchgear rooms, and maintenance area. Wall mounted switches and sensors shall be provided at the latch side of the door entrance.

Electric power to outdoor light fixtures shall be switched with motion or heat detectors to keep lights off when not required. Convenience outlets and switches throughout shall be industrial grade rated for standard voltages and amperes per country standards. Convenience outlets located outdoors shall be provided with weatherproof snap-action covers. Outlets shall be spaced in the energy storage area such that there is a maximum 100 feet (30 meters) distance to a receptacle outlet, unless codes allow or require otherwise. As a minimum, an accessible receptacle outlet shall be reachable within 25 feet (7.6 meters) from each HVAC unit. Provide outdoor receptacles protected by ground fault interrupters, and interior receptacles in locations as required by codes. In finished areas, general-purpose power outlets shall be located on each wall and in no case shall they be located more than 10 linear feet (3.0 meters) apart.

2.15.10 Control Shelter (if control room not provided in building-based solution)

For container-based solutions, the Contractor shall design, engineer, and provide a shelter suitable for use to house the Project controls and all indoor components common to the Site. The shelter shall be designed to comply with the Oregon building code requirements. The Contractor shall provide the shelter required to accommodate the Project controls commensurate with the Project design life, including but not limited to seismic events, wind loads or other controlling criteria. The shelter shall be considered an occupied space and shall be designed in accordance with codes pertaining to occupied space.

If energy storage media is located within containers, the design shall be such that normal maintenance and operation can be performed without personnel entering the enclosure.

The Project shelter and containers shall be designed with the appropriate insulation to meet local building codes and ensure an energy efficient operation of the HVAC and/or ventilation system. Control shelter will be installed on a graded concrete pad and all components mounted thereon shall be designed for and anchored sufficiently for transportation to the jobsite. Control shelter shall be designed without shipping splits. The control shelter shall be made from either steel (galvanneal), aluminum or stainless steel. The control shelter shall have doors to accommodate installation and replacement of equipment housed in the structure. The roof shall have a pitch design with a minimum slope of 0.25 inch per linear foot and shall be designed to support interior or exterior loads of 100 pounds per linear foot without compromising the roof load design.

The control shelter shall be equipped with DC cabinet, AC panels and disconnects (480/240/120), lights, switches, receptacles, controls rack, fire suppression, HVAC units, push buttons, HVAC controls, cable tray, wireway, grounding system and conduit.

Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

2.15.11 Project Building (if applicable to proposed system)

The Contractor shall design, engineer, and provide a building suitable for use to house all indoor components of the Project. The building shall be designed to comply with the Oregon State Building Code requirements. The Contractor shall provide the building required to accommodate the Project commensurate with the Project design life, including but not limited to seismic events, wind loads, or other controlling criteria as specified in Section 1.4.

The building shall be designed with the appropriate insulation to meet local building codes and ensure an energy efficient operation of the HVAC and/or ventilation system. Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

2.15.12 Structural Steel and Connections

All structural steel shall comply to the following applicable materials standards:

- Wide Flange Shapes - ASTM A992
- Angles and Channels - ASTM A36
- Plates - ASTM A572 Grade 50
- High Strength Structural Bolts - ASTM A325N Type 1, or A490
- Washers - Hardened steel, ASTM F436
- Nuts - Heavy hex, ASTM A563
- Welded stud anchors shall be headed arc-welded mild steel studs conforming to ASTM A108, Type B having minimum yield strength of 51,000 pounds per square inch (psi) and a minimum tensile strength of 65,000 psi.

- Anchor Bolts - ASTM F1554 Hex Head, Grade 36 or Grade 55
- Electrodes for Welding - Electrodes shall be E70XX 70ksi tensile strength, minimum.
- All structural steel shall be hot-dipped galvanized in accordance with ASTM 123 and all mill certifications shall be available. Structures shall be fabricated such that double dipping is not required.
- Bolted connections shall be ASTM A325 with hardened washer and heavy hex nuts installed as snug-tightened in accordance with the Research Council on Structural Connections Specification for Structural Joints Using ASTM A325 or A490 Bolts.
- All welding shall comply with the requirements of AWS D1.1, Structural Welding Code - Steel. Welders and welding processes shall be qualified in accordance with AWS D1.1, and as set forth in M1-05-06 (Applicable Standards).

2.15.13 Foundations and Concrete Work

The Contractor shall furnish all labor, equipment, materials and services to layout, design and construct all foundation and concrete work required for the Project. The Contractor shall provide foundations for all equipment and structures, as appropriate, including but not limited to shelters, containers, buildings, transformers, switches, breakers and instrument transformers.

The design and construction of all foundations shall be in accordance with the requirements set forth in M1-02-01 (General Civil Requirements), ACI 318, and Oregon Structural Specialty Code. All concrete exposed to weather or in contact with soil shall be designed to be compatible with the life of the Project.

The appropriate manufacturer shall specify the quantity, size, and location of anchor bolts for enclosures and equipment per seismic qualification reports. Embedded steel items shall be hot dip galvanized. Anchor bolts and embedded steel items subject to corrosive action shall be fabricated from stainless steel.

Concrete shall be batched, mixed and delivered in accordance with the requirements of ACI

301. Reinforcing shall be detailed and fabricated in accordance with ACI 315. Details of concrete reinforcement not covered in ACI 315 shall be in accordance with the CRSI manual. Concrete placing methods shall conform to the requirements of ACI 301, 304, and 318.

The Contractor shall provide the services of an independent testing agency to perform tests on concrete material such as compressive strength, slump, concrete mix designs, during the course of the Work. Testing, evaluation and acceptance of concrete shall be done in accordance with the requirements of Chapters 16 and 17 of ACI 301. Any concrete that does not meet the requirements shall be replaced with no increase to the Purchase Price.

2.15.14 Mechanical

All exposed surfaces (inside or outside) of ferrous parts shall be thoroughly cleaned, primed, and painted or otherwise suitably protected to survive outdoor conditions for the design life of the Project.

The building housing the energy storage system and any other outdoor enclosures or shelters shall be waterproof and capable of surviving, intact, under the Site environmental conditions for the design life of the Project. Flat Roofs are not allowed – minimum roof slope shall be 0.25 inch per linear foot.

Components mounted inside of the building and any other enclosure shall be clearly identified with suitable permanent designations that also shall serve to identify the items on drawings provided.

The Project shall include an HVAC, thermal management system, and/or ventilation system for the enclosure(s) housing the energy storage system(s) and control shelter which shall be seismically anchored. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

The Project shall be designed to maintain component temperatures within design limits for all modes of planned Project operation. The HVAC system shall be sized to maintain ambient temperature and humidity in the enclosure to within the limits specified by the battery manufacturer during all operating modes and ambient conditions.

HVAC communications and control technology shall make use of the best Industry Standard components and be compatible with the Owner's existing environment for substation communications infrastructure.

2.16 QUALITY ASSURANCE / QUALITY CONTROL

2.16.1 Quality Control Program

The Contractor shall establish, implement, and maintain a comprehensive QC Program, which shall be reviewed for approval by the Owner prior to implementation. This program shall include provision of a qualified, on-site Quality Assurance / Quality Control (QA/QC) support staff for the duration of the Project.

The QC Program shall clearly establish a QA/QC Manager and/or staff with the responsibility and authority to inspect the Work, to enforce the quality requirements of the Statement of Work and the Agreement, and to verify the effectiveness of problem resolutions and corrective actions.

The QC Program shall be capable of assuring that the design, construction, purchasing, manufacturing, shipping, storage, testing, inspection and examination of all equipment, materials, procedures, and services shall comply with the requirements of the Agreement and building code requirements. Reports generated under the QC program must be submitted to the Owner within three days of receipt.

The Contractor shall provide all equipment, materials, and labor required to perform all Work in support of QA/QC. As a minimum, this applies to soil density, concrete, welding, and any laboratory tests. Any Subcontractors or third-party inspectors hired by Contractor to perform any Work in support of QA/QC shall be subject to the approval of the Owner.

The Owner shall have the right to independently review and inspect all Work associated with the Project that occurs or will occur at the Site. This may include review and inspection by third parties and contractors of the Owner.

The Owner shall have the right to independently review and inspect any Work or equipment associated with the Project that has been previously developed, constructed, or manufactured. For any work, equipment, or materials that are stored outside the Project location (e.g., off-site storage facility), the Contractor shall provide Owner will reasonable opportunities to inspect such items, including any affiliated documentation. This may include review and inspection by third parties and contractors of the Owner.

2.16.2 Quality Assurance Manual

The QC Program shall consist of one or more bound sets of documents comprising a single Quality Assurance Manual. The form and format of the Quality Assurance Manual is at the discretion of Contractor and its Subcontractors. Upon review and final approval by the Owner, it shall become the sole guide for Contractor and all its Subcontractors for quality performance of all Work on the Project. The content of the Quality Assurance Manual shall include written descriptions of QA/QC policies, procedures, methods, instructions, exhibits, or other quality assurance descriptions. An uncontrolled copy of Contractor's corporate QC manual shall be provided to the Owner Representative. The Owner shall always have access to all QA/QC documentation and shall be provided copies upon request.

The Contractor's Quality Assurance Manual shall include, at a minimum, control procedures or methods to assure the following:

- The establishment of on-site QA/QC staff.

- A plan for receipt inspection, in-progress inspection, examination, and testing of the equipment and material installed by Contractor.
- A description of the authority and responsibilities of the persons in charge of the quality assurance program.
- Current and accurate maintenance of design documents, drawings, specifications, quality assurance procedures, records, inspection procedures, and purchase control documents.
- Conformance of purchased materials, equipment and services to the requirements of the Agreement.
- Proper performance of receipt and in-process inspections as well as equipment examinations, testing, corrections as well as checkout procedures.
- The inclusion of adequate inspection and quality of all Contractor's subcontracted work and shop fabricated components.
- Shop inspections are performed and documented at an adequate frequency rate.
- Assurance that the quality of all special processes such as welding, and any other nondestructive testing is properly inspected, verified, and documented.
- Assurance that the proper methods are employed for qualifying all personnel performing welding and non-destructive testing.
- Assurance that inspection hold points are identified and monitored in coordination with the Owner Representative.
- All deviations and non-conformance will be communicated to the Owner in writing within three days.

2.17 REQUIRED TRAINING COURSES

The training courses described below, with accompanying written text, shall be a live presentation at an Owner facility with the Owner having the right to video tape the training course. Such taped training will be used only for training of new personnel and will be subject to confidentiality agreements, and other protections of Contractor's Intellectual Property. The training course shall cover all aspects of installing the Project, a pictorial breakdown of the energy storage subassemblies, procedures related to emergency response including Emergency Response Documentation from the Battery Manufacturer (ruptured modules, gas detected fire, etc.), and operation, maintenance and control of the Project.

2.17.1 General

The Contractor shall provide training for the Project as specified below. The Contractor shall determine the content and duration for each training session. The suggested class durations in this Specification are meant to illustrate the level of training expected. Performance evaluation testing of all trainees (i.e., a written test) is required for all classes except the orientation training.

2.17.2 Orientation Training

The Contractor shall provide two orientation training sessions. It is anticipated that each session will last half a day. These sessions shall be suitable for managers, supervisors, professional and technical personnel. Each session will be limited to a maximum of 20 people.

The orientation training sessions shall be scheduled before commencing Acceptance Testing. An outline for this orientation training shall be submitted to the Owner 90 days ahead of the actual date of training. Approval of this outline shall be obtained from the Owner. The Owner will provide comments and/or approval at least 30 days before the scheduled training date.

2.17.3 Operator Training

The Contractor shall provide the necessary training in proper operation of the Project and related equipment. This training shall be conducted after successful completion of the Acceptance Testing, but before system commissioning. It is anticipated that this session will last one (1) to two (2) days. This session will be limited to a maximum of 20 people. Emphasis shall be placed on hands-on operating experience interspersed with critical background as necessary, including switching procedures and emergency response training.

2.17.4 Maintenance and Diagnostic Training

The Contractor is responsible for providing necessary training on energy storage and inverter diagnostic software which includes a set of the necessary cables to diagnose these issues. This training shall be completed onsite using the Owner's field personnel equipment. Documentation of the software and steps needed to communicate with various equipment will be supplied by the vendor.

2.17.5 Emergency Planning and Training

The Contractor is responsible for providing emergency planning and training so that operations personnel and emergency responders can effectively and safely address foreseeable hazards associated with on-site systems. Emergency planning and training shall include procedures for safe shutdown; alarm response procedures; emergency response procedures following fire, explosion, or release of toxic chemicals; and any other procedures as determined necessary by the AHJ to provide for the safety of occupants and emergency responders.

This training shall be provided in a separate and distinct document such that Owner may provide periodic training to local fire department personnel. This must include any handouts, videos, checklists and all other materials required for a comprehensive training product.

The Contractor shall coordinate with the Owner and adhere to any PGE guidelines or communication protocols for engagement with local emergency services; if such guidelines are not yet available at the time of bid, they will be provided by the Owner prior to local agency outreach.

3.0 FUNCTIONAL REQUIREMENTS

3.1 GENERAL

The Project shall serve multiple purposes on the Owner's system for bulk energy services, ancillary services, and distribution level services. Each service is described as a control mode. These modes will all be supported within the system capabilities and the system's self- protection requirements. Most of the control modes are simply accomplished by the Owner sending active power (P) and reactive power (Q) setpoints via the SCADA interface while the system is in PQ mode. These control modes are described in this section for the Contractor to understand the expected operation of the system and potential impacts on maintenance, guarantees and system longevity. Only two services are accomplished through built-in applications within the Contractor's Site Controller. These two services are frequency/watt control (sometimes called frequency support or freq/watt) and Volt/VAr support (sometimes called voltage support).

Dispatch of the system will be limited to 2 full charge/discharge cycles per day and 365 full charge/discharge cycles per year.

All services that the Owner dispatches through P and Q commands will have ramp rates unique to that service; those ramp rates being controlled by the Owner. The P and Q setpoints will be sent to the system along the appropriate ramp curve, not as a step change. The Supplier will provide four data tags for the Owner to select the overall system maximum ramp-up and ramp- down rates (one data tag input for ramp up, one data tag input for ramp down and two data tags for feedback for each of the two ramp inputs). These four data tags will be shared with the Owner's SCADA system to be used by the Owner, subject to the Project's internal ramp limits for safety and system longevity. These two ramp rates will be used by the Owner as maximum ramp rates for charging and discharging. In dispatching the system, the Owner will send setpoints that ramp up or down and the Contractor is expected to respond to these commands no slower than the maximum rates established.

As well as ramp rates, all Customer PQ commands will be limited by the Contractor's site controller's Contractor-specified SOC limits and power limits to avoid damage to the Project.

Description of Various Ramp Rates and Their Hierarchy	
Project Internal Ramp Rates	Maximum ramp rates established by the Contractor and hard- coded into the system. These ramp rates are for ultimate safety and protection of the Project. They are not adjustable by the Owner.
Owner-Selectable Ramp Rates	Maximum ramp rates established by the owner. They are four data tags within the Project that can be written-to and read- from the Project's Project Site Energy Controller by the Owner. These ramp rates cannot exceed the Project Internal Ramp Rates.
P and Q Setpoint Ramps	These ramps are built into the P and Q setpoints sent by the Owner. If they should exceed the Owner-Selectable ramp rates, the Project will default to the Owner-Selectable ramp rates.

At any time during operation, if the system is responding to abnormal conditions as described in IEEE1547-2018 Clause 6, the system will respond in accordance with that standard without regard to any established ramp rates.

Termination of operating modes due to reaching the discharge limit shall take into account the ramp down energy required.

3.2 CONTROL MODES

The following sections describe the control/operational modes and sources of commands for the Project. Contractor shall work with the Owner to ensure that the appropriate command and source hierarchy are enforced by the Project.

3.2.1 Offline

The Project shall open the breaker/contactor(s) on the DC bus, inverter AC output breaker/contactor(s), and de-energize non-critical power supplies. It should physically isolate the inverter output from the grid, not just provide a zero output, to prevent interaction with the grid (nominal auxiliary load contactors may continue to serve these loads). This mode includes both normal shutdown and system trips requiring reset. The entire system must be capable of remote reset. The control system shall initiate the offline mode under the following conditions and remain in the offline state until a reset signal, either local or remote, is initiated.

- Emergency trip operation
    - AC circuit breaker trips that isolates the Project from the grid such as direct transfer trip or other system protection
    - Smoke/fire alarm and suppression operation

3.2.2 Standby

The Project controller should close the inverter AC output contactor after synching, but neither charge nor discharge, and only draw necessary auxiliary load or power required to maintain a requested SOC (if requested). Under certain conditions, the system may spend long amounts of time in standby mode. The Project is expected to maintain a state of charge of 100% (or other SOC setpoint as provided from the Owner's controller) and be prepared to respond to a signal for P or Q dispatch within the specified time. The Project controller will maintain a requested SOC within +/-1%.

3.2.3 Contingency Reserve

The Project must respond from an idle state to a request for contingency reserve within two seconds of receiving the command. From that time, the facility will ramp up at a rate of at least 20MW per minute until the full rated active power output of the system is achieved. The full rated active power output shall be maintained according to the Customer's P setpoint. If the Project becomes depleted of charge prior to the completion of the service and the Customer's P setpoint is not reduced, the Project will ramp-down and go into standby mode. It will not recharge until the Customer sends a P command with a negative polarity.

3.2.4 Fast Frequency Response (FFR)

This dispatch is controlled by a central controller in the Owner's SCADA system. When this service is dispatched, it is a result of the Owner's system sensing a drop in frequency of a pre- defined magnitude. In this situation, the Owner's RTU will send a single bit that will be used to trigger the FFR application. The appropriate response from the site controller is to immediately ramp to a FFR setpoint also coming from the Owner's RTU. This setpoint is additive to whatever the P value was at the time. After three minutes the output will be ramped back to where the original P setpoint was.

The Project must respond from a standby state to a request for frequency response within two seconds of receiving the command.

3.2.5 Active Power Regulation in Response to Area Control Error (ACE)

The Project shall charge or discharge in response to the Owner's P setpoint, received from the Owner's RTU.

The Project must be capable of performing regulation according to Area Control Error (ACE) signals. The control for this service will originate from the Owner's RTU. The Project must be able to respond to these MW signals within four seconds or less. Response is defined as the time from the Project controller receiving a MW setpoint until that steady-state MW output is achieved.

The Project shall be capable of both positive (supplying) and negative (absorbing) active power setpoints, which may be of any magnitude up to 100% of the system's real power rating. Over time, these active power setpoints are intended to be energy neutral (no net gain or loss in energy). In the event battery SOC is at a level where the requested setpoint (either positive or negative) cannot be met, the Project controller shall respond only to active power setpoints for the polarity it can achieve. The Project will resume responding to MW setpoints of both polarities once the battery SOC has returned to an acceptable range.

Contractors must stipulate clearly how the thermal limitations of their system would affect this service.

3.2.6 Reactive Power Regulation

The Project will respond to reactive power setpoint requests from the Owner's plant controller within four seconds. Setpoints may be constant (fixed) or variable reactive power outputs in order to maintain voltage using closed-loop proportional integral control (an application residing within the Owner's site controller). The Project must be able to regulate reactive power to within

+/- 1% for reactive power setpoints between 10% and 100% of the Project's reactive power nameplate rating.

The only limitation for providing this service must be the overall MVA rating of the Project, with active power setpoints having precedence over reactive power setpoints.

3.2.7 Manual/HMI

The Project shall be capable of being operated manually from a local operator HMI. All Project functionalities shall be available via this HMI including all control modes, operating parameters or setpoints and monitored information/status.

This operator HMI shall be capable of disabling other control modes from operating and signals being received from the Owner's other integrated systems in order to operate solely in local mode.

3.2.8 Frequency/Watt Service

This control mode should be a feature of the Contractor's SEC. This mode should operate as described in IEEE 1547 Clause 10 – Interoperability.

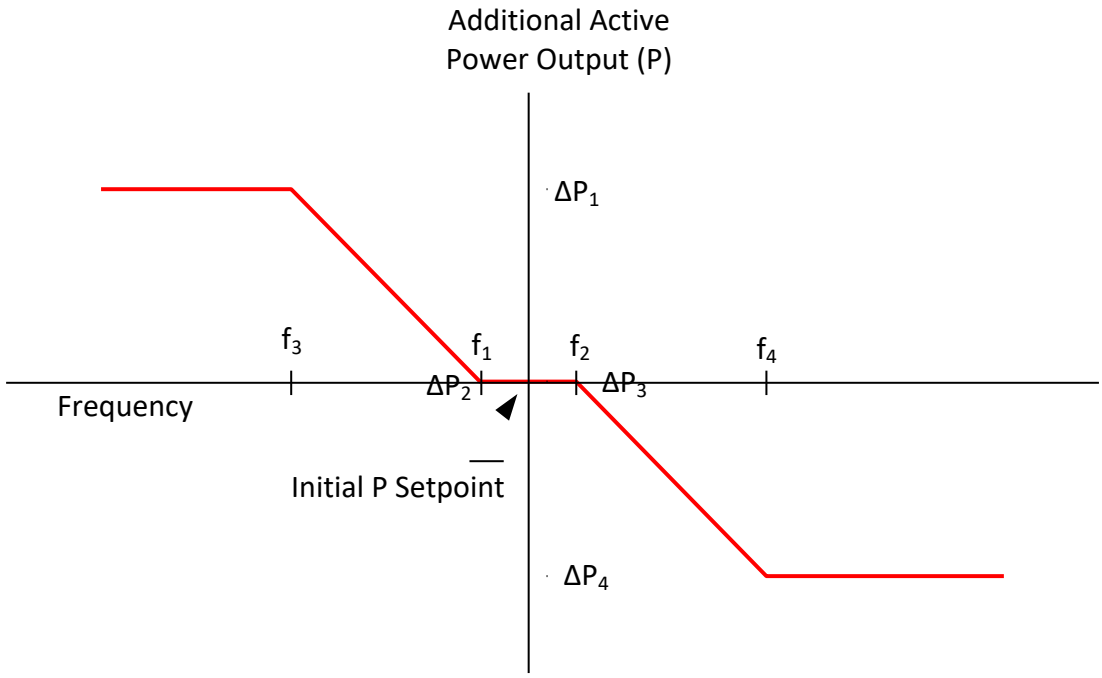
Frequency support shall be an open loop response to frequency fluctuations from 60Hz as measured at the PCS terminals. The inverter real power response is proportional to the frequency offset from the frequency deadband and the defined freq/watt curve. The total system output is the sum of the active power resulting from the P setpoint and the delta power provided by frequency support.

If the frequency drops below the limit value defined by f2, the battery algebraically increases active power output (increases discharge power or reduces charge power) according to a slope defined by the Owner-configurable table. If the frequency exceeds the limit defined by f3, the battery decreases discharge or increases charge power according to a slope defined by the ΔP1/ f4.

Frequency support is enabled by the Owner's site controller sending a "1" to the "FreqActive" register.

Parameter	Description	Units*	Example	Range*
FreqActive	Activate frequency support mode	-	0	[0-1]

FreqLow (f_1)	Low frequency deadband setpoint	mHz	59.964	Fnom – 4Hz
FreqHigh	High frequency deadband setpoint	mHz	60.036	Fnom + 3Hz
FreqLowDelta	Frequency delta for low frequency	mHz	100	[0-2000]
FreqHighDelta	Frequency delta for high frequency	mHz	100	[0-2000]
PowerLowDelta	Power change for low frequency support	Watts	5000	≥0
PowerHighDelta	Power change for high frequency support	Watts	5000	≤0



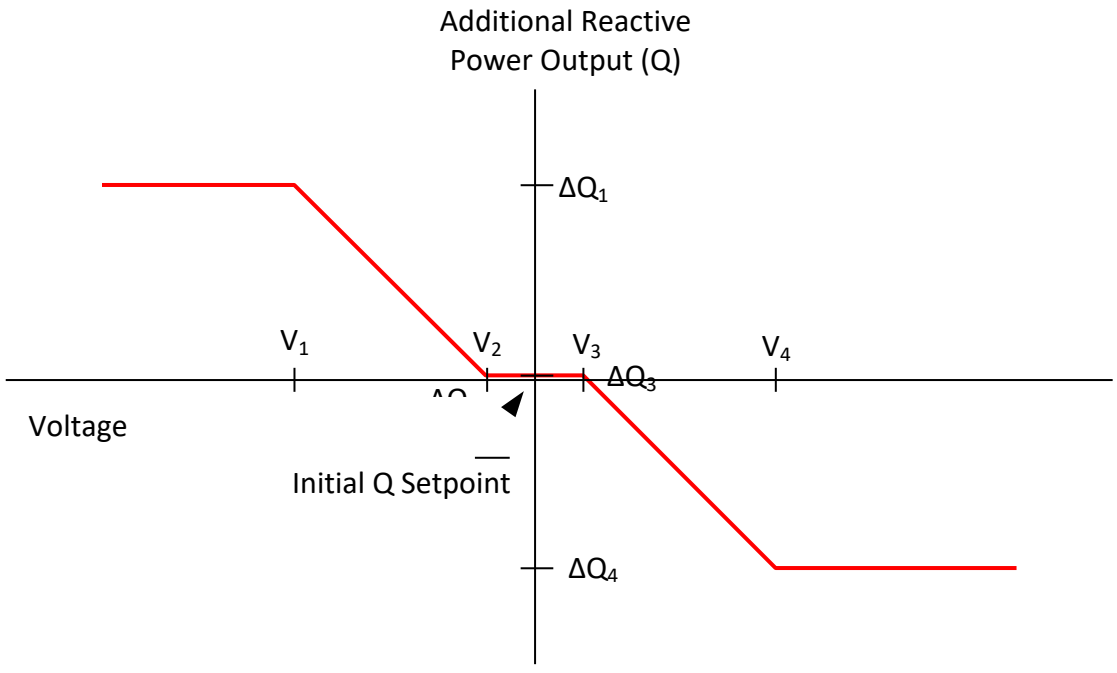
3.2.9 Voltage Support (Volt/VAr) Service

As a default, this mode should operate as described in IEEE 1547 Clause 10 – Interoperability. Alternatively, if the Contractor can achieve the same result with alternative means, that is acceptable.

Volt/VAr service shall operate as an open loop response to voltage deviations from nominal system voltage as measured at the inverter terminals. The inverter's reactive power response shall be proportional to the voltage offset from the nominal voltage as defined in a user-defined Volt/VAr table. Contractor shall make data tags available to Customer's SCADA system to populate this table. The total system reactive power output shall be the sum of any existing Q setpoint and the additional reactive power requested by the Volt/VAr service.

The Customer shall be able to configure the Volt/VAR slope through a parameter table such as that shown below:

Parameter	Description	Units	Default	Range
Volt/VAr Service Active	Enable Volt-Var mode	-	0	0-1
V1	Low voltage setpoint 1	0.1%	1000	0-2000
ΔQ1	MVARs at low voltage setpoint 1	0.1%	0	-1000 – 1000
V2	Low voltage setpoint 2	0.1%	1000	0-2000
ΔQ2	VARs at low voltage setpoint 2	0.1%	0	-1000 – 1000
V3	High voltage setpoint 3	0.1%	1000	0-2000
ΔQ3	VARs at high voltage setpoint 3	0.1%	0	-1000 – 1000
V4	High voltage setpoint 4	0.1%	1000	0-2000
ΔQ4	VARs at high voltage setpoint 4	0.1%	0	-1000 –



4.0 TECHNICAL REQUIREMENTS

4.1 GENERAL

The Project shall include the ESS, PCSs (inverter(s)), pad-mount transformers, cabling, shelters, metering, all associated control and communication interface systems, all switchgear and other interconnection equipment and all auxiliary loads necessary to support its operation to the point of interconnection with the utility.

All loads necessary to operate and protect the Project, such as controls, cooling systems, fans, pumps, and heaters, are considered auxiliary loads internal to the ESS.

The Point of Interconnection (POI) shall be defined per the Scope of Work and indicated in Appendix B which shall be submitted by Contractor at the time of bid submittal.

4.2 STORAGE CAPACITY

The Project shall be rated in terms of net delivered power and energy to the POI. All system loads and losses, including wiring losses, transformer losses, losses through the contactor/static switch, power conversion losses, auxiliary loads, and chemical/ionic losses are considered internal to the Project and ratings are net of these loads and losses as measured to the POI.

In such cases where auxiliary loads (such as cooling systems) are periodic in nature, ratings may be described for conditions in which these loads are active in the worst-case conditions.

The Contractor shall scale the reported SOC of the ESS so that 0-100% represents the maximum range of operational (usable) energy storage capacity available to the Owner regardless of the actual SOC of the system. A reported 0% SOC shall indicate that no further discharge of the system is permitted, and a reported 100% SOC shall indicate that no further charging of the system is permitted. This range shall permit the Owner to fully realize the rated energy storage capacity of the system (i.e. for a 1.0-megawatt hour [MWh] system, the Owner shall be able to discharge 1.0 MWh of energy when discharging from a reported 100% to a reported 0% SOC) as measured at the POI.

4.3 RATINGS

Following are fundamental Project unit ratings. Note that power, energy, and ampacity ratings apply through the full operating temperature range, as defined for the Site unless otherwise noted.

4.3.1 AC Voltage

Verify nominal interconnection voltage with Owner.

4.3.2 Round-trip Efficiency

The roundtrip AC-AC energy efficiency, measured at the POI, shall be provided and include parasitic and auxiliary losses under worst-case conditions prescribed in the FAT Plan.

The calculation is as follows:

$$\eta = \frac{kWh_{out}}{kWh_{in}} \times 100\% = \frac{(rated\ discharge\ power) \times (discharge\ time)}{(rated\ charge\ power) \times (charge\ time) + losses} \times 100\%$$

In which the discharge time is from a fully charged to fully discharged energy storage, and charge time is from a fully discharged to fully charged energy storage. If the auxiliary power is provided by a separate connection from the energy storage, these measured values should be reflected in the losses term in the equation.

4.3.3 Parasitic Losses

The total ESS unit losses shall be determined for standby operation, including power electronics and any environmental controls such as HVACs.

4.3.4 Self-Discharge

Contractor shall provide self-discharge characteristics.

4.3.5 Basic Insulation Level

The ESS AC system equipment shall have a Basic Insulation Level (BIL) in accordance with the IEEE for each piece of equipment.

4.3.6 Inrush Capability

It may be advantageous to the Owner for the Project to have short time overload capabilities. This may occur for power system disturbances in which both real and reactive power is required for a short period of time to control both frequency and voltage excursions.

The Contractor shall provide a curve showing the inherent overload capability (if any) of the Project as a function of time. It is not a requirement of the Specification to design specific overload capability into the Project.

For projects that include islanding, the ESS shall have capability for 1.5 x rated MW and 1.5 x rated MVA for one minute. This inrush duty will be four times per hour on top of continuous, full load.

4.3.7 Auxiliary Voltage

Auxiliary voltage will be site specific.

4.3.8 Power and Energy Metering

System ratings are defined in kVA (AC) or MVA (AC) and kWh (AC) or MWh (AC) as measured at the POI. In all instances the reference point of applicability (RPA) is the POI.

Project reactive power capability must comply with IEEE 2800 Clause 5.1.

Owner-approved 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. Revenue meter configurations will be issued by PGE metering personnel.

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

4.3.9 Design Ambient Temperature Range

System shall be designed for an ambient temperature range of 0°F (min) to 118°F (max).

4.3.10 Audible Noise

The maximum sound level generated from the Project and any associated equipment supplied by the Contractor under any output level within the Project operating range, shall be limited to levels specified by Applicable Laws, including any applicable local noise ordinance(s). The Contractor shall comply with all Applicable Laws that may apply to the Project installation as determined by the jurisdiction applicable to the site. Noise abatement or mitigation solutions must be permanent; permanent meaning the life of the project. Contractor may not use temporary means to satisfy project permitting that are of risk of becoming superseded or obsolete during the project life.

The audible noise level in the Project control room if separate from areas housing inverters, cooling equipment, etc. shall meet OSHA requirements for normally occupied areas.

The Contractor shall make audible noise measurements before and after commissioning of the Project for the purpose of verifying adherence and compliance with the local ministerial ordinance and requirements. The measurements shall be made at various locations using a Type 1 sound level meter that complies with the requirements of ANSI S1.4-1983 “American National Standard Specification for Sound Level Meters.”

4.3.11 Broadband Interference

The Contractor shall take necessary precautionary measures to ensure that there will be no mis-operation, damage or danger to the Project due to broadband interference and effects. The Contractor shall ensure that there are no discharge sources from the Project and related equipment that could cause interference with radio and television reception, wireless communication systems, or microwave communication systems per the 47 CFR Part 15. The Contractor shall propose any necessary mitigation to ensure that communication is not adversely affected.

The Contractor shall make measurements before (or with all equipment de-energized) and after commissioning of the Project for the purpose of verifying compliance with the broadband interference requirements.

All broadcast signals, radio noise, television interference and broadband interference measurements shall be made with instruments that comply with the latest revision of ANSI C63.2, “American National Standard for Electromagnetic Noise and Field Strength Instrumentation, 10 Hz to 40 GHz - Specification.” IEEE Standard 430, “IEEE Standard Procedures for the Measurement of Radio Noise from Overhead Power Lines and Substations” defines the measurement procedures that shall be used.

4.3.12 Interference and Harmonic Suppression

The PCS shall not produce EMI that will cause mis-operation of instrumentation, communication, or similar electronic equipment within the Project or on the Owner system. The PCS shall be designed in accordance with the applicable IEEE standards to suppress EMI effects.

The Project must meet the harmonic specifications of IEEE 2800 Clause 8 and IEEE 519 and comply with requirements outlined in the Energy Storage Integration Council (ESIC) technical specifications spreadsheet. Harmonic suppression may be included with the PCS or at the Project AC system level. However, the Contractor shall design the Project electrical system to preclude unacceptable harmonic levels in the Project auxiliary power system.

4.3.13 Short Circuit Currents

The interrupting and momentary duty of all circuit breakers or fault interrupting devices shall not be greater than 85% of their respective rating.

4.4 EXTERNAL AC POWER INTERFACE(S)

4.4.1 Termination

All terminations and locations of terminations shall be pre-approved by the Owner and specified in the appropriate submitted drawings. The Project shall comply with any applicable owner interconnection standard.

4.4.2 Isolation/Disconnect

An interconnection isolation disconnect device shall be placed directly on the line side of each metering section. The disconnect device shall be lockable and have a visible break or visible open. The device does not have to be rated for load break nor provide over-current protection. The Owner shall have full access and control over this device.

A LV source side isolation contactor shall be provided. The disconnect breaker shall be lockable and have a visible break. It shall be capable of breaking the full rated power of the system. The contactor will be operated by SEC and will also have provisions to be operated manually. The utility will have full access and control over this device.

4.4.3 Use for Auxiliary Power

The auxiliary power system shall include, but is not limited to, all step-down transformers, breakers, fuses, motor starters, HVAC loads, plant (non-BES) relaying, uninterruptable power supplies, panels, enclosures, junction boxes, conduits, raceways, wiring and similar equipment, as required for the Project operation or otherwise called ‘balance of plant’ load.

All uninterruptable power supplies must be provided with a Modbus Ethernet connection for monitoring.

The aux transformer will require a remote mounted revenue meter. This meter must have an Ethernet connection to the substation SCADA network. Actual revenue meter locations and instrument transformer specifications shall be determined by PGE metering personnel. Revenue meter configurations will be issued by PGE metering personnel.

Alternate auxiliary and/or station service power must be obtained from the local distribution utility. For projects within PGE’s distribution service territory, all applicable service requirements (including but not limited to: protection requirements, equipment configuration, ratings, etc) apply in addition to these specifications. Application for alternate, auxiliary and/or station service must be made separately from the transmission interconnection process. Bidder is responsible for all service equipment needed for alternate, auxiliary, and/or station service power, and is advised to anticipate appropriate lead-times for design review, equipment manufacture and delivery.

4.4.4 Power Quality Metering and Telemetry

An owner-approved power quality meter will be placed at the high-side of the generation step-up transformer, separate from the revenue meters, but sourced from the same current and voltage transformers. This power quality meter will be connected to the substation SCADA system via Ethernet.

4.4.5 System Protection Requirements

Contractor shall adhere to rules and regulations described on the Owner's Electric Distribution System Interconnection (for projects connected to the Owner's distribution system) or Generation Interconnection Handbook if available, or the applicable transmission provider's guidelines for projects interconnected to third party systems. For the avoidance of doubt, the requirements of the applicable Interconnect Handbook shall apply to all aspects of the project and not just the system protection. If Owner Handbook is unavailable the contractor shall adhere to IEEE and Manufacturer device setting recommendation for protective system settings.

Protection and coordination for the "plant-side" system including batteries, DC combiner panels, inverters, AC combiner panels, transformers, auxiliary systems, and switchgear (where applicable) shall adhere to IEEE 242. All relays protecting auxiliary power circuits used for life safety, or fire protection systems--including cooling systems, the failure of which could lead to thermal runaway or fire—or circuits which are critical for plant operation or restoration 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.

Protection relays for the interconnection shall be utility grade and shall meet the minimum requirements specified in IEEE C37.90 (latest edition) including requirements for EMI and surge withstand according to applicable standards for the intended location of the Project. A complete protective relaying system based on Industry Standards shall be a part of the AC system. The protective relaying and metering shall be integrated with the Project control system and a communications channel provided to the Owner's SCADA system. However, integration into the Project control system shall not circumvent normal protective relaying functions.

All protective equipment and schemes shall be properly coordinated with the Owner protection engineering department. The Contractor shall use Schweitzer Engineering Laboratories (SEL) microprocessor-based protection equipment to the extent practical. When SEL microprocessor- based protection equipment is not practical, Owner shall approve of equipment Contractor proposes to be used. For sites connected to the Owner's distribution system, the interconnection relay shall be an owner approved SEL relay with Mirrored Bits capability . The low side bus and cable shall be protected by multifunction feeder protection relays. Testing of protection equipment shall be conducted by International Electrical Testing Association (NETA) certified technicians. The NETA certification number of the tester shall be documented on all test reports. To the extent possible and applicable, any Energy Storage relay systems shall follow the same design masters and standards as the substation relay systems.

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.

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. Relay design shall to the extent applicable follow the same design and requirements as the interconnection substation relays in M1-05-03 and M1-05-02.

4.5 PROTECTION COMMUNICATIONS

The Contractor shall provide a fiber optic communications pathway specifically for Mirrored Bits communications between the Owner's relaying at the point of interconnection and at the Project Substation. This communications pathway will provide breaker status, transfer trip, and operate in parallel as appropriate. Exact Mirrored Bits assignment shall be approved by Owner.

4.6 INSTRUMENT AND CONTROL WIRING

In general, and where practicable, control and instrumentation wiring shall be designed and installed to minimize any and all electrical noise and transients. All cabling shall be new and continuous for each run; splices are not acceptable. All conductors shall be copper.

All cabling which may be exposed to mechanical damage shall be placed in conduit, wireway, overhead tray, or other enclosures suitable to the Owner. Wires shall have identifying labels or markings on both ends. The labels shall identify the cable tag, and opposite end destination.

Each wire in the system must have an accompanied drawing and location reference.

Control and instrumentation wiring shall be separated from power and HV wiring by use of separate compartments or enclosures or by use of separate wireways and appropriate barrier strips within a common enclosure as required by the NEC.

Project and PCS control and instrumentation system wiring shall be bundled, laced and otherwise laid in an orderly manner. Where cable is in wire trays, waterfalls shall be used, as necessary. Wires shall be of sufficient length to preclude mechanical stress on terminals. Wiring around hinged panels or doors shall be extra flexible (Class K stranding or equivalent) and shall include loops to prevent mechanical stress or fatigue on the wires.

Cable insulation material shall be thermoset composition rated for 90˚C during normal operation. Insulation and jackets shall be flame retardant and self-extinguishing and shall be capable of passing the flame test of IEEE Standard 383 or IEEE 1202. Raceway and cable systems shall not block access to equipment by personnel.

Where appropriate, Fiber Optic Cable used for instrument and/or control shall be ruggedized indoor/outdoor breakout, riser rated, orange jacket, four fiber, 50/125um MM giga link 600 fibers, 2.5 mm, RoHS, standard strip.

Ethernet cable that is run in conduit underground must be rated for wet locations or direct bury. No Ethernet cables shall be actually direct-buried.

4.7 MODULAR REPLACEMENT

The Project PCS, control, batteries and current sensors shall be connected in a manner that enables field replacement. It is expected that most maintenance will be accomplished while maintaining partial service. The physical and electrical arrangement shall permit module replacement with the isolation breaker/contactor closed and the PCS disconnected. For CTs, this means that shorting test switches must be used.

Owner shall not be required to provide additional space or resources to accommodate the battery module replacement or supplementation. Contractor shall reserve the appropriate spacing and clearance per NESC into the design of the Project to accommodate battery module replacement and supplementation.

4.8 PHYSICAL CHARACTERISTICS

The Project shall meet all applicable OSHA, NEC, IEEE, ANSI, and NFPA requirements for electrical and fire safety.

The Project shall be designed to minimize footprint and volume. The Project may also be designed to include subsurface components or modules, provided relevant operating and environmental factors normally addressed for submersible equipment are considered to assure full life-cycle performance requirements are met.

The Project components located outdoors shall be contained within weatherproof, tamper resistant, metal enclosures suitable for mounting outdoors on concrete pads with a minimum NEMA 3R rating. NEMA 3R: Types 3R, 3RX: Rain-tight, sleet-resistant. Indoor or outdoor use. Same protection as Type 1, but adds a degree of protection against ingress of falling dirt, rain, sleet and snow; also protects against damage due to external ice formation. Rust-resistant. The “X” designation indicates corrosion-resistance.

Any enclosures shall be dust tight to at least the NEMA 3R rating, except as designed to allow forced air exchange with the atmosphere.

Project Modules PCS, and controls shall be accessible and removable for replacement. The Project shall be designed to operate with minimal maintenance for at least five years.

A nameplate shall be provided including:

- Manufacturer Name
- Connection diagram
- ESS ratings; Power, energy, voltage, BIL
- Specimen data; serial number, date of manufacture
- The nameplate shall meet the requirements of IEEE C57.12.00

All necessary safety signs and warnings as described in ANSI Z535-2002 (entire series from Z535.1 through Z535.6), NEC, and NFPA 855 shall be included on the building, shelter or each enclosure. All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the building, shelter or each enclosure.

4.9 CYCLE LIFE

The ESS must be designed to achieve a minimum lifetime of 20 years for continuous operation with minimum scheduled downtime for inspections and maintenance. End-of-life is defined as when the ESS reaches 80% of the nameplate rated capacity at the time of installation. If the ESS is subject to capacity degradation, the design must accommodate future augmentation as required to maintain nameplate rated capacity, taking into consideration the specified operating profile. See the ESIC technical spreadsheet in Appendix G for cycle life requirements to various depths of discharge over the anticipated ESS lifetime.

The Contractor shall provide a graph or set of graphs that displays the relationship between depth of discharge, discharge energy throughput, operating temperature, C-rate, resting state- of-charge, and other relevant parameters and the corresponding capacity degradation experienced by the ESS.

Cycle counting shall be accomplished by applying a filter for each of the specified depth of discharge levels or based on other methodology proposed by the Contractor and agreed to by Owner. Contractor shall propose a methodology for tracking all other parameters that effect ESS capacity.

The Project will be designed to provide the equivalent of at least two (2) cycles per day and a maximum of 365 cycles per year.

4.10 BATTERY MANAGEMENT SYSTEM

As a subcomponent of the Project, a Battery Management System (BMS) shall be included to manage the operational health of the Project, provide cell-by-cell diagnostics information and assure its safe and optimal performance of the energy storage system as an interconnected asset to the Owner’s electrical system. The BMS shall be specifically built by the battery manufacturer for that battery system. If the battery manufacturer uses a third party BMS, the Contractor must provide detailed a description of how that BMS was custom designed for the application. Primary functions include but are not limited to:

- Monitoring:

  - State of Charge
  - State of Health
  - Voltage/Current
    - String
    - Bank (if applicable)
  - Temperature
    - Module Internal
    - Various Ambient
    - Highest cell temperature
    - Average cell temperature
  - Status
  - Contactor status
  - Energy Throughput
- Maximum charge/discharge current or power
- Active Cell Balancing (Passive voltage balancing is not acceptable)
  - Cell voltage
- Warning and alarms
- Internal protective measures
- Logs of operations
- Management of any software versions
- Cyber Security management of the device itself
- Provide data exchange to the SEC
- Contribute to functional safety of overall Project

4.11 POWER CONVERSION SYSTEM

The PCS shall be listed to UL 1741 Supplement B and shall comply with IEEE 1547-2018 for distribution-connected projects. PCS connected at the transmission level shall comply with IEEE 2800. The PCS must be capable of delivering any combination of active power and reactive power that results in the following equation being true: 〖apparent power〗 _rated=√(〖active power〗 ^2+ 〖reactive power〗 ^2) and as defined by the inverter P-Q capability curve; provided that at the system level there may be restrictions on reactive power output if the setpoint is chosen to boost system voltage that is already higher than nominal or reduce system voltage that is already lower than nominal.

The PCS shall be a static device (non-rotational) using solid-state electronic switch arrays in a self-commutated circuit topology. Line-commutated systems or systems that require the presence of utility voltage or current to develop an AC output are not acceptable. Only commercially proven switch technology and circuit designs are acceptable.

The PCS, in conjunction with the Project control system and the BMS shall be capable of completely automatic unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect functions.

The control of the PCS shall be integrated with the overall Project control system. However, the PCS also shall include all necessary self-protective features and self-diagnostic features to protect itself from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. The self-protective features shall not allow the PCS to be operated in a manner that may be unsafe or damaging. Faults due to malfunctions within the PCS, including commutation failures, shall be cleared by the PCS protection device(s) or external protection devices. Such faults shall be acknowledged, cleared and reset remotely.

All PCS components shall be designed to withstand the stresses associated with steady state operation, transient operation and overload conditions as required by this Specification. The Contractor shall demonstrate that all relevant aspects of overvoltage stresses have been considered.

The PCS system shall include provisions for disconnection on both the AC and DC terminal(s) for maintenance work. Conductor separation must adhere to the requirements of the Owner's Generator Interconnection Handbook, the Owner's Distribution Interconnection Handbook, or IEEE standards and best practices. These disconnecting devices shall be capable of being locked open for maintenance work. Any PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 volts within five minutes of de- energization per UL1741 requirements.

The PCS or battery system must have DC bus pre-charging functionality or other means of arc mitigation during switching of the DC disconnect devices.

The PCS shall record disturbance information in conformance with PRC-028, and records shall be retrievable remotely and automatically via software over a provided network connection.

Outdoor located PCS electronic compartments shall be NEMA 4 at a minimum and the overall enclosure rating shall be a minimum of NEMA 3R. PCS shall meet IEEE 519 and IEEE 2800 for transmission-connected projects IEEE 1547 for distribution-connected projects for harmonic content.

PCS cooling system shall not be susceptible to particle contamination and require minimal scheduled maintenance. The PCS shall be furnished with nameplates or stickers that are suitable for the environment. Nameplates shall be located to be visible with equipment installed and operating. Each nameplate shall indicate the following information:

- Nameplate ratings
- Component name
- Manufacturer's name
- Serial number
- Year built (or may be found in a reference document based on serial number)

4.12 SITE ENERGY CONTROLLER (OR PLANT CONTROLLER)

The Project shall include all necessary software applications and supporting hardware required to meet the specified functional requirements. Software algorithms, external data input capabilities, and user interfaces shall provide for user specified variable input or set point values, as well as external data value streams required by programs directing the Project operations.

The Project shall include the necessary communication and telemetry hardware, and support communications protocols, to effectively provide the required services. No single mode of failure shall result in loss of power to the control and data acquisition module. The control shall include provisions for an orderly and safe shutdown in the absence of utility power.

4.12.1 Operations and Control Functions

The SEC shall be the primary dispatching location for local monitoring and control command functions, and is responsible to perform the following by priority in this order:

- Protect itself (isolate for any internal fault)
- Remain within power constraints (transformer and Project ratings)
- Remain within frequency constraints
- Remain within voltage constraints
- Remain within operating temperature constraints
- Isolate in response to system anomalies
- Charge/discharge Real Power and Reactive Power in response to SEC programs or external commands
- Communicate status and diagnostic data

The SEC shall respond to commands issued remotely or locally, including but not limited to:

- Change Modes (e.g. charge, discharge)
- Startup/Shutdown
- Change Status (enable/disable)
- Reset Alarms
- System Reset/Restart

The SEC shall respond to the following modes of operation:

- Controller must be able to transition from one setpoint within a given mode of operation to another setpoint within the same mode without ceasing operation. Changing of output from an existing inverter setpoint to any other setpoint as a transition step (e.g. returning inverter to 0 output) before executing next command will be considered unacceptable.
- Controller must be able to accept and validate a given setpoint command prior to executing a given operation mode. For example, if the Owner sends a command for the BESS to discharge at 1.0 MW in constant real power output mode, the controller must be able to validate and accept the 1.0 MW setpoint prior to it initiating constant real power output mode. Setpoint validation will vary depending on the control mode command but may include limits associated with state of charge, facility ratings, ramp rates, system operating conditions, etc.
- For Projects that include either black start or islanding functions, the Controller must be able to switch from current source mode to voltage source mode and back via a single remote- control point (“Voltage Source Inverter Mode”), as well as a local point on the Human Machine Interface (HMI).
- Controller must be able to open and close inverter contactors via remote control points. Controller must also be able to open and close inverter breakers if those breakers are motor operated. Controller must be able to reset all applicable system alarms via a remote-control point.
- Controller must be able to conduct real and reactive power operations completely independently of one another until the apparent power limit of the asset is reached.
- Controller shall allow for the prioritization of either real power setpoints over reactive power setpoints or reactive power setpoints over real power setpoints once the apparent power limit of the asset is reached. Prioritization shall be indicated via remote commands from the Owner.

- Controller shall assign a positive sign convention to system real power output information when the system is discharging (real power).
- Controller shall assign negative sign convention to system real power output information when the system is charging (real power).
- Controller shall assign a positive sign convention to system information when the system is injecting reactive power (acting like a capacitor). This should be considered a leading PF.
- Controller shall assign a negative sign convention to system information when the system is absorbing reactive power (acting like an inductor). This shall be considered a lagging PF.
- Controller sign convention for real and reactive power commands shall match the desired convention assigned to system information reporting. In other words, positive real power commands refer to discharging, negative real power commands refer to charging, positive reactive power commands refer to injecting vars, and negative reactive power commands refer to absorbing vars.
- Specific to the Target State of Charge or Energy (SOC) operational mode, the Controller shall ensure the system reaches the commanded SOC setpoint and then not dispatch the system until after the SOC falls outside the commanded SOC deadband.
- For Power Conversion Systems (PCS) that integrate multiple inverters, the controller must be capable of balancing the State of Charge (SOC) of each inverter both automatically and manually. For example, if a PCS includes an 'A' inverter and a 'B' inverter, the controller should be able to manage the charge of each inverter independently.

4.12.2 Loss of Communications

The Project shall remain functional in the absence or loss of communication from the Owner's site controller. The Project shall continue its current mode of operation for a set time period (variable setting, 15-minute default). On expiration of the time, the Project shall ramp to standby mode at a selectable ramp rate (25MW/minute default).

During an interruption to communications, the remote controller will make repeated attempts to re-establish communications at a set time interval (variable setting, default of five minutes).

When communications have been re-established, the Project and remote controller shall automatically make any necessary updates or resets to resume performance. Once the system is again ready, it shall remain in standby mode until a new setpoint is sent by the Owner's site controller.

4.12.3 Monitoring, Data Logging, Alarms, and Status

4.12.3.1 Alarms

Alarms shall be provided for all critical ESS parameters (see Appendix E for more details).

Alarms shall be provided for all critical balance of plant system parameters (see Appendix E for more details).

Owner shall have the ability to acknowledge and clear alarms remotely through the Owner's site controller.

An alarm log with time stamps shall be provided.

Details or help screens shall be provided for each alarm.

An alarm matrix shall be provided to show the relationship and hierarchy of all alarms.

The SEC shall provide relevant status information, for feedback to the Owner's supervisory control system. The telemetry points should include:

- Operation Control
- Operation Status
- System Information
- AC/DC Status
    - An alarm shall be sent via SCADA to appropriate personnel to investigate or take the equipment out of service if any protective relay loses control or tripping power. The alarm shall be fail safe and may need to consider cases such as loss of communications to the relay.
- Status
- Device Status and Error Codes (Alarms)
- Data Logging:
    - Log of Operations for one year on-site. Life-of-project duration for off-site log.
    - Historical data and trending for one year on-site for a limited set of parameters as agreed with the Owner. Life-of-project duration for off-site data.

4.13 NETWORK COMMUNICATIONS

The Project and all its subcomponents required for operation shall be configured to be on its own sub-network, separate from any Owner communications network. All such work shall comply with M1-05-04 (Communication, SCADA, and Metering Facilities Facilities).

Communication between the energy storage system and any Owner IP network shall be accomplished using a managed gateway between the Contractor-provided energy storage system and any Owner IP-based network (such as a Cooper SMP or SEL RTAC).

DNP3 is the required communications protocol for external communications between Owner networks and the Contractor's energy storage systems. This must be accomplished without the use of an additional communications gateway device. If the Contractor's SEC cannot accommodate DNP3 protocol, then a different protocol such as Modbus TCP/IP may be allowed. The Owner has the ultimate authority to accept or reject any protocol other than DNP3. A secure, encrypted site to site IP virtual private network (VPN) tunnel may be established between the Owner and the Vendor to allow the Vendor remote access to the Project for monitoring and support purposes. The Owner firewall will deny IP traffic by default and allow authorized IP traffic only by exception. Vendor will provide a detailed list of devices and protocols that require access for remote support.

Any additional Contractor or Vendor external communications inbound to the energy storage system are prohibited. This includes analog lines, cellular modems, wired or wireless communications circuits, internet connections, cloud, or any other connection methods. If the Contractor requires alternate external communications, these must be submitted to the Owner for review. If the Owner grants approval, it is the sole responsibility of the Contractor to provide, install, secure, and maintain. For cybersecurity purposes, the Owner will not interconnect any Vendor network that has Internet access with any Owner routed IP network or networked device.

The Project's HMI for control shall be able to be controlled by the Owner electric control centers using a TCP/IP routable protocol specified by the Owner.

The solution shall use wired connections for communications. If the Contractor wishes to include wireless communications in the proposal, these must be submitted to the Owner for review. The Contractor shall provide a list of any proposed wireless communications devices, security methods and encryption standards, the associated protocols, and a list of endpoint devices that would be connected.

Contractor provided communications equipment shall be suitable for the intended purpose and the environment where it is installed. Contractor shall use hardened devices that support extended temperature and humidity where required. For key system communications, the equipment should have built in high availability or redundancy capabilities, or separate redundant devices should be used.

The proposed solution shall provide communications for any required security and fire alarm systems, including fire and first responders, in compliance with all Applicable Laws and Owner standards. The solution shall be capable of communicating with Owner-selected Remote Terminal Unit (RTU) via currently supported protocols and cabling types, as assisted by an Owner Interface.

The Project's Owner-facing network and firewall equipment shall be interoperable with Owner Networks LAN switches, routing, and firewalls, to include static routing, MPLS, OSPF, and 802.1q VLAN trunking.

4.14 INFORMATION SECURITY

In addition to any requirements set forth below, the Contractor shall coordinate with the Owner to ensure all Project-related physical, cyber, information, and other security controls conform to M1-01-07 (Security and Compliance), including adherence to Owner's current access and security guidelines.

4.14.1 Contractor

Contractor shall design the Project to be hardened against willful attack or human negligence using Cybersecurity industry best practices and incorporating technical controls as applicable to the Project as outlined in the NISTIR 7628 Framework. The reference for these controls can be found through the NIST government publications for the Framework NISTIR 7628 – Guidelines for Smart Grid Cyber Security: Vol. 1, Smart Grid Cyber Security Strategy, Architecture, and High-Level Requirements. A summary of these controls is listed in Appendix G.

4.14.2 Application Partitioning

The Contractor shall design the Project to support integration with Role-based Access Controls, as assisted by an Owner Interface. For example, functions necessary to administer databases, network components, workstations, or servers, and typically requires privileged user access.

The separation of user functionality from information system management functionality is either physical or logical.

4.14.3 Audit Logging and Reporting Mechanisms

The Contractor shall design the Project to provide logging capabilities. Preferably the logging mechanism is in a standard format like Syslog that can easily integrate with the Owner Security Integration and Event Management system.

4.14.4 Authentication and Authorization Controls

The Contractor shall design the Project to provide the following authorization controls:

- Log account access events, such as failed login, login, logout, session timeout.
- Display an approved system use notification message or banner before granting access to the system that provides privacy and security notices consistent with all Applicable Laws, Executive Orders, directives, policies, regulations, standards, and guidance.
- Prevent non-privileged users from executing privileged functions to include disabling, circumventing, or altering implemented security safeguards/countermeasures.

4.14.5 Authenticator Feedback

The Contractor shall design the Project to obscure feedback of authentication information during the authentication process to protect the information from possible exploitation/use by unauthorized individuals. For example, do not display a separate error message for an invalid username versus an invalid password.

4.14.6 Baseline Configuration and Configuration Settings

The Contractor shall provide a checklist of security configuration requirements / system hardening requirements for all IT assets deployed as part of the Project, as assisted by an Owner Interface.

The Contractor shall provide an asset baseline configuration for all applicable assets. For network-connected assets, the baseline configuration shall list all open/listening logical ports (both TCP and UDP), the executable that opened that port, and the underlying justification for that port being open. For all assets capable of installing software, the baseline configuration shall list all intentionally installed software and the version of that software, and all applied security patches.

All unused logical ports should be closed/disabled (per equipment capability).

4.14.7 Boundary Protection System

The Contractor shall segment trust zones using a barrier technical control such as a firewall. The barrier technical control shall be configured to deny inbound and outbound network communications traffic by default and allow inbound and outbound network communications traffic by exception.

4.14.8 Cryptographic Key Establishment and Management

The Contractor shall provide certificates that support at least SHA-2, SHA-1 certificates are not permitted. Wildcard certificates like *.example.com are not permissible and certificates must be for specific (list) of sub-domains. All PKI certificates must support SHA-256 or higher. The Contractor will provide cryptographic keys from a Certificate Authority approved by the Owner.

4.14.9 Device Identification and Authentication

The Contractor shall provide an asset inventory containing all programmable electronic devices in the Project. The asset inventory will include the following fields: Device Name, Network Name, IP Address, MAC Address, Building Location, Rack Location, Firmware version / software version, Device Description.

4.14.10 Information Input Validation

The Contractor shall provide a solution that validates user input and network input for malicious content and unstructured data within the Project. For example, user interfaces should not be susceptible to untrusted user inputs.

4.14.11 Information System Backup

The Contractor shall provide the Project with a solution that is scheduled to conduct periodic backups of user and system-level information and protect the confidentiality, integrity, and availability of the backups.

4.14.12 Information System Monitoring

The Contractor shall allow the Owner to monitor network traffic leveraging SPAN ports on switches and routers provided as part of the Project.

4.14.13 Least Functionality

The Contractor shall configure information systems to provide only essential capabilities, open ports, protocols, and services as part of the Project.

4.14.14 Malicious Code Protection

The Contractor shall provide malicious code Endpoint protection software on all assets that support it in the Project and provide a method for updating the software. The Contractor shall configure the Endpoint protection software to perform periodic scans of the information systems and real-time scans of files that are downloaded, opened or executed. The malicious code protection software will block malicious code, quarantine malicious code and send alerts to administrators of the system. Enforced Whitelisting of system software and operation may be considered an alternative to Endpoint protection.

4.14.15 Password-Based Authentication

The information system shall offer provisions for a password-based authentication. These features should include, but are not limited to, the following:

- Enforce password complexity to include case sensitivity, a minimum of eight characters, mix of upper-case letters, lower-case letters, numbers, and special characters.
- Stores and transmits only encrypted representations of passwords.
- Enforces password minimum and maximum lifetime restrictions of specific defined numbers for lifetime minimum, lifetime maximum.
- Prohibits password reuse for 10 generations.
- Allows the use of a temporary password for system logons with an immediate change to a permanent password.
- Employs automated tools to determine if password authenticators are sufficiently strong as related to above criteria of password authentication requirements.

4.14.16 Protection of Information at Rest

As part of the Project, the Contractor shall implement Information Systems that:

- Protects the confidentiality and integrity of information at rest.
- Implements cryptographic mechanisms to prevent unauthorized disclosure and modification of information on information system components.
- Securely stores off-line storage.

4.14.17 Session Authenticity

As part of the Project, the Contractor shall implement Information Systems that:

- Invalidates session identifiers upon user logout or other session termination.
- Generates a unique session identifier for each session with randomness and recognizes only session identifiers that are system-generated.
- Only allows the use of certificate authorities for verification of the establishment of protected sessions.

4.14.18 Transmission Confidentiality and Integrity

As part of the Project, the Contractor shall implement cryptographic mechanisms to prevent unauthorized disclosure of information during data transmission (e.g. VPN Tunnel).

4.14.19 Unique Identification and Authentication

As part of the Project, the Contractor shall provide the means to uniquely identify and authenticate organizational users (or processes acting on behalf of organizational users) such as Multifactor authentication. Shared user accounts shall not be permitted.

4.14.20 3rd Party Assessment

Contractor shall contract information/cyber security scans and penetration tests by an Owner- approved third-party security company, prior to Substantial Completion.

The Contractor will provide the Owner with a copy of the original report from the 3rd party security company. The Owner reserves the right to perform its own internal security testing in addition to the Contractor's testing.

Contractor shall develop a cybersecurity plan that addresses and mitigates the critical vulnerabilities inherent in both the hardware and software that comprise the control and data acquisition systems. The cybersecurity plan will include regular qualified software patches and service packs to Windows and Linux based operating systems, the underlying software and device firmware. The patches will be applied at least every 30 days with an expedited method for highly critical vulnerabilities (Common Vulnerability Scoring System Score of 19). Security related patches should continue to be applied for the duration of the system's useful life.

4.14.21 Portable Media and Laptops

As part of the Project, the Contractor shall disable all mass storage device capabilities for Windows and Linux based servers and workstations (USB drives, SD Cards, CD-ROMs, External Portable HDDs and Floppy disk drives).

Any portable device (or variant) such as process control service laptops will be regularly managed by policy to ensure it is inspected and found to be free from malicious code. Using latest version Endpoint protection with regular updates no older than 30 days. Portable devices will be restricted from connecting to a secondary network while connected to the Process Control network. The Owner may request logs and audit access to review system scans, patching and management tools to ensure compliance. Under no circumstances will the Contractor allow its employees to access any part of the Project with their personal laptop or tablet.

4.14.22 Unused Network Ports

As part of the Project, the Contractor shall disable all unused network ports on switches, routers and firewalls.

4.15 CONTAINMENT

4.15.1 Lightning Protection

Contractor shall provide a UL Master Label lightning protection system for all buildings, shelters and other structures per the requirements of NFPA 780 and UL 96A. Provide evaluation and risk assessment of remaining Owner and Contractor furnished equipment and enclosures to confirm that remaining equipment is self-protected under NFPA 780 paragraph 7.2.2.

4.15.2 Cooling Systems

The Site temperatures and the effect of temperature on component life shall be considered in developing the thermal design for all components, including the batteries and PCS. There may be several separate heat removal systems to accommodate the particular needs of Project components and subsystems (e.g. PCS, transformers). The heat removal and/or cooling system may include vapor-compression cooling system or other conventional environmental conditioning equipment. Final rejection of all waste heat from the Project shall be to the ambient air.

The cooling system shall be sized for end-of-life battery heat loss information. Total battery heat dissipation shall account for all installed batteries including any provisions for battery augmentation throughout the project life.

Air handling systems shall include filters to prevent dust intrusion into the Project. Exterior wall make-up air inlet louver shall be sized to avoid water penetration. HVAC system(s) efficiency and control requirements must comply with applicable local and national codes. HVAC system(s) for energy storage cooling shall include three or more stages. Sufficient redundancy shall be considered in the design such that no single component failure will shut down the system.

HVAC and ventilation systems shall be seismic braced/anchored. All design shall be in accordance with local and national seismic design requirements.

Evaporator coil coating shall be required if outside air is drawn from the exterior. Indirect waste from the HVAC system(s) shall be disposed per local and national plumbing codes.

HVAC/ventilation design shall comply with all Applicable Laws. HVAC/Ventilation shall require interlock to the shelters fires alert system for shutdown. If explosion prevention or deflagration venting is required by the applicable safety codes and standards as a result of large-scale fire testing, activation of mechanical ventilation system activation shall require interlock to the shelter's flammable gas detection system.

4.15.3 Fire Protection

The Contractor shall provide fire protection system for the complete energy storage system including modification of existing site fire protection system to meet all applicable codes including the 2020 Edition of NFPA 855 "Standard for the Installation of Stationary Energy Storage Systems" and the latest approved revision of the applicable local fire protection codes.

Contractor shall comply with NFPA coordination, design, installation, commissioning, testing, training and startup requirements. This shall include all other requirements as outlined in this specification. Fire Protection system design shall include, but not be limited to, the following:

- Emergency vehicle access and fire hydrants per applicable local and national codes;
- Failure Modes and Effects Analysis or other approved Hazard Mitigation Analysis (HMA) in accordance with the applicable local fire protection codes and safety standards to defend and gain alignment for the system design with all key stakeholders before the design is finalized (e.g. risk mitigation for thermal runaway prevention);
- Enclosure design in accordance with NFPA requirements for location, separation, materials of construction, ventilation, smoke or flammable conditions detection, fire suppression, communications/alarms, explosion control, training, commissioning, permitting, and documentation as required by UL 9540 listed design and applicable local codes. Unless otherwise approved by Owner and the local fire code official, design shall include:
    - Smoke detection system in accordance with NFPA 72.
    - Off-gas detection.

  - Fire control and suppression with automatic sprinkler system per NFPA 13 or other approved automatic fire control and suppression systems or equivalent. based on reports issued as a result of large-scale fire testing.
  - Permanent source of water for fire protection. If water source is not available on site, water storage tank and all other necessary equipment shall be provided internal to the enclosure.
  - Explosion prevention system designed and installed per NFPA 69 or deflagration venting installed per NFPA 68.
- The fire alarm control panel shall provide supervised addressable relays for HVAC controls. The HVAC Engineer shall design and specify startup and testing services to support the interface with the Fire Protection System and ensure that the HVAC is controlled as designed. Alarms shall clearly annunciate location of detected condition within building or by individual enclosure.
- Startup and testing of the Fire Protection System will be provided by the fire protection contractor in accordance with NFPA requirements.
- Fire suppression chemicals shall be selected based on their effectiveness and also based on their long-term availability. Some common fire suppression chemicals such as Novec and FM200 are being phased out and these chemicals shall not be used.

Contractor will provide an Emergency Operations Plan that includes emergency procedures to be followed in case of potentially dangerous conditions, in addition to response conditions similar to a safety data sheet (SDS) that will address response safety concerns and extinguishment.

If lithium-ion batteries are proposed as the storage medium, the Contractor shall provide an optional price for a lithium-ion battery fault detector utilizing an off-gas sensing system that will detect off-gassing at the cell level. This system shall be integrated into the Contractor's control system and/or site controller.

4.16 STATION DC SYSTEM AND UNINTERRUPTIBLE POWER SUPPLY

The Project shall be equipped with a Station DC system and/or, if required, a UPS to power essential functions in the event of a total failure of auxiliary supply systems(s) for orderly shutdown. The provided DC system/UPS shall comply with applicable standards. UPS systems shall not be used to power EMS or communications equipment. Communications and controls equipment shall be supported by a dedicated -48V DC system or redundant converters from the 125V DC plant, depending on system ownership and design. All UPSs and battery chargers must have Modbus Ethernet connections for SCADA monitoring. Protective relays must have a minimum of 8 hours of backup power, directly from batteries without the use of UPSs, converters, or inverters. The relaying DC system shall provide sufficient capacity to adequately trip all necessary devices under worst-case conditions, and to close (including the charging stored-energy mechanisms) all devices necessary to restore the primary voltage system to normal configuration under a worst-case scenario. DC power quality, including excessive ripple and transients, shall not cause protection system misoperations. AC sources to battery chargers powering relays shall be connected upstream of any breakers or switches controlled by the relay, or on an independent circuit.

4.17 ENERGY STORAGE SYSTEM DESIGN

The Contractor shall design, furnish and install an Energy Storage System (ESS) that meets all the requirements of the Agreement, including this Specification.

4.17.1 Cells, Modules, and Enclosure (if applicable)

The energy storage shall consist of cells of proven technology designed for the type of service described herein. For the purposes of this Specification, proven technology shall be defined as cells that have been in successful commercial service in similar type applications for a period of time sufficient to establish a service life and maintenance history. Only cells that are commercially available or for which suitable (not necessarily identical) replacement cells (or modules or strings) can be supplied on short notice throughout the Project life will be allowed. Cells shall be listed to UL 1642 and manufacturer must provide UL certificate prior to shipment to Project Site.

The cells may be supplied as separate, individual units or as a group of cells combined into modules. Modules shall be listed to UL 1973, and UL 9540 and manufacturer must provide UL certificate prior to shipment to Site.

Cell construction and accessories (as applicable) shall be sealed to prevent electrolyte seepage. Post seals shall not transmit stresses between the cover or container and the posts. Cell terminals and interconnects shall have adequate current carrying capacity and shall be designed to withstand short-circuit forces and current generated by the energy storage. Safety features shall be designed into each cell in accordance with UL 1642, UL 1973, and UL 9540.

DC Contactors will disconnect the string from the circuit during high temperature conditions but will reconnect once the cell temperatures reach an acceptable range and other conditions are met allowing reconnection. Labeling of the cell (or modules) shall include manufacturer's name, cell type, nameplate rating and date of manufacture, in fully legible characters or QR code.

Contractor shall provide a list showing all the modules by their unique identification number along with their corresponding physical location within the project site. The unique identification numbers shall correspond to their identification within the Project so to provide easy location of all cells or modules.

The energy storage subsystem and its individual cells shall be designed to withstand seismic events as described herein. The batteries may consist of one or more parallel strings of cells.

DC wiring shall be sized per NEC Article 310 or based on UL standards and be appropriately braced for available fault currents. Protection shall include a DC breaker, fuse or other current- limiting device on the energy storage bus. This protection shall be coordinated with the PCS capabilities and energy storage string protection and shall consider transients and the Inductance/Resistance (L/R) ratio at the relevant areas of the DC system. The Project shall operate no higher than 1,500 Volts DC.

The Contractor shall provide information on the impact that weak or failed cells have on the life and performance of the entire string. The Contractor shall specify critical parameters, such as temperature variation limits between cells of a string. The Contractor shall provide a means of monitoring critical parameters to ensure the limits are being met.

Cells, wiring, and all DC electrical components shall be insulated for 2,000 Volts DC. The Contractor shall have overall responsibility for the safety of the electrical design and installation of the Project. The Project shall include a monitoring/alarm system and/or prescribed maintenance procedures to detect abnormal cell conditions and other conditions that may impair the ability of the Project to meet performance criteria.

The energy storage monitoring system shall be capable of balancing the voltages across cells automatically and independently without any input from the operator or the SEC. Cell monitoring system shall be specified so as to alert the proper personnel in a timely manner that an abnormal cell condition exists or may exist. Abnormal cell conditions shall include over- and under-cell voltage. Temperature is not expected to be monitored at the individual cell level.

The monitoring/alarm system will record data and notify the Owner on the number and general location of failed modules, to expedite maintenance and cell replacement. This data shall be stored in non-volatile memory. Such monitoring/alarm systems shall be integrated into the overall control system.

The Project shall include racks or shall consist of stackable modules of batteries. Aisle spaces shall be set to permit access for equipment needed for easy removal and replacement of failed modules. The lengths and widths of aisles shall conform to all applicable codes, facilitate access by maintenance personnel and be approved by Owner. As applicable, the racks shall provide sufficient clearance between tiers to facilitate required modules maintenance, including modules testing and inspection, and replacement.

Rack-mounted modules shall have all connections located on the front of the enclosure or module. Modules shall not be required to be removed from the racks during regular maintenance. All racks and metallic conductive members of stackable modules shall be solidly grounded. Racks shall be seismically designed based on the requirements of Section 1.4 and shall include means to restrain cell movement during seismic events. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification. Battery equipment shall be NEMA 4X rated.

4.18 MEDIUM VOLTAGE SWITCHGEAR

Metal-enclosed switchgear shall be designed, constructed and tested per IEEE C37.20.3. Metal- clad switchgear shall be designed, constructed and tested per IEEE C37.20.2. Design test results shall be provided to the Owner prior to shipment to the Site.

4.18.1 Field Tests

Contractor shall:

- High-potential test each breaker in accordance with IEEE C37.20.2, Table 1 and part 6.5. Apply test voltage to each pole of the breaker for one minute.
- Test and record contact resistance on each phase from bus to load terminal through a closed breaker.
- Record operation counter reading.
- Perform vacuum integrity test.

The MV switchgear lineup shall be rated to continuously carry nominal Project generation. The lineup shall contain power metering and voltage transformers, fused switches and circuit breakers as necessary to collect and interconnect full plant generation.

Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and a 120/240 Volt Control Power Transformer. The Control Power Transformer shall be fused and able to disconnect. The Control Power Transformer shall be sized to supply the expected continuous load, with approximately 20 percent margin for future load growth. The transformers shall be air-cooled, dry type, with a 150°C rise. Alternatively, site DC backup power may be used.

Switchgear shall be provided with a metering section containing provisions for utility meters. Consistent with the Owner's Electric Distribution System Interconnection Handbook, the metering section includes cable pull sections, bus bars for metering CT/PT insertion; disconnect switches, a metering panel, a meter socket(s), and accommodations for test switches/test blocks. A set of visible disconnect switches, or rack-able breaker, shall be placed directly on the line side of each metering section as well as a set of disconnect switches for the metering PTs (accessible by Owner personnel only) per the Owner's service requirements. In addition, a set of disconnect switches shall be placed on the load side of the meter or at the point of generator output. Disconnect switches and rack-out breakers must have auxilliary contacts for feedback and accommodate locking devices to allow the Owner to lock-out services or net-generation points when necessary.

Protective relaying, metering, and control parameters shall be in accordance with the Owner Electric Distribution System Interconnection Handbook, or applicable transmission interconnection handbook, and reviewed and approved by Owner prior to construction. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.19 INVERTER-CONNECTED 3 PHASE, LIQUID-FILLED OR DRY-TYPE PAD-MOUNT TRANSFORMER

Transformer LV windings shall be per inverter manufacturer's recommendations. Percent impedance voltage shall be according to the inverter manufacturer's recommendation.

Transformers shall be rated for continuous operation of the inverters.

Individual PCS unit step-up transformers shall provide for effective grounding of collectors, regardless of the status of collector breakers or MPT, unless this requirement conflicts with manufacturer recommendations or other requirements. If the PCS's are directly connected to PGE's distribution system, the system MUST be effectively grounded per PGE's Distribution Interconnection Handbook and Medium Voltage Service Requirements. Grounding banks or other options may be considered. The winding configuration on the side toward the PCS is the Contractor's choice.

Liquid filled transformers shall be designed, constructed and tested in conformance with IEEE C57.12.00. Liquid filled transformers shall contain a UL-listed and Factory Mutual Global Approved less-flammable dielectric coolant meeting the requirements of NEC Section 450-23 and the requirements of the National Electrical Safety Code, Section 15. Transformer shall be suitable for indoor or outdoor use as applicable meeting the requirements of NFPA 855. Routine test results shall be provided to the Owner prior to shipment to the Site. All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

For transformers connected to the PCS, the Contractor must provide calculations to demonstrate that the appropriate H-factor or K-factor has been selected.

4.19.1 Field Testing

- Verify nameplate data.
- Coordinate and perform instrument transformer tests on CTs with transformer assembly.
- Verify correct polarity of CTs.
- Winding Tests:
    - Transformer Turns Ratio (TTR) at all no-load taps.
    - Megger winding to ground.
    - Megger winding to winding.
    - Set HV taps at positions determined by Engineer.

- Check and measure equipment ground; ground shall not be more than one ohm.
- Check insulating fluid for clear or pale amber color and report any variance to the Owner. Other colors may indicate contamination from decomposition of insulation, foreign material, carbon, or other substances.
- Test oil samples from each transformer with standard AC test in accordance with ASTM D1816. Notify the Owner if breakdown voltage is less than 30 kV.
- Check liquid level in tanks, and in bushings of the liquid-filled type, and check nitrogen content in inert gas sealed oil preservation systems.
- Check that all valves are open between the transformer tank and cooling equipment.
- Check operation of cooling equipment and cooling controls before energizing transformer.
- Check calibration of pressure relief device, top oil temperature relay, and hot spot temperature relay.
- Pressure test the sudden pressure relay in accordance with the manufacturer's instructions to verify proper operation of device and electrical contacts.
- Alarm Sensor Testing: Induce the device to operate with proper input medium (heat, cooling, pressure, vacuum, voltage, current, etc.) and verify operation of the device at the correct input medium level by monitoring the output contacts with an ohmmeter.
- Annunciator Testing: Check each unit of annunciators by closing or opening the trouble contact and observing operation of control board.
- Check all annunciator lamps, bell cutoff, and reset operation.
- Test all gauges including level, temperature, and pressure gauges.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.

Transformer compartments shall have provisions for padlocking.

- High-voltage compartment shall contain terminations for dead-break elbows, and provisions for entrance of multi-conductor high-voltage, insulated, shielded, power cable. Provide terminations with stress relief devices.
- Transformer shall be equipped with a load-break switch that is oil immersed in transformer tank. The handle shall be located on the exterior tank wall. The switch shall be operable without exposure to any live circuits.

Include accessories as follows:

- Dial-type thermometer with contacts for high-temperature warning and alarm levels
- Magnetic liquid level gauge with alarm contact for low level.
- Pressure/vacuum gauge with alarm contacts.

4.20 DRY TYPE TRANSFORMERS

Dry type transformers shall be designed, constructed and tested in conformance with IEEE C57.12.01. Dry type transformers shall be ventilated dry-type cast coil, Class AA suitable for indoor or outdoor use as applicable. All designs shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.20.1 Field Testing

- Verify nameplate data.
- Winding tests:
    - Transformer Turns Ratio (TTR) at all taps.
    - Megger winding to winding.
    - Megger winding to ground.
- Check equipment ground to assure continuity of connections. Notify the Owner if ground is more than one ohm.
- Check electrical neutral of the transformer. This connection shall be a copper wire connection to the station ground grid.
- Check for proper operation of the winding temperature gauge and cooling fans.
- Set HV taps at positions determined by Engineer.
- Check connections for tightness; clean out dust and other foreign material.

No Load taps labeled per IEEE Std C57.12.34. Full-capacity taps in high-voltage winding:

- Two 2.5% taps above rated voltage.
- Two 2.5% taps below rated voltage.

4.21 RACEWAYS

Contractor to refer to M1-**05-02 for raceways to, from, and within the project's substation,**

4.21.1 Conduit

Contractor shall install all conduit, bends, accessories, fittings, junction boxes, mounting hardware, etc., to produce the complete system.

All cabling shall be installed within conduits. Direct buried underground cable is not allowed at all within the project scope. This includes the BESS yard, the collector substation and any ancillary power or communications connections. This includes power cables, control and communications cables. The only exception is for bare earthing conductors. All other cables including non-metallic (such as fiber optic cable) must be protected with underground conduit.

Conduit shall be sized and installed in accordance with the NEC.

In general areas, Electrical Metallic Tubing can be used for all feeders hidden from view above ceilings and in walls. Electrical Metallic Tubing fittings shall all be compression-type fittings. Set-screw fittings shall not be utilized.

Flexible Metal Conduit or Liquid-tight Flexible Metal Conduit shall be used for connections to motors, transformers, machinery, lighting, and for other equipment subject to vibration.

Rigid Metal Conduit or Intermediate Metal Conduit shall be used as allowed in the NEC.

Plastic conduit, elbows, couplers and other fittings for underground application shall be Schedule 40 PVC, UL or ETL Listed. Fabrication, testing, and installation shall be per NEMA TC-2. Direct buried conductors will not be allowed. Each underground conduit package shall include at least one spare conduit for communications circuits.

Reinforced Thermosetting Resin Conduit (Fiberglass RTRC) conduit, elbows, couplers and other fittings shall be UL or ETL Listed. Fabrication, testing, and installation shall be per NEMA TC-14. Direct buried conductors will not be allowed. Each underground conduit package shall include at least one spare conduit for communications circuits.

Threaded or compression fittings shall be used with all raceway types. Set-screw fittings are not permitted.

All conduits shall be sealed by Owner approved duct seal or foam.

Any conduits intended to contain fiber optic cables will only use large radius factory sweeps, not 90-degree elbows and no more than 270 deg of bend without pull point installed. .

Conduits containing CT or PT conductors for Owner's revenue metering may not use condulets.

4.21.2 Tray

Tray shall be fabricated, tested, and installed per NEMA VE1, NEMA VE2, and the NEC.

Aluminum: Straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063 and all fabricated parts shall be made from Aluminum Association Alloy 5052, in accordance with ASTM B221 and ANSI H35.1.

Pre-galvanized Steel: Straight sections, fitting side rails, rungs, and covers shall be made from steel meeting the minimum mechanical properties and mill galvanized in accordance with ASTM A653 SS, Grade 33, coating designation G90.

Hot-dip Galvanized Steel: Straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A1011 SS, Grade 33 for 14 gauge and heavier, ASTM A1008, Grade 33, Type 2 for 16 gauge and lighter, and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. All hot-dip galvanized after fabrication cable trays and components must be returned to point of manufacture after coating for inspection and removal of all icicles and excess zinc to mitigate damage to cables and/or injury to installers.

Hardware shall be zinc plated in accordance with ASTM B633, SC1. If aluminum cable tray is to be used outdoors, then hardware shall be Type 316 stainless in accordance with ASTM F593 and F-594.

Any exterior tray shall include a cover.

All design shall be in accordance with seismic design requirements as specified in Section 1.4 of this Specification.

4.22 MEDIUM VOLTAGE CABLE

Aluminum or Cooper cable shall be listed to UL 1072 and adhere to NEC requirements.

All medium voltage cables shall be installed within conduits. Direct buried cable applications shall not be used.

Cable furnished shall be suitable for installation in underground ducts and conduits, trays, underground structures, and in outdoor applications for use in suitable supported aerial applications. Cable shall be rated for wet and dry locations.

Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90°C, 140°C for emergency operation condition, and 350°C for short circuit conditions.

Cable shall be tested at the factory and reports delivered to the Owner prior to shipment. Once test results are provided to the Owner, it will have five business days to review testing reports. Contractor shall not ship cables until the Owner approves the test reports or the review period expires.

MV Cable is not allowed to be in the same tray as LV cable

4.22.1 Field Tests

Field high potential test in accordance with NEMA WC 74 (ICEA S-93-639), Table F-1, DC Test Voltages After Installation and NETA ATS, Table 100.6, Medium-Voltage Cables Acceptance Test Values, as follows:

		DC TEST VOLTAGE (KV)	
Rated Voltage (kV, Phase-Phase)	**Conductor Size AWG or kcmil**	**100% Insulation**	**133% Insulation**
2,001 – 5,000	8 – 1,000	28	28
2,001 – 5,000	1,001 – 3,000	28	36
5,001 – 8,000	6 – 1,000	36	44
5,001 – 8,000	1,001 – 3,000	36	44
8,001 – 15,000	2 – 1,000	56	64
8,001 – 15,000	1,001 – 3,000	56	64
15,001 – 25,000	1 – 3,000	80	96
25,001 – 28,000	1 – 3,000	84	100
28,001 – 35,000	1/0 – 3,000	100	124
35,001 – 46,000	4/0 – 3,000	132	172
46,001 – 69,000	4/0 – 3,000	N/A	195

The initially applied DC voltage shall be not greater than 3.0 times the rated AC voltage of the cable.

The duration of DC voltage test shall be 15 minutes.

Do not test cables with an AC test set. Disconnect from all equipment during testing. Testing cable on the reel will not be acceptable. Perform tests after installation, but before final connection to equipment. Make high potential tests between each conductor and shield, or between conductor and armor with shield or armor grounded.

4.23 2.0 KV CABLE

Aluminum or Copper cable shall be listed to UL 44 and adhere to NEC requirements.

Cable shall be rated for use in conduit, underground ducts, and cable tray.

Insulation shall be thermosetting compound with minimum ratings for normal conductor temperatures of 90˚C.

Field Tests

- Megger insulation resistance testing is required prior to energization.

4.23.1 Field Tests

All field tests shall be performed by a certified third-party testing company.

In addition to the tests specified previously, the following tests shall be conducted:

- LV breakers 100A and greater shall be trip tested.

4.24 SUBSTATIONS/SWITCHYARDS

All Project substation design and construction shall comply with M1-05-03 (Substation Design and Construction Specification) and M1-04-02 (General Transformer Specification).

4.25 COMMUNICATION FACILITIES

All Project communications facilities shall comply with M1-05-04 (Communication, SCADA, and Metering Facilities).

APPENDIX A - APPLICABLE STANDARDS AND CODES

Refer to M1-05-06 (Applicable Codes and Standards) for Applicable Codes and Standards the Project must comply to.

APPENDIX B - CONCEPTUAL ONE-LINE DIAGRAM

To be submitted by Contractor at the time of bid submittal.

APPENDIX C - ENERGY STORAGE SYSTEM FACTORY ACCEPTANCE TESTING PROCEDURE

To be submitted by Contractor as an exhibit to the Agreement at the time of contract execution.

APPENDIX D - NOT USED

APPENDIX E - SCADA INTERFACE

The following is information of the data objects being used by the Owner for the purpose of controlling and monitoring storage systems via a communications gateway. Contractor will appropriately deploy or provide an interface which utilizes either DNP3 or Modbus TCP/IP protocol. This interface shall be a port that is integral to the Contractor's SEC or Ethernet switch. Achieving the correct communications protocol by use of a separate communications gateway is not allowed. Additionally, Contractor will implement and make available multiple points lists, including integration of the Owner's Points List as specified below.

Note the alarms list for each system has not been listed, as systems provide a multitude of alarms. In all cases, the complete set of all possible alarms must be conveyed via alarm word points at each level, System and Subsystems (Inverters and Energy Storage Banks Blocks, Modules or Cells). Each bit of a given word must be mapped to a single alarm (fault or warning). Multiple alarms words can be utilized at every level if the number of alarms exceed the number of bits available in a single alarm word.

It should be also noted that any other device capable of generating alarms within the energy storage system should have its alarms passed to the Owner's gateway via the same, single interface described in this section. Any resettable alarms, for any device capable of generating alarms, must be able to be reset via the same, single interface.

Contractor will provide a draft communications and tag name spreadsheet at the 30% design review. The spreadsheet will include an IP address for every addressable device in the project as well as all the Project tag names. Accommodation will be made for Owner addressable devices on the network and Owner's required tags. When the spreadsheet reaches the 90% review level, new tag names shall only be added to the bottom of the list.

Contractor's tag list shall comply with IEEE 1815-2012 and DNP Application Note AN2018-001 Version 2019-01-15.

APPENDIX F - SITE ACCEPTANCE TEST

To be submitted by Contractor as an exhibit to the Agreement at the time of contract execution.

APPENDIX G - APPROVED VENDORS AND SERVICE SUPPLIERS - UNUSED

Refer to section M1-05-07 (Approved Vendors and Service Suppliers for a complete list and specifications regarding Owner approved vendors and service suppliers.

WARRANTY AND PERFORMANCE GUARANTEES

<TBD>