~~M1-01-02~~

APPENDIXppendix M1
ATTACHMENT ttachment 01
Exhibit EXHIBIT 02

(a) ENGINEERING DOCUMENTS, DRAWINGS, AND OTHER DELIVERABLESngineering Documents, Drawings, and Other Deliverables

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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1.0 SubmittalsUBMITTALS

1.1 GeneralENERAL

(a) M1-01-02-Engineering Documents, Drawings, and Other Deliverables

Submittals

Contractor shall supply all drawings, calculations and study reports, plans, specifications, and information to the Owner as part of the scope of Work. Documents and information shall include, but are not limited to, the deliverable list in M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table), in each case for the relevant technology (wind, solar, storage) as applicable. Items marked in the submittals table per the applicable technology (wind, solar, storage) shall be submitted for the Owner's review and approval prior to equipment purchase or construction.

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.

(b)1.2 Document Submittal Requirements

1.1.11.2.1Drawings

Drawings requested by the technical specifications are to be sent as directed therein. Drawings associated with this Contract shall be in the English language and English 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 202414 format including bound files, XREF files, 3D models (saved out to

Autodesk Plant 3D 202214 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.

1.1.21.2.2Design Masters

Contractor shall produce applicable drawings per Owner's standard Design Masters. In addition to standard design requirements, Design Masters dictate scope, size, symbology, nomenclature, and level of information required in a drawing. Contractor to request latest version of Design Masters from Owner prior to initiating any design. Microstation 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
-

1.1.31.2.3Other 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 ([_____ GPDxC@PGN.com] for Owner; [ ] for Contractor) is responsible for assigning the correspondence number and maintaining their respective company transmittal log.

All correspondence shall be distributed electronically.

1.4 Document Review and Approval

The Contractor and Owner shall participate in 30%, 60%, 90%, and Issued for Construction (IFC), 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.

Design level	Description
30% Design	Most, if not all, of the design submittals may be conceptual in nature, without having all exact details defined. 30% design documents shall be provided as a single comprehensive submittal. To the extent possible, all PDFs shall be combined into a single file. For example, 30% design documents level of detail shall include (at minimum): • General arrangement drawings • Single line drawings • Cable and road layouts • Equipment specifications and data sheets Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

60% Design	Design documents intended to represent a reasonably complete design package. Many of the design submittals may be conceptual in nature, without having all exact details defined. 60% design documents shall be provided as a single comprehensive submittal. To the extent possible, all PDFs shall be combined into a single file. For example, 60% design documents level of detail shall include (at minimum): • Design Basis: • Design criteria for each engineering discipline • Contractor's equipment and system designation methods • List of systems and system designations Electrical Package: Schematics and single line drawings detailing: collection system circuits, ac collection system, step-up substation, auxiliary and backup power, MET stations, SCADA/DAS and communications systems, grounding design Wiring details including: specifications for all conductor types, conduit, protective devices and relays; ampacity calculations for all conductors; voltage drop calculations for all conductor runs; wiring details, minimum bend radii, conductor termination details, conduit fittings, etc. Equipment arrangement including conduit entry Supporting documentation for all components including: specification of all requirements for all components, manufacturer's datasheets, installation manuals, operations and maintenance manuals Civil/Structural Package: Calculations in accordance with Specifications • Geotechnical and Hydrology Reports • Structural inspection results/reports • Detailed Site layouts with elevation and topographic detail depicting mounting configurations for all equipment, grading plans, etc. • Foundation designs • Corrosion analysis Refer M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

90% Design	Design documents intended to represent a nearly complete design package for final approvals prior to being issued for permit approval. The 90% design documents shall be provided as a single comprehensive submittal. For example, 90% design documents level of detail shall include (at minimum): • An updated version of the 60% design documents with revisions and additional detail where applicable. • Shall include equipment ratings for all power systems equipment, bus Work, enclosures, protective devices, inverters, etc. • Include all detailed information required to obtain all necessary construction permits from the AHJ • Commissioning Plan • Acceptance Test Plan • Final Energy Estimate Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.
IFC Design	Design documents intended to provide all required information for Subcontractors to construct the Project. IFC design documents shall be provided as a single comprehensive submittal. IFC design documents shall include, at minimum, complete and fully detailed submittals (all applicable drawings and calculations) for the following: • An updated version of the 90% design documents with revisions and additional detail where applicable. • Shall include all completed test results such as pile uplift and lateral resistance testing • Shall address any responses/comments from the AHJ Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.
As-Built (AB) Design Documents	Design documents intended to reflect design changes after the release of the IFC design documents and to document the design of the as-constructed facility. All changes from the IFC documents shall be approved by Owner. Refer to M1-01-02-01 (Engineering Documents, Drawings, and Other Deliverables Table) for specific details.

Where drawings or other documents are required, these documents shall be submitted for review in accordance with the Contractor's drawing submittal schedule. Drawings, specifications, and performance data submitted will be reviewed for adherence to the specification, suitability of design, equipment selection, conformance to design criteria, interfacing data, and for general information

regarding plant operating characteristics. They shall include erection diagrams and other details, such as interface connections. Identification numbers shall be used to identify items on the documents. The sequence of submission of documents shall be such that information is available for an effective review of each document when it is received. Information on drawings shall be checked by the Contractor for accuracy before submission for review.

Owner will update the Master Document List indicating the documents have been reviewed and will email the transmittal to Contractor.

All documents and drawings submitted by Contractor for the first cycle will be reviewed by Owner and returned with comments within 20 Business Days after receipt of the documents or as agreed to between Owner and Contractor. For subsequent review cycles, a 15 Business Day cycle will be followed or as agreed to between Owner and Contractor.

Contractor documents will be considered received after documents have been posted and Owner has received email notification of the posting.

Contractor may request, in writing, expedited review for specific documents and drawings. All requests will be considered.

1.1.41.4.1 Documents / Drawings

Documents, including drawings and electronic models, submitted for review shall be provided in the document's original (native) format with another copy in Adobe Acrobat (.pdf) format. A separate file shall be provided for each unique document number. Multiple sheets with one unique document number can be submitted as one file.

All revisions shall be noted in redline format, where applicable. All drawing revisions shall be clouded.

1.1.51.4.2 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.

1.1.61.4.3 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

1.1.71.4.4 Resubmittal Naming Convention

Resubmittals shall bear the original submittal number and append a number sequentially. Following initial submittal of a document or drawing by Contractor, that document or drawing shall not be resubmitted until Owner comments have been received and incorporated by Contractor.

1.5 Document Transmittals

All correspondence that transmits data, documents, drawings and other information that is considered a contract deliverable (or affects the design, construction, commissioning or operation of the project), is to be transmitted with a transmittal letter. An email with transmittal number in subject line and transmittal letter attached shall be issued to alert Owner that documents/drawings were submitted. Informal correspondence can be transmitted via email or other means and will not require a transmittal number.

Document transmittals shall be in accordance with a specified project schedule.

Submittals shall be in accordance with the following:

- Prints shall be sharp, clear, and suitable for direct reading. The prints shall be black line reproducible on bond paper. Scanned submittals are not permitted.
- Hardcopy documents shall be folded, collated sets mailed flat in a regular mailing envelope. Electronic formats of documents shall be submitted on CD, DVD or electronic storage devicea secure document management system (SharePoint or other as appropriateapproved 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.

1.1.81.5.1 Spare Parts List

The vendor shall provide a recommended Spare Parts list for regular equipment maintenance. The Spare Parts list shall be submitted in Microsoft Excel spreadsheet format.

1. Entries into the electronic parts list shall conform to the following:

Description using the Noun, Modifier, Characteristic 1, Characteristic N, Standards Requirements:

2. Example description of an existing item in PGE's for – 36 IN 5/8 double arming bolt

BOLT, DOUBLE ARMING, 5/8 IN X 36 IN, SQUARE HEAD, WITH 4 SQUARE NUTS, HOT DIP GALVANIZED PER ASTM A153, MADE IN ACCORDANCE WITH ANSI C135.1, PER ASTM A36, 12,400LB MINIMUM TENSILE STRENGTH

Description Element	Identify by answering the question:	Descriptor	Abbreviation Spelled out
Noun	What is it?	BOLT,	
Modifier	What kind?	DOUBLE ARMING,	
Dimensions	What size?	5/8 IN X 36 IN	
Characteristic	What is specific about this item?	SQUARE HEAD	
Characteristic	What is specific about this item?	WITH 4 SQUARE NUTS,	This is more of a requirement
Standard Requirements	Standard to adhere to?	HOT DIP GALVANIZED PER ASTM A153,	Specific Standard
Standard Requirements	Standard to adhere to?	MADE IN ACCORDANCE WITH ANSI C135.1,	Specific Standard
Standard Requirements	Standard to adhere to?	PER ASTM A36,	Specific Standard
Characteristic	What is specific about this item?	MIN TENSILE STRENGTH OF 12.400 LBS	This is more of a requirement

A.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

1.1.91.5.3 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

1.1.101.5.4 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.

1.1.111.5.5 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	^
Plus	+	Backslash	\
Underscore	_	Square Brackets	[ ]
Vertical Bar	|	Round Brackets	( )
Grave Accent	`	Curly Brackets	{ }
Tilde	~		

1.1.121.5.6 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.

1.1.131.5.7 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.

1.1.141.5.8 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.

1.1.151.5.9 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.

1.1.161.5.10 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.

1.1.171.5.11 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~~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.

Project Closeout Documentation

~~1.1.18~~ ~~Project Closeout Documentation~~

~~1.1.19~~1.6

~~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.~~

~~Project Workbook~~

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.

~~At the conclusion of the project and prior to final completion (as defined for the applicable Project type – e.g., Wind Plant Final Completion or Solar Plant Final Completion), the Contractor shall provide the Project Workbook listing the Project documentation as specified below. Project Workbook must contain deliverables included in but not limited to M1-01-02-01 Documents and Deliverables table.~~

~~Potential terms to be used in Project Workbook drop-down menus: Document Types:~~

- ~~Bid Document~~
- ~~Budget~~
- ~~Calculation~~
- ~~Certificate~~

- Collection System
- Construction Work Package
- Contract
- Correspondence
- Design Basis
- Drawing
- Easement
- Estimate
- GIS
- Historical Document
- Incident Reports
- Inspection
- Invoice
- Job Books
- License
- Manual
- Meeting
- Model
- Permit
- Photograph
- Plant Systems
- Presentation
- Plan/Procedure
- Proposal
- Purchase Order
- Regulatory
- Report
- RFI

- RFP
- Schedule
- Schematic
- Site Certificate
- Specification
- Submittal
- Transmittal
- Vendor Information
- Video
- W

elding
Discipline
s:

- Architectural
- Geotechnical
- Civil
- Communication
- Electrical
- Instrumentation & Control
- Mechanical
- Project Management
- Structural
- General
- Environmental
- HVAC
- Plumbing
- Fire

Protection
Document
Status

- 30%, 60%, and 90% design package
- As-Built

- Final Project Document
- Issued For Approval
- Issued For Construction
- Issued For Contract
- Issued For Information
- Issued for Record
- Issued For Review
- Mark-Up
- Redline
- S1 - No Exception taken. Proceed in accordance with Specification.
- S2 - Minor Comments, Revise and Return, Proceed with Construction, or fabrication.
- S3 - Major Comments, Revise and Return, DO NOT proceed with construction or fabrication.
- S4 - For Information Only
- Superseded

~~M1-01-05~~

APPENDIX M1
ATTACHMENT 01
EXHIBIT 05

~~(a)~~ PROJECT MANAGEMENT AND CONTROLS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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1.0 PROJECT CONTROLSROJECT CONTROLS

1.1 GENERALENERAL

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 MEETINGICK-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 CONTROLOCUMENT-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 data room shalldocument management system shall be set up that Contractor and Owner can effectively use.

1.4 PROJECT MANAGEMENT PLANROJECT-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 (initial draft or outline)
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 SCHEDULECHEDULE

The Contractor shall furnish a detailed, minimum level 31, Project Schedule, referred to as "Schedule", for its scope of work utilizing the Critical Path Method (CPM) 8 weeks after Notice to Proceed (NTP). The 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 43 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)

~~1. Project description~~

~~2. Project scope~~

~~a. Provide work breakdown structure (WBS)~~

~~Schedule methodology~~

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.

3.

[1] As defined by AACE International (Association for the Advancement of Cost Engineering)

a. Key milestones and interface milestones

b. Schedule duration basis (i.e. time estimates)

c. Schedule assumptions (e.g. workweek, resources and equipment availability)

d. Project schedule settings (i.e. activity type, duration type, default scheduling options)

e. Summary of activities on the critical path

f. Execution strategy summary for engineering, procurement, construction, installation, testing and commissioning

4.2. Risk and opportunity analysis

a. Summarize key risks that could delay the schedule

b. Summarize strategies to mitigate key risk

5.3. Major constraints

a. Key dates and constraints

6.4. 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. After the Notice to Proceed, Tthe 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 also prepare, after mobilizationduring construction, a rolling three-week Gantt chart schedule, updated weekly, for review at each progress and coordination meeting.

The Contractor shall use Oracle/Primavera P6 scheduling software, or Owner approved alternate software, that is based on network logic and will display the schedule critical path. Schedule performance shall be measured against a fixed project baseline schedule approved by the Owner. Initial schedule submittal and monthly updates shall be in PDF format along with the native file from the scheduling software.

A written schedule analysis shall be prepared as part of the monthly progress reporting. The analysis shall include Schedule status, variance, and constraints, including actual

versus planned progress as indicated by the initial baseline Schedule (and any updates thereof), with reference to the major milestones and Schedule. All Schedules shall be configured to calculate data as follows:

1. Retained logic
2. Total float calculations based upon finished data
3. Contiguous scheduling
4. Start-to-start lags calculated from actual start dates
5. Percent completion and remaining completion not linked

All updates shall comply with the following requirements unless specifically altered in writing from Owner:

1. Contractor's construction schedule shall be carried out to support the overall project Schedule and key milestones identified in the Engineering, Procurement and Construction Contract
2. It shall be the Contractor's responsibility to maintain the progress of its Work in accordance with the Schedule
3. The Contractor, at its option and at no cost to Owner, shall develop additional schedule procedures it deems necessary to control and manage its work

All Schedules required by this specification are subject to Owner review and acceptance. Owner shall reject any Schedule or report that fails to show timely completion of the Work or any contract milestone date, or otherwise indicates unrealistic performance.

1.6 PROJECT STATUS REPORTINGROJECT 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 issued transmittedto the Owner (through an approved document management system) by the 10th 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.

1.6.11.6.2 Earned Value Quantities Report (EVQR)ARNED 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.

1.6.21.6.3 Contract Progress S-CurvesONTRACT 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.

1.6.31.6.4 Contract Overall Man-Hours S-CurvesONTRACT 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.

1.6.41.6.5 Contract Overall Staffing HistogramsONTRACT 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.

1.6.51.6.6 Contract Overall Craft HistoryONTRACT OVERALL CRAFT HISTOGRAMS

This is a bar graph showing the overall weekly craft manpower planned, actually employed, and forecast (if different from plan) broken down into various crafts. This should be derived from the craft hour loaded Schedule. A composite bar graph is acceptable for 1.4.4 and 1.4.5.

1.6.61.6.7 Key Quantity S-CurvesEY 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.

1.6.71.6.8 Contract Deliverables LogONTRACT 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

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. ~~Contractor shall hold a meeting prior to tower erection with Owner.~~

1.8 RISK ASSESSMENTISK 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.

~~M1-01-07~~

APPENDIX ppendix M1
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1.1.1.1 SECURITY AND COMPLIANCEecurity and Compliance

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

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2.0 GENERAL

1.11.0 GENERALSPECIFICATIONS

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.

(a)2.0 SCADA CYBER SECURITYYBER SECURITY

In this section, the term "SCADA" specifically refers to the plant control system. This is not intended to influence or dictate requirements for the substation or Transmission System Operator.

Contractor shall incorporate all security appliances in the collector substation control house and Owner's security center into the SCADA system. SCADA system to be compliant with NERC Critical Infrastructure Protection (CIP) and Owner's internal standards.

In the event Owner is responsible for maintaining the SCADA system and/or performing day- to-day operations at the site, Owner shall have input on whichdetermine 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.

(b)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.

1.1.12.1.1 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.

1.1.22.1.2 Backup and Restoration

Contractor will provide a backup and management system capable of taking operating system backups of all SCADA equipment for the purposes of rapid restoration in the event of a system failure or cyber incident.

Contractor will install backup and restoration software on all Windows and Unix-based devices within the SCADA system. The system must be configured to take automated backups and Contractor must have a procedure for validating backup validity.

Other devices within the SCADA system and support systems (such as networking devices) must be configured to have their configurations, firmware, and any other applicable configuration files pulled automatically on a scheduled basis.

Backups may be stored locally to the site; however, an offsiteline backup must be maintained for incident recovery. The offline offsite backup must be regularly updated, at minimum once per year or after any major software upgrade.

1.1.32.1.3 Security Logging

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

1.1.42.1.4 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.

(c)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.

1.1.52.2.1 Device Management

Contractor will turn over management of all servers, applications, application and networking devices within the SCADA system or any other provided system to the Owner at the conclusion of the SAT. This will include Domain 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.

1.1.62.2.2 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. These accounts must be approved by the Owner.

All accounts within the SCADA systems and support systems will adhere to least privilege permission schemes.

All passwords will adhere to Owner's password policy.

Contractor will notify Owner within 24 hours of an employee, who has access to the SCADA system or any support system, quits or is terminated with cause.

Contractor will notify Owner within 3 days when an employee, who has access to the SCADA system or any support system, retires or changes position, or otherwise no longer needs access to the system.

No local accounts will be enabled within the generation SCADA system.

Contractor will provide all password change procedures/requirements during the site acceptance test.

(d)2.3 SCADA NETWORK DESIGN

1.1.72.3.1 Network Segmentation

The individual SCADA system components must be logically segmented from each other. The following networks shall remain separate where technically feasible:

a.1. Domain Controllers
b.2. SCADA Servers
c.3. User workstations
d.4. Controllers/PLCs
e.5. Auxiliary Systems
f.6. Monitoring systems
g.7. Terminal/VPN Servers
h.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.).

1.1.82.3.2 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.

1.1.92.3.3 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.

1.1.102.3.5 Security Design Workshops

In the event Owner is responsible for maintaining the SCADA system and/or performing day-to-day operations at the site, the following requirements apply. If Owner is not performing any day-to-day maintenance, this section does not apply.

Owner, Contractor, and any pertinent subcontractor (including SCADA Contractor) will have at minimum 5 security design workshops lasting no less than one hour each.

These interactive meetings will allow the Contractor to present the methods used for conforming to the requirements of PGE Cyber Security Policies and Procedures and relevant compliance requirements.

The minimum topics that will be covered in these workshops are:

a.1. Review of requirements
b.2. Presentation of hardware and software products to be used.
c.3. Implementation plan
d.4. Long term system maintenance, operation, and support requirements
e.5. Network design and requirements

(e)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.

(f)2.5 INCIDENT RESPONSE/DISASTER RECOVERYECOVERYY

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.

(g)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.

(h)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 ~~chain link~~ 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.

~~(i)~~

~~1.2~~3.1 GENERAL DESIGN

Contractor shall provide the necessary below grade, and above grade infrastructure for PGE's security system that includes, but is not limited to the following requirements:

A centralized point for the security system and cabling to be housed and secured, either on a concrete foundation and an outdoor rated 4 post communications rack with a heating and cooling system, or adequate wall space of 8' X 8' in an indoor location or an indoor rated 4 post communications rack mounted in a temperature controlled secured room to be provided by Contractor.

All underground conduits provided by the Contractor and will be a minimum of 2" PVC routed from the centralized location to the appropriate point and stubbed up and capped with an 8" X 8" Non-metallic weatherproof enclosure unless otherwise specified.

There will be (1) conduit provided by the Contractor from the centralized area to the closest point on the fence line stubbed up 24" – 30 "for the Fence Detection System. If the Fence line is more than 2,600' in length, another conduit will also be needed and will be identified during design for placement.

There will be (1) conduit provided by the Contractor from the centralized location to wherever the PGE communication equipment is housed to provide a

communications pathway for the security system. If both systems are housed internally inside the same rack or building, it is acceptable to use cable tray if it is available in leu of conduit.

For each gate either personnel or vehicle there will be (1) conduit provided by the Contractor under each gate stubbed up 24”-30” and 12”-20” for both edges of the gate.

For each gate either personnel or vehicle there will be (1) conduit provided by the Contractor for the access control and Intrusion detection systems back to the centralized security location.

There will be enough camera locations within the project’s exterior within the footprint of the fence line to view the entire area without obstruction. This may require the Contractor to install footings and poles. PGE’s preference for these poles is a 16’-20’ non-metallic pole.

All internal locations may have camera coverage depending on type of work location:

a.1. Substation Control House – 100% coverage
b.2. Switchgear building – 100% coverage
c.3. Communications Room – 100% coverage
d.4. Control system Room – 100% coverage
e.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.

(j)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)

(k)3.3 SECURITY FENCING PERIMETER WITH GATES

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

a.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.

b.

c.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)

d.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.

e.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.

f.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

(l)4.0 SUBSTATION PPHYSICAL 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.

(m)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 cContractor 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 Sstandards the cContractor 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. **BAL-005-0.2b R1.1:** Generation facilities must be included within the metered boundaries of a Balancing Authority.

2. **BAL-005-0.2b R12:** Tie Line metering requirements

3.1. **CIP-002-5.1a R1 – BES Cyber System Categorization:** Generator Contractor will provide information, as needed, for Owner will to determine BES impact for of the Project's generation resources and associated Cyber Systems.

2. **CIP-003-9 R2 – Low Impact Cyber Security Plan:** Generator OwnerContractor will coordinate with Owner to implement controls to that ensure low impact BES Cyber Systems are rating is are met for all protected according to applicablethe following sections of Attachment 1 of the Standard, as applicable: CIP requirements.

   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

   1.f. Section 6: Vendor Electronic Remote Access Security Controls

3. **EOP-005-32 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 must be submitted to Peak RC West for approval before any planned BES modification that would change the implementationprior 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*.

   4. **FAC-002**

6. **FAC-008-53 – Facility Ratings:** Contractor to provide facility rating documentation including applicable equipment ratings and facility rating methodology of installed components.

   5.

6. **IRO-010-5/ & TOP-003-6 – Data Specifications & Collection:** There are a number of Contractor will provide, as requestedas needed, information necessary to meet IRO-010 and TOP-003 Ddata Sspecifications. requiring modeling information to be submitted to Peak and others 30 days before the change to the network.

7. **MOD-001-2 R2:** ATCID methodology must take into account generation and transmission additions.

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.~~.~~

10. ~~**PRC-001-1.1 R5:** GOP must notify TOP in advance of changes in generation that could require changes to Protection Systems, and TOP must notify other TOPs of the same.~~

11. **PRC-005-6 R1, R2, R3, R4, and R5 – Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance:** Contractor ~~Generator Owner to~~must 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 ~~relay and battery~~ prior to commercial operation. Also requires in-service checks on protective relays after energization~~. maintenance is a timely manner~~.

~~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.

12.

~~13.~~ **PRC-024-~~2~~ 3 R1 and ~~E~~R2 – Frequency and Voltage Protection Settings~~or PRC-029~~:** 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.

13.

14. **PRC-025-2 R1 – Generator Relay Loadability:** Contractor to verify generator relay settings are in accordance with PRC-025-2~~1~~ – 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.~~>Disturbance Monitoring and Reporting Requirements for Inverter-Based Resources~~. 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.

14.19. **VAR-001-4.1-5 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.

15. **VAR-002-4.1 (allAll) – Generator Operation for Maintaining Network Voltage Schedules:** Contractor to comply with operation and notification requirements during testing and upon initial commercial operation.n

16. **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.**VAR-002-WECC-2 R1:** have AVR in service and in automatic voltage control upon initial commercial operation

20.

17. **VAR-501-WECC-34 : (aAll) – Power System Stabilizer (PSS)**: Contractor to comply with all PSS settings, tsettings. Testing, and operational requirements established by this Standard.

The standards 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.

21.

~~M1-01-09~~

APPENDIXppendix M1
ATTACHMENTttachment 01
EXHIBITxhibit 09

~~(a)~~ PGE CAD AND NUMBERING STANDARDS

[Content to be provided at time of contracting]

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	
0	15Oct21	Issued for Implementation	DNV-GL	DS	CPA	Craig Armstrong
1	14Apr23	Update from 2021 Version	PGE		CPA	Craig Armstrong

~~M1-02-01~~

APPENDIX M1
ATTACHMENT 02
EXHIBIT 01

~~(a)~~ GENERAL CIVIL REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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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. ~~Refer to M4-01-01 (Energy Storage Technical Documents) (the "BESS Spec") for additional requirements applicable to energy storage projects.~~

The geotechnical investigation shall also include an appropriate document review of the regional geological information, including review of geological and geotechnical hazards.

1.2 DOCUMENT REVIEW

1. A document review shall be conducted consisting of available geotechnical and geologic documentation, which at a minimum includes the following:

~~1.~~2. Historical and current aerial imagery
~~2.~~3. Regional geologic maps
~~3.~~4. Soil survey reports
~~4.~~5. Groundwater hydrology data and maps
~~5.~~6. Landslide hazard maps (as applicable)
~~6.~~7. Karst hazard (sinkhole) maps (as applicable)
~~7.~~8. Mine subsidence maps (as applicable)
~~8.~~9. Seismic hazard maps
~~9.~~10. Field photographs
~~10.~~11. Other geologic/geotechnical hazard maps (as applicable)
~~11.~~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). ~~the BESS Spec~~. Sufficient rock core samples shall be obtained from each boring including coring from the point at which competent rock is encountered and until the appropriate boring depth is achieved (at a minimum).

1.5 GROUNDWATER CONSIDERATIONS

Effects of groundwater shall be accounted for in the foundation design and considered in construction of the project. Monitoring of groundwater levels shall be taken over a sufficient period to capture seasonal fluctuation in groundwater levels. The geotechnical engineer shall determine the design groundwater level, which shall take into account seasonal fluctuation as well as long term groundwater levels, and shall account for any buoyancy effects resulting from the design groundwater level.

1.6 GEOTECHNICAL LABORATORY TESTING

Laboratory testing shall be conducted on samples from soil borings gathered during the subsurface exploration program to determine engineering properties for design of the proposed foundations. Laboratory testing on samples collected during the exploration program shall be sufficient to characterize all soil types and layers that may have an impact on the foundation design.

The following tests shall be included, as appropriate, in the soil laboratory testing program to support foundation design and electrical design activities:

1. Moisture content per ASTM D2216 and unit weight per ASTM D7263 (all relatively undisturbed samples).
2. Atterberg Limits per ASTM D4318.
3. Grain size analysis per ASTM D422.
4. Soil shear strength per ASTM 3080 (unconfined, triaxial, direct shear, vane shear, etc.).

5. Consolidation/settlement characteristics per ASTM D2435.

6. Compaction characteristics per ASTM D698 (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). ~~maximum unit weight, optimum moisture content, etc.).~~

6.

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

~~2.0~~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). ~~the BESS Spec.~~

All roads and tracks shall be designed in accordance with the geotechnical engineer's recommendations appropriate to the site, climatic conditions and their period of use. Treatment of cut and fill slopes and installation of drainage shall be in accordance with applicable state and local standards and regulations. All fences, gates, cattleguards, and entrances shall be in accordance with applicable standards and permits, and shall be of a standard type and similar in all aspects with the type commonly used in the local area unless otherwise specified. All fencing and gates shall comply with the requirements set forth in M1-01-07 (Security and Compliance).

Requirements for formwork, reinforcement, concrete works and batching plant, materials strength, shall be in accordance with applicable state and local codes, standards and guidelines, and shall comply with the requirements in M4-01-01 (Energy Storage Technical Documents). ~~BESS Spec~~.

Restoration shall be in accordance with the Permits and planning and environmental constraints on the Project. All crossings shall be in accordance with utility and county agreements.

~~2.1~~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.

~~2.2~~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.

~~2.3~~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.

~~2.4~~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.

~~2.5~~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~~.~~.

~~2.6~~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).

~~2.7~~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

~~2.8~~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.

~~2.9~~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)~~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)~~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)~~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)~~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)~~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)~~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)~~7. Fill all depressions and water pockets caused by construction operations and remove all obstructions within waterways.

~~(8)~~8. Spread surplus fill on-site in areas and depths approved by Owner.

~~(9)~~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)~~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 ~~3.0~~ WILDFIRE MITIGATION PLAN

~~1.0~~3.1 WILDFIRE MITIGATION PLAN PRIOR TO CONSTRUCTION (PRE)

~~1.1~~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.

~~2.1~~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

~~2.0~~ PRIOR TO CONSTRUCTION TASK LIST (PRE)

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

~~1.1~~3.3 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.

~~2.1~~3.4 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.

~~3.0~~ Construction Wildfire Mitigation Plan (CON)

~~1.1~~ 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.

~~2.1~~3.5 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.

~~3.1~~3.6 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.

~~4.1~~3.7 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.

~~5.1~~3.8 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

~~6.1~~3.9 VEGETATION MANAGEMENT

~~6.1.1~~ 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"~~10-12~~ 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.
    - ~~o~~ 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

~~7.1~~4.0 CONSTRUCTION TRAINING(S)

~~7.1.1~~ 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.

~~M1-04-01~~

APPENDIX M1
ATTACHMENT 04
EXHIBIT 01

~~(a)~~ GENERAL ELECTRICAL STUDY REQUIREMENTS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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1.0 SCOPESCOPE

1.1 GENERALENERAL

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 DOCUMENTSTANDARDS 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 REQUIREMENTSOFTWARE AND MODELING REQUIREMENTS

Electrical system studies (3.1— 3.3) shall be performed utilizing Easypower software (Contractor shall confirm acceptable software version with Owner). Systems or components considered as part of the Bulk Electric System (BES) shall be modeled using Aspen OneLiner (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.

10.

~~11.~~ ~~11.~~ 480 V panelboards including all branch circuit information.

11.

~~12.~~ Protective relay make, model, and protective settings.

12.

~~13.~~ DC/UPS chargers, inverter, batteries, disconnects, and panelboards.

13.

~~14.~~ ~~14.~~ 120/208 V panelboards including all branch circuit information.

14.

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 ~~WECC PSCAD transient model~~RMS power flow and transient stability models in PSS/E or PSLF format and

~~16.~~ EMT models in PSCAD format.

3.0 DESIGN CALCULATIONS~~ESIGN CALCULATIONS~~

3.1 ELECTRICAL STUDIES~~LECTRICAL STUDIES~~

3.1.1 Load Flow

Prepare a load flow study in ~~Easypower~~ 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~~3.1.1.2 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.

3.1.33.1.2 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).

3.1.43.1.3 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.

3.1.53.1.4 Short CircuitHORT-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)

3.1.63.1.5 Motor Starting StudyOTOR 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

3.23.1.6 Coordination StudyOORDINATION STUDY

The Contractor shall provide a selective coordination study using either Easypower or 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 settingsl 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

3.33.1.7 Arc Flash Hazard StudyRC FLASH HAZARD STUDY

An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and personal protective equipment that people within the arc flash boundary shall use. These results shall be provided for all reasonably operated enclosures and corresponding buses at major substation equipment, collection system, transformers (including pad-mounted), switchgear (as applicable), operations and maintenance building, and other major components, as applicable.

The Contractor shall perform an Arch Flash Hazard Study in 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. and 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

3.43.1.8 Insulation CoordinationNSULATION COORDINATION

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

3.53.1.9 Transformer SizingRANSFORMER SIZING

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

3.63.1.10 DC/UPS SizingIZING

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

3.73.1.11 Grounding CalculationROUNDING 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.

3. 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.

3.83.1.12 Harmonics StudyARMONICS 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.

3.93.1.13 Subsynchronous Resonance Study (if required)UBSYNCHRONOUS 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).

3.103.1.14Effectively Grounded StudyFFECTIVELY GROUNDED STUDY

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

3.113.1.15Auxiliary Power StudyUXILIARY 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.

3.123.1.16Bus Structural Analysis StudyUS 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.

3.133.1.17Substation Bus Design StudyUBSTATION 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.

3.143.1.18Substation Lightning StudyUBSTATION 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.

3.153.1.19Substation Lighting StudyUBSTATION 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.

3.163.1.20Field Effect StudyIELD 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 4.0 NERC COMPLIANCEOMPLIANCE

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 DELIVERABLESEPORTS AND DELIVERABLES

5.1 APPROVAL REPORTS AND SOFTWARE FILESPPROVAL 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~~INAL 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

~~M1-04-02~~

APPENDIX M1
ATTACHMENT 04
EXHIBIT 02

GENERALeneral TRANSFORMERransformer SPECIFICATIONpecification

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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1.1.0 GENERAL

1.1. INTRODUCTION

1.1.1. 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.

2.2.0 POWER TRANFOMERS

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

2.1.1.1. • SDS-M010 (in Section M1-04-02-01 via secure website)

2.1.1.2. • SDS-M011 (in Section M1-04-02-02 via secure website)

2.1.2.

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).

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

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

2.3.1. • (HV, MV) Continuous MVA Ratings: 96/128/160MVA (full tapping range)

2.3.2. • Tertiary winding MVA Ratings: The tertiary windings shall be rated at least 35% of the main HV & MV windings' ONAN / ONAF / ONAF MVA ratings.

2.3.3. • Number of Windings: 2 (HV, MV) + 1 (13.8kV) Stabilizing TV Winding

2.3.4. • Winding Connection (HV/LV/TV): Ynynd1 (Wye-gnd/Wye-gnd/Delta corner ground)

3.3.0 WIND TURBINE PAD-MOUNTED STEP-UP TRANSFORMERS

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

4.4.0 GROUND REFERENCE TRANSFORMERS (GRT)

4.1. 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.

~~M1-05-02~~

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		Issued for Implementation				

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1.0 SECTION 1.0 GENERAL INFORMATION

1.0 GENERAL

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.

2.01.1 OVERALL SCOPE OF ENGINEERING

A. 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 *Exhibit GG*XXXX *XXXX* and a list of Industry Standards is listed below in *Section 1.1*.

B. 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.

C. All engineering drawings shall be developed in AutoCAD using Owner provided Drafting Standards (*Exhibit GG.2*).

D. 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.

E. 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.

END OF SECTION

1.2 ~~SECTION 1.1 STANDARDS AND APPLICABLE LAWS~~STANDARDS AND APPLICABLE LAWS

~~1.0 General~~

1.01.2.1 PGE Standards, Practices, and Design Masters

~~A.~~ 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.

2.01.2.2 Industry Standards and Applicable Laws

~~A.~~ 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

Reference Abbreviation	Name
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.

3.01.2.3 List of Standards

A. 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

Standard Reference	Title
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
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**

Standard Reference	Title
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

~~END OF SECTION~~

1.3 SECTION 1.3 DESIGN SOFTWAREESIGN SOFTWARE

1.0 General

2.0 Design Software

A. 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
Scheduling	Primavera P6
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

END OF SECTION

1.4 SECTION 1.4 SUBMITTAL REQUIREMENTSUBMITTAL REQUIREMENTS

1.0 General

A. Contractor shall follow the Owner's submittal process described in Substation Engineering Practice SEP-10.01M1-01-02.

2.01.4.1 Record Drawings

A. 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.

A. 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 qualityquality, 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.

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

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

D. 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.

END OF SECTION

1.0 SECTION 2.0 MAJOR SUBSTATION EQUIPMENT

2.0 MAJOR SUBSTATION EQUIPMENT

1.02.1 GENERAL

A. PGE shall specify and procure the following major substation equipment. Refer to the equipment specifications (*Exhibit DD.2*) for additional details this equipment

Equipment	Qty.
Gas Insulated Switchgear	1
28MVA Transformer	2

B. All major Substation equipment shall be specified and procured by ContractorContractor shall specify and procure all major substation equipment except for the equipment listed aboveusing PGE approved Vendors. Owner has provided preliminary Equipment Specifications for the Major Equipment (**Exhibit DD.2**). Contractor shall verify accuracy, complete missing information, and submit to Owner for final Approval.

C. For Owner Equipment Supplier List of Major Equipment, refer to ***Exhibit DD.1***. **Supplier List should be followed unless prior approval has been received from the Owner.**

D. Contractor shall review each **Major Equipment manufacturer's design, including items procured by the Owner, and provide comments and recommendations to ensure apparatus conforms to this specification and 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.**

E. The Owner reserves the right to attend all FAT **for Contractor procured equipment and Contractor shall coordinate schedules with the Owner.**

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

2.1.1 Transformers

Transformers shall comply with Owner **Specification SDS-M010M1-04-023.**

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 votalgevoltage **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 MedumMedium Voltage Circuit Breakers

High votalgevoltage **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 c**ompartment shall contain the protective relays, controls, and meters for the circuit breaker.**

2.1.3 Circuit Switchers

~~High Voltage Circuit Switchers~~

High voltage circuit switch**ers 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 trans~~-~~**formers shall comply with Owner provided detailed ~~S~~specifications and ratings ~~SDS-M0XX~~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 1.41.4*.

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

2.1.8 Reactors

~~1.0 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).

~~END OF SECTION~~

2.2 SECTION 2.1 SUBSTATION ELECTRICAL ARRANGEMENT

1.0 **General**

2.0 **Substation Electrical Arrangement**

A. The Contractor shall be responsible for the completion of the Substation design based on the performance standards laid out in the RFP. Conceptual design created General Layout drawing 1000-1 (*Exhibit AA.1*). 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. Contractor shall optimize the layout design per the Major Equipment being installed, but all changes to the Conceptual design shall require Approval by Owner.

B. The electrical clearances for the air-insulated equipment within the Substation shall comply with Owner Standard S-130-04 (*Exhibit GG.2*) and IEEE 1427.

C. 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. (*Exhibit GG.2*).**

D. In addition to the requirements in the previous paragraphPart C, any overhead bus tie between Switchgear shall allow for drive access of Owner vehicles for maintenance. There shall be a Conceptual design General Layout purposely provides 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.

E. 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.**

F. 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. The phasing for this Project is defined on the Conceptual design drawing 1100-1 (*Exhibit AA.1*). Contractor shall coordinate and ensure incoming transmission lines are the proper phasing.**

END OF SECTION

2.3 SECTION 2.2 RIGID BUS AND CONDUCTOR

1.0 **General**

2.0 **Rigid Bus and Conductor**

A. 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 (*Exhibit GG.2*). Refer to the Preliminary General Layout 1000-1 in *Exhibit AA.1*.

B. 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 (*Exhibit BB.4*). 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*.

C. 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. Refer to *Exhibit GG.4* for Owner Approved Substation Materials.

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

E. 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.

~~F.~~ Design of overhead strain bus exceeding 40' in length shall be based on Owner Standard S-130-10 ~~(*Exhibit GG.2*)~~. 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. ~~It is not expected overhead strain bus shall be used for this Project.~~

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

~~G.~~ 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.

~~H.~~ 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 ~~(*Exhibit GG.2*)~~.

~~—~~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

~~I.~~ 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).

~~J.~~ 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.

~~K.~~ For bolting hardware requirements, refer to MSTR-9090-1 ~~(*Exhibit GG.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.

~~L.~~ Contractor shall provide electrical connection details for all rigid bus, conductor, and major electrical equipment connections within the Substation Above Grade drawing set. ~~Engineering References for typically used major electrical equipment have been provided by the Owner. Any required electrical connection details not provided by Owner shall be created by the Contractor.~~

~~M. REFER TO CONSTRUCTION SPECIFICATION SECTION 6100 (*EXHIBIT HH*) FOR SPECIFICATIONS CONCERNING THE RECEIPT OF DELIVERY, HANDLING, AND INSTALLATION OF RIGID BUS AND CONDUCTORS.~~

~~END OF SECTION~~

2.4 SECTION 2.3 CONDUIT AND VAULTS WITHIN SUBSTATION

1.0 **General**

2.0 **Conduits and Trench**

A. 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.A Conduit Plan, 1300-1, has been provided as part of the Conceptual Design (*Exhibit AA.2*) that shall be used as the starting point for the raceway design.**

B. 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. Refer to 1001-1 (*Exhibit AA.1*) for the Conceptual Future General Layout drawing, if applicable.**

C. 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

D. 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.**

~~E.~~ 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.**

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

~~G.~~ Contractor shall be responsible for supplying conduit with pull rop or mule tape for Owner's Communications and Security designs within the Substation. ~~The preliminary requirements are provided in the Conceptual Conduit Plan, 1300-1 (*Exhibit AA.2*).~~

~~H.~~ 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 76.1* for more details.

~~I.~~ 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.**

~~J.~~ 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

~~K.~~ 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 ~~multiple installations of innerduct~~3-1" innerducts if doing so does not exceed Industry Standard installation practices.

~~L.~~ 13 kV **and 34.5 kV Underground Distribution Duct Banks**

- Refer to ***Section 2.5*** **for details**

M. Contractor shall provide conduit details for all **Major Equipment.** **Engineering References for typically used Major Equipment have been provided by the Owner.** **Any required conduit details not provided by Owner shall be created by the Contractor.**

N. Contractor shall comply with Owner Construction Specification Section 6060 (*Exhibit HH*) for the furnishing of all labor, tools, and equipment necessary to install the control/power cable conduit system in the Substation.

END OF SECTION

2.5 SECTION 2.4 SUBSTATION GROUNDING

1.0 **General**

2.0 **Grounding**

A. 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. (*Exhibit GG.2*). Contractor shall also evaluate the impact of the ground grid design on any other nearby utilities such as sewer and water.

Fault data are provided to support the analysis and may include soil resistivity measurements (Exhibit GG.X). Contractor to verify any resistivity measurements provided are accurate for the needs of the project. If the Contractor shall be responsible for performings 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. shall be followed.

B. Contractor Shall perform a 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.

C. 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.

D. Contractor shall provide grounding details for all Major equipment within the Substation Design Drawings. Refer to the Design Masters for Owner grounding detail standards (Exhibit GG.1). Any required grounding connection details not provided by Owner shall be created by the Contractor.

~~END OF SECTION~~

2.6 SECTION 2.5 13 KV AND 34.5 KV UNDERGROUND DISTRIBUTION CABLES

1.0 General

2.0 Medium Voltage Cables and Duct Banks

A. Contractor shall be responsible for designing and installing the conduits and duct banks for the Medium Voltage (MV) underground cables within the substation. Reference the General Layout and Conduit Plan provided in the Conceptual Design for the preliminary design (*Exhibits AA.1 & AA.2*). 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 for Owner use.

B. The Conceptual Design includes the preliminary routing plan for the feeders leaving the Substation. Contractor shall coordinate with Owner for updating the Substation conduit design for the finalized distribution routing plan.

C. 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.

D. Conduit fill shall meet the recommendations of IEEE 525.

E. Owner shall supply and pull all MV cables that originate outside of the Substation to the appropriate equipment, most notably the distribution feeder cables. Contractor shall pull and supply cable for the Capacitor Banks and Station Service from switchgear.

F. 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.

~~G. Unless otherwise specified, all Medium Voltage cable for this Project shall be rated for 15 kV and operated at 13.2 kV (13 kV nominal).~~

~~H. Minimum underground 13 kV Station Service cable shall be #2 Aluminum.~~

~~I. Minimum underground 13 kV Capacitor Bank cable shall be 1-750 kcmil Aluminum per phase.~~

~~J. Minimum underground 13kV Distribution Feeder cable shall be minimum 2-750 kcmil Aluminum per phase, but selection shall be determined by Owner. Contractor shall coordinate with Owner for final cable selection.~~

~~K.~~ Medium Voltage cables and terminations shall comply with Owner Standards LD32020 ~~,and~~ LD32021, LD32023, and LD32024 ~~(*Exhibit GG.3*)~~.

~~END OF SECTION~~

2.7 SECTION 2.6 UNDERGROUND MEDIUM VOLTAGE SWITCHGEAR BUS TIE

1.0 **General**

2.0 **Scope of Work**

A. **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 this 13 kVthe Underground Bus Tie. Substation design contractorContractor shall provide a proof of concept design that adequately demonstrates that any future 13 kV Underground Bus Tie between switchgear can be installed without the use of extraordinary construction methods.**

B. 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 360% and 90% Below Grade Design. Analysis report shall provide thermal concrete and thermal backfill specifications if applicable.

C. Contractor shall provide all engineering drawings and supporting calculations required to adequately demonstrate the construction of the 13 kV Underground Bus Tie and ability to meet all specification requirements. These shall include but are not limited to:

- Above Grade **Elevations and Construction Details**
- 13 kV **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
- 13 kV **Medium Voltage Cable Material specification**

~~END OF SECTION~~

2.8 SECTION 2.7 ANIMAL MITIGATION

1.0 General

2.0 Animal Mitigation

A. **Contractor shall install animal mitigation using Owner Approved materials (*Exhibit GG.4*) per Owner Standard S-130-50**

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

C. The metalclad switchgear Equipment Specification (Exhibit DD.2) includes Owner standard animal mitigation requirements for the rooftop supports and entrance bushings. These ratings shall not be modified by the Contractor.

~~END OF SECTION~~

2.9 SECTION 2.8 LIGHTNING PROTECTION

1.0 **General**

2.0 **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.

A.

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

- (a) The overall height of the masts above grade shall be determined from the direct stroke protection study, as defined by requirements set forth in M1-04-01 (General Electrical Study Requirements.
- (b) Masts shall have a single uniform taper from top to bottom.
- (c)Each mast shall be capped with a suitable finial.
- (d) Each mast shall be equipped with an internal vibration dampening device.
- (e) The design of masts shall have a safety factor of two (2) based on the allowable

~~END OF SECTION~~

3.0 ~~SECTION 3.0~~ SURVEY

~~1.0 GENERAL~~

~~2.0~~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 delim**ited ASCII text format, suitable for upload into CAD software.**

~~A. A SURVEY HAS BEEN COMPLETED AND PROVIDED BY OWNER. CONTRACTOR SHALL VERIFY ADEQUACY AND ACQUIRE ADDITIONAL INFORMATION AS NECESSARY WITH OWNER APPROVAL. THE CONTRACTOR IS RESPONSIBLE FOR LOCATING AND PROTECTING ANY AND ALL BELOW GRADE UTILITIES WITHIN THE PROPERTY BOUNDARY DURING CONSTRUCTION.~~

~~END OF SECTION~~

3.2 ~~SECTION 3.1~~ GEOTECHNICAL INVESTIGATION

~~1.0 General~~

~~2.0 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

~~A.~~ 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.~~A Geotechnical Report, Soil Thermal Analysis Report, and Soil Electrical Resistivity measurements have been completed by Owner and provided in Studies and Site Data. Contractor shall verify adequacy and acquire additional information as necessary upon Owner Approval.~~

END OF SECTION

3.3 SECTION 3.2 PERMITTING

1.0 General

2.0 Permitting

A. **Contractor provided permits and other permitting requirements are described in in the Administrative Requirements Specification.**

B. **When requested, Contractor shall provide all supporting information necessary for the Owner to obtain the federal, state, and/or local government permits and/or approvals required to complete the Project.**

C. The site development design shall comply with the local governing jurisdiction's Land Use Permitpermitting requirements.

END OF SECTION

3.4 SECTION 3.3 SITE DEVELOPMENT

1.0 General

2.0 Site Development

A. 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).

B. 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.

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

~~D.~~ 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.

~~E.~~

~~END OF SECTION~~

3.5 SECTION 3.4 YARD SURFACING

1.0 **General**

2.0 **Yard Rock Surfacing**

A. 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.

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

C. 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.

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

E. 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.

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

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

END OF SECTION

3.6 SECTION 3.5 FENCE AND GATES

1.0 General

2.03.6.1 Fence

A. 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. See preliminary Fence Plan in the Conceptual Design.

B. 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.

3.03.6.2 Gate

A. Gates shall be 30’ wide. Reference the preliminary Fence Plan in the Conceptual Design. 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.

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

4.03.6.3 Gate and Fence Signs

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

END OF SECTION

3.7 ~~SECTION 3.6~~ FOUNDATIONS

~~1.0 General~~

~~2.0 Foundations~~

~~A.~~ 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.

~~B.~~ 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.

~~C.~~ 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.

~~D.~~ 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

~~E.~~ 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.

~~F.~~ 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*.

~~G.~~ Each unique foundation shall have a detail(s) and assigned drawing numbers following the guidelines in MSTR-0000-2 ~~(*Exhibit GG.1*).~~

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

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

~~J.~~ 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*.

~~K.~~ 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.

~~END OF SECTION~~

3.8 SECTION 3.7 STRUCTURAL

1.0 **General**

2.0 **Structural**

A. 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.

B. 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.

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

D. 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.

E. 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 (*Exhibit GG.1*).

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

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

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

END OF SECTION

3.9 SECTION 3.8 OIL CONTAINMENT

1.0 General

2.0 Oil Containment

A. 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.

B. 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.

C. 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.

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

E. 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).

END OF SECTION

3.10 SECTION 3.9 FIRE WALLS

1.0 **General**

2.0 **Fire Walls**

A. 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.

B. 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.

C. 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).

D. 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.

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

F. 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.

END OF SECTION

4.0 ~~SECTION 4.0~~ STATION SERVICE

~~1.0 GENERAL~~

~~2.0~~4.1 AC STATION SERVICE

~~A.~~ 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. ~~A Preliminary Station Service One Line Schematic, 4500-1, has been included in the Conceptual Design (*Exhibit AA.3*). All station service equipment ratings shall be considered preliminary and must be validated by the Contractor.~~**

~~B.~~ 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 ~~3~~60% and 90% Control and Protection design.**

~~C.~~ 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.**

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

~~E.~~ The **station service transformer for the Normal source shall be one of the following:**

- ~~-~~A single phase, ~~7200-~~120/240V secondary, transformer sourced from the main distribution bus~~ of the switchgear that will be nearest the control enclosure, or the switchgear installed and energized first when there is more than one phase to the construction sequence~~. 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 ~~must~~ shall be a padmount ~~and~~ 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, ~~13,200-~~120/240 V secondary, double bushing, overhead transformer can sourced from the tertiary of one of the ~~320 MVA bulk~~ power transformers.

F. The station service transformer for the Alternate source shall be single phase, 7200-120/240V 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. Medium voltage cable shall be supplied and pulled by Owner but terminations inside the Substation fence shall be performed by the Contractor. Contractor is responsible for all other Alternate station service materials and connections inside the Substation.

G. Padmount**Pad mount station service transformers shall meet the Owner Specification L10003 (*Exhibit DD.2*) except that the primary terminals shall not include loop-feed terminations as referenced in the specification Part 4.4.1.**

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

I. 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 SDS-M026 (*Exhibit DD.2*).**

Power conductor size and ampacity shall be coordinated with circuit protection devices. Conductor size shall be determined for 125% of connected load at the design basis maximum outdoor ambient temperature. Within the Project Substation, below-grade power cable conductor size shall be determined in accordance with the methods in IEEE 835.

J. 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 and in the Control Enclosure Equipment Specifications SDS-M025 and SDS-M026 (Exhibit DD.2). Contractor shall verify all equipment ratings and adjust the Equipment Specification as needed for a functional AC distribution system.

K. AC **panelboards shall be provided by the Control Enclosure and switchgear Vendors. 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 (*Exhibit GG.1*) for typical layout drawing.**

L. 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 m**ay be top fed or bottom fed**
- Shall be accessible to cable tray system
- NEMA 1

~~M.~~ ~~This Project shall have **no fewer than three AC panelboards in the Control Enclosure and one AC panelboard per switchgear. Each panelboard shall be at least 42 poles.**~~ **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.**

~~N.~~ 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~~Enclosure but may use the switchgear Vendor provided panelboard drawings. The drawing number assigned for the AC panelboards are described in MSTR-0000-1 ~~(*Exhibit GG.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.**

~~O.~~

~~P.~~ 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 ~~bulk~~ power transformer, this would then be shown on a Miscellaneous Three Line Wiring Diagram instead (see MSTR-6800-1 ~~*Exhibit GG.1*~~).**

~~Q.~~ 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.**

R. 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.**

S. **ACP2 IS TYPICALLY USED FOR CONTROL ENCLOSURE AC LOADS AND YARD LIGHTING SO A THIRD PANELBOARD IS NEEDED FOR THE OTHER SUBSTATION AC LOADS. HOWEVER, THIS VARIES FROM PROJECT TO PROJECT AND THE CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING AC BRANCH CIRCUIT ASSIGNMENTS WITH THE CONTROL ENCLOSURE VENDOR.**

3.04.2 DC STATION SERVICE

A. 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.**

B. Contractor shall provide Owner calculations following the methods described in **the latest version of IEEE 485 and Owner Standard S-135-10 (*Exhibit GG.1*) that demonstrates adequate battery sizing, taking into account all planned future loads. These calculations shall be submitted for review with the 630% and 90% Control and Protection design. The calculations shall utilize the PGE standard report format, DC Battery Sizing Calculation Template (*Exhibit GG.2*).**

C. DC Station Service System shall be **ungrounded.**

D. Contractor shall determine the **Substation DC load and install all equipment and materials necessary to complete the DC station service. A Station Service One Line Schematic, 4500-1, has been included in the Conceptual Design (*Exhibit AA.3*).**

E. 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 SDS-M025 and SDS-M026 (*Exhibit DD.2*). Contractor shall verify all equipment ratings and adjust equipment specifications as needed for a functional DC distribution system.**

F. 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. Refer to the DC Battery Sizing Calculation Template (*Exhibit GG.2*) for how to size the battery chargers. For additional details, refer to Owner Standard S-135-10 (*Exhibit GG.2*).**

~~G.~~ Battery bank **rack shall meet the seismic requirements specified in Owner Standard S-135-10 (*~~Exhibit GG.2~~*).**

~~H.~~ 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.**

~~I.~~ 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.** ~~Refer to the conceptual design Control Enclosure Plan View 4700-1 (*Exhibit AA.3*).~~

~~J.~~ Contractor shall provide a **battery trailer connection panel for each battery bank.** ~~This shall be connected as shown in the conceptual design Station Service One Line Schematic (*Exhibit AA.3*).~~

~~K.~~ This Project shall have a **Group A, B, and C DC distribution and protection system (see also Owner Standard S-135-10~~, *~~Exhibit GG.2~~*~~).~~**

- Group A
    - ~~o~~ DC **loads connected to Primary battery bank**
    - ~~o~~ Transmission **breaker Trip Coil 1/Close Coil circuits**
    - ~~o~~ Primary **protective relays for transmission system**
    - ~~o~~ Every re**lay scheme**~~, and~~ **breaker scheme**, and Comm racks, if applicable, **shall be connected to its own 30A DC branch circuit breaker**
    - ~~o~~ DC **Panelboards shall be named DCP21 (Main), DCP22, etc.**
    - ~~o~~ If **possible, locate the breaker control branch circuits on a separate panelboard from the protective relay branch circuits**
- Group B
    - ~~o~~ DC Loads connected to Backup **battery bank**
    - ~~o~~ Transmission **breaker Trip Coil 2 circuits**
    - ~~o~~ Backup **protectives relay for transmission system**
    - ~~o~~ Every relay scheme and breaker scheme shall be connected to **its own 30A DC branch circuit breaker**
    - ~~o~~ DC **Panelboards shall be named DCP41 (Main), DCP42, etc.**
    - ~~o~~ If possible, locate the **breaker control branch circuits on a separate panelboard from the protective relay branch circuits**
- Group **C**
    - ~~o~~ DC loads that can be transferred between either **battery bank via DC** ~~automatic~~ **transfer switch.**
    - ~~o~~ 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**

L. 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 (*Exhibit GG.1*) for typical panelboard layout.**

M. 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

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

O. 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.

P.

Q. 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. Wiring diagram for the DC ATS shall be shown on the DCP61 wiring diagram.

~~4.0~~4.3 STATION SERVICE ONE LINE SCHEMATIC

~~A.~~ Contractor shall be responsible for developing a Station Service One Line Schematic. ~~A preliminary version is provided by the Owner as part of the Conceptual Design 4500-1 (*Exhibit AA.3*).~~ 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.

~~**END OF SECTION**~~

SECTION 4.1 YARD LIGHTING AND RECEPTACLES

1.0 GENERAL

2.04.4 YARD LIGHTING

A. Contractor **shall develop a Lighting Plan using Visual™ software based on the General Layout and Owner Standard S-137-10 (*Exhibit GG.1*). 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.**

B. Substation **lights shall only be LED.**

C. 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, *Exhibit GG.1*) 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.**

D. Contractor shall comply with **the governing entity regarding requirements for Substation Lighting. For additional details, refer to the permitting requirements (*Exhibit E.2*).**

E. 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.**

F. 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 (*Exhibit GG.1*).**

~~G.~~ 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.** ~~**Owner shall be responsible for installation of wiring from the Security System to the lighting control cabinet.**~~ **Contractor shall ensure the lighting control cabinet allows for ease of installation of security wiring.**

~~H.~~ Cables for LED luminaire power supply shall be shielded and grounded at both ends. For more details refer to Owner **Standard S-144-20** ~~***(Exhibit GG.2)***~~**.**

~~3.0~~4.5 YARD RECEPTACLES

~~A.~~ 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.**

~~B.~~ Receptacle shall be rate**d for outdoor use and have a weather proof cover.**

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

~~**END OF SECTION**~~

SECTION 4.2 CONTROL ENCLOSURE

1.0 GENERAL

2.0 CONTROL ENCLOSURE

A. THE CONTROL ENCLOSURE SHALL BE A PREFABRICATED ENCLOSURE FOLLOWING THE SPECIFICATION REQUIREMENTS IN SDS-M025 AND SDS-M026 (*EXHIBIT DD.2*). CONTRACTOR SHALL VERIFY ACCURACY, COMPLETE MISSING INFORMATION, AND SUBMIT TO OWNER FOR FINAL APPROVAL.

B. A PRELIMINARY LAYOUT IS PROVIDED IN THE CONCEPTUAL DESIGN (*EXHIBIT AA.3*). THE PRELIMINARY LAYOUT INDICATES THE MAJOR PROTECTION AND STATION SERVICE EQUIPMENT, BUT REFER TO THE EQUIPMENT SPECIFICATION FOR ADDITIONAL DETAILS. CONTROL ENCLOSURE DESIGN SHALL BE CONSISTENT WITH THE STATION SERVICE ONE LINE SCHEMATIC AND PANELBOARD WIRING DIAGRAMS. FINAL VENDOR DESIGN SHALL BE APPROVED BY OWNER.

C. THE RELAY RACKS SHALL BE SHIPPED WITH THE CONTROL ENCLOSURE AND INSTALLED BY THE VENDOR. COMMUNICATION RACKS WILL BE INSTALLED AND PROVIDED BY PGE COMMUNICATIONS.

D. 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.

E. CONTRACTOR SHALL BE RESPONSIBLE FOR ACQUIRING ALL CONTROL ENCLOSURE PERMITS. REFER TO THE ADMINISTRATIVE REQUIREMENTS SPECIFICATION AND

EXHIBIT F FOR ADDITIONAL DETAILS.

F. CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATING DELIVERY AND INSTALLATION OF THE CONTROL ENCLOSURE PER THE INSTRUCTIONS OF THE VENDOR.

G. CONTROL ENCLOSURE ANCHORS SHALL MEET THE MINIMUM VENDOR SPECIFICATIONS. ANCHOR PLATES SHALL BE WELDED TO THE STEEL CHANNEL. THE MINIMUM WELD FOR EACH ANCHOR PLATE SHALL BE 3" OF ¼" FILLET WELD.

HG. FOR DRAWING SUBMITTAL REQUIREMENTS, REFER TO *SECTION 1.4*.

END OF SECTION

5.0 SECTION 5.0 CONTROL AND PROTECTION SCHEMATICS AND WIRING

1.05.1 GENERAL

A. Control and Protection selection is the responsibility of the Owner. Alternatives proposed by the Contractor must be Approved by Owner in writing. Owner has provided a Conceptual Design (**Exhibit AA.3**) that shall be used as the basis for the Control & Protection design. These drawings are based on Owner standards and practices for the selected Control and Protection schemes as referenced herein. It shall be the Contractor's responsibility for verifying the accuracy of all drawings and material specifications provided by the Owner. Contractor shall modify, expand, and customize the Owner provided drawings to accurately represent exclusively the Control and Protection of this Project. Material substitutions for Owner provided relay rack materials are not permitted without prior Approval from Owner.

B. Contractor shall be responsible for developing the Control and Protection schematic and wiring design for the Substation based on the Owner provided Conceptual Design (Exhibit AA.3), Relay Configuration Summaries (Exhibit AA.3), and Design Masters (Exhibit GG.1) unless otherwise stated in this specification. For any questions or conflicts, Contractor shall request clarification from Owner.

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

~~D.~~ 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.

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

~~F.~~ Vendor Drawings**:**

- Vendor supplied drawings shall not be used in the One Line Sch**ematic, 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 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.

2.05.3.1 Control and Protection Design Requirements

5.3.1.1 A. One Line Schematic

Contractor **shall review preliminaryprepare the One Line Schematic provided in the Conceptual Designper Owner Design Master (*Exhibit AA.3*) to ensure scheme coordinates effectively with the system and equipment. Contractor shall also ensure One Line Schematic is consistent with Owner provided Operating One Line. Contractor will be responsible for making all modifications to the One Line Schematic during detailed design. Contractor shall inform Owner of any changes in the One Line Schematic that impacts the Operating One Line.**

- 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 (*Exhibit GG.2*). Note – these letter exclusions shall also be followed when developing wiring tags.**

5.3.1.2 B. 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 (*Exhibit GG.1*) 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 C. Protective Relaying Control Schematics

- Contractor **shall prepare the protective relaying control schematics per Owner Design Master (*Exhibit GG.1*) standards to the extent applicable and possible. and Relay Configuration Summaries (*Exhibit AA.3*). For any conflicts between these documents Contractor shall notify the Owner for clarification.**

- ~~13 kV~~ **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 ~~D.~~ Breaker Control Schematics and Wiring

- Contractor shall review all ~~transformer~~ breaker **Vendor supplied drawings and verify accuracy of drawings and accordance with the Control and Protection design for this Project. In general, all** breaker~~transformer~~ **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 ~~E.~~ 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.** ~~In general, all~~**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 equip**ment mounted on the transformer with communication over fiber.** ~~Refer to the preliminary Network Block Diagram in the Conceptual Design for additional details (*Exhibit AA.3*).~~ **For standard** ~~distribution~~ **transformer alarm and tripping functions, refer to the Owner** ~~Design Masters (*Exhibit GG.1*) and Conceptual Design.~~Standard S-110-30.

5.3.1.6 ~~F. 13 kV~~ Capacitor Bank Switch Control Schematics and Wiring

- The Capacitor Bank protective relaying schematics shall be provided by the ~~switchgear~~ **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 ~~G.~~ SCADA

- Contractor shall ~~use~~ prepare **the Network Block Diagram** ~~provided by the~~per **Owner** ~~in the Conceptual Design (*Exhibit AA.3*)~~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 630% 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 630% 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 ~~(*Exhibit GG.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 ~~(*Exhibit GG.1*)~~.**

- 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 ~~H.~~ Station Service One Line Schematic

- Refer to ***Section 4.1*** **for additional details**

5.3.1.14 I. 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.**
- A preliminary Control Enclosure layout is provided in the Conceptual Design **(4700-1, *Exhibit AA.3*). This drawing shall be reviewed and updated by the Contractor for each review submittal. Contractor shall use Vendor designed version of this drawing when available.**
- 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 J. 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.**
- **A preliminary version of the** relay rack layouts, 4800, and List of Materials, 9911, are provided in the Conceptual Design (*Exhibit AA.3*). Contractor shall verify the accuracy of these drawings. Contractor shall inform and request Approval from the Owner for any necessary engineering changes.

5.3.1.16 K. Wiring Diagrams and Requirements

- Owner Design Master**s 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 switche**s, 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. ~~Refer to the Owner Design Masters (*Exhibit GG.1*) for examples and guidance for when these functions are used.~~ 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 ~~(*Exhibit GG.2*)~~.**

- 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, e**ach 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, e**ach 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 ~~(***Exhibit GG.1***)~~ **for how that should be depicted in the drawings.**

Refer to Owner Standard S-144-60 ~~(***Exhibit GG.2***)~~ **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.

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5.3.1.24 ~~L.~~ AC and DC Panelboard Wiring Diagrams

- Refer to ***Section 4.0*** **for details.**

5.3.1.25 M. 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 (*Exhibit GG.1*).**

- T**he 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 N. 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 O. 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 630% and 90% design submittals. The drawing list provided in the Conceptual Design (*Exhibit AA.3*) shall be used as the starting point.**

- Contractor shall apply Owner Design Master (*Exhibit GG.1*) **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. Contractor shall also refer to the Relay Configuration Summaries (*Exhibit AA.3*) for additional details.**

- 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 P. 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 (*Exhibit GG.2*).**
- 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 (*Exhibit GG.2*). Refer to *Section 6.0* for additional details on cable materials.**
- Cables and conductors shall be installed per Construction Specification Section 6040 (***Exhibit HH***) **unless otherwise stated in this specification. In addition to these requirements, no more than two conductors shall be terminated to a single terminal. For the purposes of this requirement, each side of a terminal block shall be considered a unique terminal.**
- All rack to rack **cables, except for Network, Irig-B, and communications circuits, shall be multiconductor cables.**

5.3.1.29 Q. Supporting Documents

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

5.3.1.30 R. 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.**

~~END OF SECTION~~

6.0 SECTION 6.0 MATERIALS

1.06.1 GENERAL

A. **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.**

B. **When available and suitable for the application, Contractor shall use materials specified in the Owner Standard Design Masters (Exhibit GG.1) or the Substation Standard Material List(Exhibit GG.4). Contractor shall request written Owner Approval for any substitutions.**

C. **If the Design Master drawings do not provide a suitable material for an application, Contractor shall utilize other materials that are in active use by the Owner. These have been cataloged in a material database system. A copy of the material list is provided as reference in Exhibit XX.**

DC. If a required material parts isare 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.

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

2.06.2 CABLES AND CONDUCTORS

A. All insulated control and power cables and conductors rated up to 600V shall follow Owner Standard S-144-20 (Exhibit GG.2). 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 (Exhibit GG.3).

B. 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.

~~C.~~ 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).

~~D.~~ 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.

~~E.~~ 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.

~~F.~~ 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 ~~(Exhibit GG.2)~~. 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.

~~H.~~ Irig-B distribution cable shall be installed per the Conceptual Network Block Diagram ~~(Exhibit AA.3)~~. Twisted Shielded Pair cable shall follow ~~Appendix 1~~Section 4.7 in standard S-144-20.

~~3.0~~6.3 STATION POST INSULATORS

~~A.~~ 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 ~~(Exhibit XXXX)~~ for station post insulator requirements within Owner Substations.

B. 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 STATION POST INSULATORSUNDERGROUND 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 accord- ance 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.

~~END OF SECTION~~

7.0 SECTION 6.1 SUPPORTING DOCUMENTATION

1.07.1 GENERAL

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

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

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

D. 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.

E. Minor commodity construction materials such as bolts, washers, ~~unistrut~~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.

2.07.2 ABOVE GRADE LIST OF MATERIALS (9900)

A. 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.

B. 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.).

C. 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 (*Exhibit GG.2*)
- **CONTRACTOR SHALL SEEK CLARIFICATION FROM OWNER IF UNSURE WHICH LIST A MATERIAL SHOULD BE INCLUDED.**

3.07.3 OUTDOOR ARRANGEMENT LIST OF NAMEPLATES (9902)

A. 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.

B. 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.

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

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

4.07.4 CONTROL AND PROTECTION LIST OF MATERIALS (9911)

A. 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.).

B. 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.

5.07.5 CONTROL AND PROTECTION LIST OF NAMEPLATES (9912)

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

B. 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.

C. 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 (*Exhibit GG.1*) for that device.

D. 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.

E. 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.

~~6.0~~7.6 BELOW GRADE LIST OF MATERIALS (9920)

~~A.~~ 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

~~B.~~ 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 ~~(*Exhibit GG.2*)~~

~~7.0~~7.7 CABLE AND CONDUIT SCHEDULES (9930 AND 9931)

~~A.~~ 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.

~~B.~~ 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.

~~C.~~ 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.

~~D.~~ 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.

E. 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.

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

G. **CONTRACTOR SHALL FOLLOW GUIDELINES FOR MANAGING OLDER CCS DATABASE SYSTEMS PER OWNER STANDARD S-146-00 (*EXHIBIT GG.2*).**

8.07.8 DRAWING LIST

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

B. 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.

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

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

E. 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.

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

END OF SECTION

~~M1-05-03~~

APPENDIX M1
ATTACHMENT 05
EXHIBIT 03

SUBSTATION CONSTRUCTION SPECIFICATIONS

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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~~1.1 The purpose of these construction specifications is to summarize the minimum requirements for Contractor, which generally include the complete substation development, procurement, and construction. ..... 0~~

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~~GENERAL 4~~
~~1. TESTING AND ENERGIZATION 4~~
~~2. SPECIFICATION LIST 5~~

1.1.0 GENERAL

1.1. INTRODUCTION

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

1.1.1. The Substation Construction shall follow, to the greatest extent possible, the requirements outlinesd in the PGE Substation Standards referenced in this specificaitonspecification.....

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

1.1.3. 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

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

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

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

1.1.7. 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.

~~1.1.7.1.~~ Installation of Relay Settings after approval from the O~~o~~wner.

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

Perform Protective relaying testing (Acceptance and Functional) and provide the results to O~~o~~wner 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 ~~performed~~utilized after approval ~~from~~by the ~~o~~Owner.~~'s~~

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

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

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

~~1.1~~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

~~(a)~~ COMMUNICATION, SCADA, AND METERING FACILITIES

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2023

REQUEST FOR PROPOSAL

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

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~~(a) M1-05-04 Communication, SCADA, and Metering Facilities~~

~~Communication Facilities~~

~~1.1.1~~1.0 GENERAL

~~1.1.2~~1.1 SUMMARY

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

~~1.~~• M2-01-01 (Wind Plant Specifications)

~~2.~~• M3-01-01 (Solar Photovoltaic Plant Specifications)

~~3.~~• M4-01-01 (Energy Storage Technical Documents)

~~B.~~ The SCADA section in those specifications includes the following:

1. General
2. Main SCADA Components
3. SCADA Device Requirements
4. Interfaces
5. Fiber Optic Network Design
6. Fiber Optic Installation
7. Fiber Terminations and Testing
8. Availability and Reliability
9. Cyber Security
10. Viewing and Display
11. Reporting
12. Support for Warranty Calculations
13. Remote Alerts
14. Time Base and Date Formats

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

~~D.~~ The proposal shall address four aspects of the telecommunications design.

1. Intra-site Communications - the Network shall primarily be an Ethernet Fiber network to support intra-site data and voice communications needs.

2. Field Voice Communications System – to support Operations and Maintenance activities, a 2-way radio system should be deployed for voice communications.

~~2.~~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.

~~3.~~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.

~~4.~~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.

~~1.1.3~~1.2 TELECOMMUNICATIONS APPROACH

~~A.~~ The Contractor shall provide a bid that both meets these specifications and allocates a budget for the design, procurement, and construction of these telecommunications facilities. The site network and the interconnection requirements should be known and the design and costs of these facilities should be accounted for and well understood. The communications link to PGE will depend greatly on the location, size, and type of facility proposed, and therefore the Contractor shall propose a solution that meets these functional specifications. Contractor shall coordinate the communications systems for Substation and O&M Building to ensure compatibility and cost effectiveness and obtain owner's approval. During negotiations, this aspect of the design may be revised based on site specific conditions. An allowance for each of these four sections (Intra-site Communications, Substation Interconnect, PGE Connectivity, and Local Data Collection) shall be provided. The proposal price will not be revised if the ultimate solutions remains within these allowances.

~~1.1.4~~1.3 TELECOMUNCATIONS FACILITES

~~A.~~ The facilities shall consist of the following:

~~1.~~ Communications during construction: The Contractor shall provide a communications network to be used during construction, and specifically communications services to the on-site trailers used during construction. A minimum of 10~~5~~ Mbps Ethernet link shall be provided to each PGE trailer, along with (2) phone lines per trailer, which may be either VOIP or POTS. The Ethernet link shall only be dedicated to PGE and no other users.

~~2.~~ Intra-Site Network: The Contractor shall provide a data network that extends from a central substation or O&M building to all equipment enclosures throughout the facility that house microcontroller equipment.

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

~~i.~~• Shall support the Real-time control for the operation of the plant.

~~ii.~~• Shall support remote monitoring for the Owner to gather operational data from microprocessor-controlled equipment.

~~iii.~~• Shall support monitoring of weather information.

~~iv.~~• Shall allow the Owner to remotely access remotely configurable equipment to make settings changes and firmware upgrades.

~~v.~~• Shall support the use of Voice at each enclosure, desk, conference room, or security control point.

~~vi.~~• Shall support the use of Video where required for security and operations of the plant.

~~vii.~~• Shall include Wireless Access Points in Office locations.

~~viii.~~ Offices and conference room areas will have multiple data/analog wall jack locations. Each location will have two CAT6 station cables home run back to the Communications room where it will

- terminate in the main distribution field (MDF) enclosure on a specified 110 patch panel.

b. The network shall be capable of meeting the following specifications:

i. Use IP/Ethernet communications over a fiber and copper network.

ii. At least 60 Strands of single mode (SM) fiber shall be installed between all buildings as part of the project. Fiber shall be configured in a logical ring and where possible into a diverse optical ring.

iii. Category 6 copper shall be used for all connections between switches and equipment within a building.

iv. Use gigabit Ethernet ~~connections~~Interfaces.

v. Use VLANS for segmentation of traffic

vi. Use Quality of Service to Prioritize traffic flows

vii. Use Rapid Spanning Tree or other advanced ring convergence protocols.

viii. Support POE where phones or wireless access points are installed.

ix. Use managed equipment that support the following:

x. Centralized authentication via RADIUS or TACACS

xi. Centralized logging via Syslog

xii. Use hardened network equipment rated for the environment in which it will be installed.

3. Interconnection to Bulk Electric Power System:

a. Determine specific equipment required by the Utility/Transmission Owner and the System Operator, specifically relating to SCADA, metering, and telemetering due to the interconnection agreement as well as equipment required to complete the indicated control and protection requirements.

b. Build any fiber, microwave, or leased facilities ~~needed~~ to PGE's current communication standards in order to tie facility into bulk electric power system.

~~c.~~• Follow Western Electricity Coordinating Council (WECC) teleprotection standards.

~~4.~~ PGE Communications Circuits:

~~a.~~• Contractor shall provide the following communication circuits, each with the respective parameters given. These communications circuits can be delivered over the one or more aggregate leased circuits if possible. These circuits may make use of a private data network or a leased facility from a common carrier. The Contractor's proposal shall include the capital cost for construction, as well as the estimated monthly recurring cost if applicable. The Contractor shall make use of the PGE equipment listed below where such equipment is required:

Circuit Name	LOC A	LOC Z	Type	Capacity	Latency	Avail.	Circuit Description
O&M CORPORATE NETWORK	O&M	PGE WHQ	ETH	25 Mbps	100 msec	99.00%	CORPORATE NETWORK SERVICE
INTRA-SITE NETWORKING	SUBSTATION	O&M	ETH	1 Gbps	0.05 msec	99.00%	CORP NETWORK & SECURITY LAN
SUB REMOTE ACCESS LAN	SUBSTATION	PGE WHQ	ETH	1.5 Mbps	0.5 sec	99.00%	REMOTE ACCESS LAN FOR PROTECTION & AUTOMATION GROUP
SUB COMM TECH LAN	SUBSTATION	PGE WHQ	ETH	1.5 Mbps	0.5 sec	99.00%	REMOTE ACCESS LAN FOR COMM TECHS
PRIMARY AGC+SCADA	SUBSTATION	PGE WHQ	ETH	~~64 kbps~~1.5 Mbps	0.5 sec	99.95%	~~SERIAL~~ETHERNET/IP DNP 3.0 AUTOMATIC GENERATION CONTROL AND SCADA
SECONDARY AGC+SCADA	SUBSTATION	PGE WHQ	ETH	~~64 kbps~~1.5 Mbps	0.5 sec	99.95%	~~SERIAL~~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

~~1.1.5~~1.4 OTHER COMMUNICATIONS CIRCUITS/SERVICE

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

~~1.1.6~~1.5 TELECOMMUNICATIONS EQUIPMENT

~~A.~~ 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.

~~B.~~ 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.

~~C.~~ Communications equipment shall be grounded per Motorola R56 standards in O&M and Administration Buildings. Grounding in the Switchyard/Substation shall follow IEEE 80 standard industry practices.

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

~~E.~~ Equipment specified for this project shall be of the same manufacturer and model as PGE uses in their existing communications systems:

1. Dual-post Rack – Chatsworth "Clear", 19" x 84"
2. Ethernet Switch – Cisco
3. VoIP Phone - Cisco
4. Wireless Access Point – Cisco
5. Service Aggregation Node – Nokia 7705-SAR-8 with support cards
6. Fiber Patch Panel – Clearfield 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

~~13.~~

2.0 SCADA SYSTEM-LOCAL DATA COLLECTION

~~1.1.7~~2.1 GENERAL

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

~~1.~~ In addition to the Telecommunications, IT Operations, and Physical Security communication racks, Vendor will also provide space for Owner to install (2~~1~~) 30” x 42” x 84” fully-enclosed, lockable, 4-post network cabinet with venting doors. One being located within the ~~in either the~~ O&M communication room and the other in the~~or the~~ Switchyard/Substation.

~~2.~~ 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.

~~3.~~ 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.

~~4.~~ Vendor shall provide (~~1~~2) 30A, 240V circuit to each cabinet.

~~1.1.8~~2.2 SCADA HARDWARE AND SOFTWARE REQUIREMENTS

~~A. Contractor will provide the following equipment for Owner’s data collection system. Contractor will install all equipment in the provided cabinet in coordination with Owner at least 90 days prior to Substantial Completion. Once installed, Contractor will turn over all equipment and licenses to Owner for configuration.~~

B. Owner will have final approval on what hardware and software is provided to ensure system operations. If the specific devices below are not available or if the OEM has announced any end of support for the hardware or software, Owner will provide equivalent models for the Contractor to procure (at Contractor's cost).

a. 1x AR3150 (APC NetShelter SX 42U Deep Rack Enclosure) with 2x AR3150 (0U PDU mounts) and 1x AR7714 (rack roof brush strip)

b. 1x 4-node Dell VxRail Custer (E660F or newer). Each server should be single-socket with an Intel Xeon 6346 or better with 256GB RAM and 4-port SFP28 network card. Storage should be all-flash with a total usable space of 20TB, with the ability to expand to at least 45TB in the future.

c. 2x Cisco C9300X-48TX (or newer) with C9300X-NM-8Y and stack cables with 5-year DNA license

d. 16x Cisco SFP-10/25G-CSR-S= Transceivers

e. 8x Dell-compatible 10BASE-T SFP+ Copper RJ45 Transceivers

f. 2x Cisco FPR-1120 (or newer), with 5-Year Malware and Threat licenses

g. 1x Eaton 9PX8KSP

h. 2x Schneider AP8870

i. 1x Black Box LES1516A

j. 1x Recessed 19" rack-mounted DIN Rail with terminal blocks and 30A 2-pole breaker

k. 1x 1U Mixed-use (copper & fiber) feed-through patch panel

l. Software and Licenses:

i. All server cluster fully licensed with vSphere Enterprise Plus and vSAN (version 8 or newer)

ii. Windows Server 2022 (or newer) Datacenter licenses for all CPU Cores

iii. 2x Microsoft SQL Server 2019 (or newer) Standard licenses

iv. Emerson Ovation Green (MiScout) data collector software, configured in High Availability mode, with sufficient licenses for provided system.

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.

~~C.~~1. If Owner will not be responsible for any day-to-day maintenance, then the Contractor, in coordination with OEM SCADA Vendor, shall:

~~1.~~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.

~~a. If PGE is responsible for day-to-day maintenance or control of the plant, this system shall have read/write access to the OEM SCADA System and act as an overlay- SCADA from which operators can use to manage and control the facility.~~

~~b. If PGE will not be responsible for any day-to-day maintenance, the system shall have read-only access.~~

~~2.~~3. Ensure data values are available in the native resolution in which they were collected, up to 1Hz.

~~3.~~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:

~~a.~~• OPC UA

~~b.~~• OUPC DA

~~c.~~• SQL~~ODBC~~

• Direct queries to ~~tower~~ controllers using native ~~protocol~~protocols.

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

~~4.~~

3.0 METERING AND TELEMETRY FACILITES

~~1.1.9~~3.1 GENERAL

~~A.~~ PGE requires one owner per Point of Interconnection.

~~1.1.10~~3.2 DIRECT TELEMETRY REQUIREMENTS

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

~~1.~~• Direct, real-time telemetry (SCADA) from RTU (site) to RTU (PGE control center)

~~2.~~ ICCP over WECC Operations Network (WON)

~~1.1.11~~3.3 METERING REQUIREMENTS

~~A. PGE requires primary and backup metering for each metered point. Meters shall be sourced from wound-type instrument transformers for~~

~~voltages 230kV and below. Meters shall be accessible via PGE's MV90 system for accounting purposes.~~

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):

~~1.1.12~~4.1 HYDRO TURBINE

~~A.~~1. Turbine Guide RTD
~~B.~~2. Lower Guide RTD
~~C.~~3. Upper Guide RTD
~~D.~~4. Thrust Bearing RTD
~~E.~~5. Lube Oil Pressure
~~F.~~6. Lube Oil Temperature
~~G.~~7. Gen Turbine Local Ambient Temp
~~H.~~8. Turbine Guide Bearing X VIBR
~~I.~~9. Turbine Guide Bearing Y VIBR
~~J.~~10. Upper Guide Bearing X VIBR
~~K.~~11. Upper Guide Bearing Y VIBR
~~L.~~12. Lower Guide Bearing X VIBR
~~M.~~13. Lower Guide Bearing Y VIBR
~~N.~~14. Wicket Gate Position
~~O.~~15. Wicket Gate Pressure
~~P.~~16. Cooling Water Pressure
~~Q.~~17. Cooling Water Temperature
~~R.~~18. Forebay Level
~~S.~~19. Tailrace Level

~~1.1.13~~4.2 WIND TURBINES

~~A.~~1. Pitch - Blade A/B/C Pitch Motor Current
~~B.~~2. Pitch - Blade A/B/C Pitch Motor Voltage
~~C.~~3. Pitch - Blade A/B/C Pitch Position
~~D.~~4. Pitch - Blade A/B/C Hydraulic Oil Accumulator Pressure
~~E.~~5. Pitch - Pitch Pressure Output From Hydraulic Power Unit
~~F.~~6. Pitch - Pitch Oil Temperature - Outlet Hydraulic Power Unit
~~G.~~7. Pitch - Pitch Oil Accumulator Temperature
~~H.~~8. Pitch - Pitch Controller Panel Temperature
~~I.~~9. Pitch - Pitch Bearing A/B/C Vibration
~~J.~~10. Hub - Hub Temperature
~~K.~~11. Hub - Ice Detection System
~~L.~~12. Main Bearing(S) - Main Bearing Temperature
~~M.~~13. Main Bearing(S) - Main Bearing Vibration

~~N.~~14. Main Bearing(S) Oil Lubrication System - In Line Metal Particle Counter
~~O.~~15. Main Bearing(S) Oil Lubrication System - Oil Filter Differential Pressure
~~P.~~16. Main Bearing(S) Oil Lubrication System - Oil Pump Amps
~~Q.~~17. Main Bearing(S) Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
~~R.~~18. Main Shaft - Main Shaft Brake Pressure
~~S.~~19. Main Shaft - Main Shaft Brake Accumulator Pressure
~~T.~~20. Main Shaft – Shaft RPM
~~U.~~21. Gearbox – All Bearing Temperatures
~~V.~~22. Gearbox - Gearbox Lube Oil Pressure, Before Filter
~~W.~~23. Gearbox - Gearbox Lube Oil Pressure, After Filter
~~X.~~24. Gearbox - Planetary Vibration
~~Y.~~25. Gearbox - High Speed Shaft Vibration
26. Gearbox - Intermediate Speed Shaft Vibration ~~AA.~~
~~Z.~~ Gearbox - Oil Temperature - Gearbox Sump
27. ~~BB.~~
~~1.~~28. Gearbox Oil Lubrication System - In Line Metal Particle Counter
~~2.~~29. Gearbox Oil Lubrication System - Oil Filter Differential Pressure
~~3.~~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
~~4.~~36. Generator - Generator Non-Drive End Bearing Vibration
~~5.~~37. Generator - Phase A/B/C Voltage
~~6.~~38. Generator - Phase A/B/C Current
~~7.~~39. Generator - Power Factor
~~8.~~40. Generator - Heat Exchanger Water Inlet/Outlet Temperatures
~~9.~~41. Generator – Shaft Torque
~~10.~~42. Generator – Frequency (generator side)
~~11.~~43. Generator – Shaft RPM
~~12.~~44. Generator – Active Power
~~13.~~45. Generator – Reactive Power
~~14.~~46. Yaw - Yaw Position
47. Yaw - Yaw Brake Accumulator Pressure
48. Yaw - Yaw Brake Pressure
49. Yaw – Yaw Motor/Gear Temperature
~~15.~~50. Tower - Wind Speed Primary
~~16.~~51. Tower - Wind Speed Secondary
~~17.~~52. Tower - Wind Direction
~~18.~~53. Tower - Nacelle Temperature

~~19.~~ Tower - Tower Base Temperature

54.
55. Tower - Control Panel(sS) Temperature
~~20.~~56. Tower – Converter Inside Compartment Temperature
~~21.~~57. Tower – Converter Coolant Pressure
~~22.~~58. Tower – Converter Coolant Temperature
~~23.~~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
~~24.~~64. Tower - Transformer Temperature MMM. Tower - Ambient Temperature
~~25.~~65. Tower – Air Density
66. Tower - Sway
67. Tower – Error Code(s)
~~26.~~68. Tower – Operational State
~~27.~~69. Main Breaker - Status
~~28.~~70. Main Breaker - Faults
~~29.~~71. Main Breaker - Temperature
~~30.~~72. Main Breaker - Fan Ampere
~~31.~~73. Meteorological Station - Air Temperature
~~32.~~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
~~33.~~77. Meteorological Station - Barometric Pressure
~~34.~~78. Meteorological Station – Air Density
~~35.~~79. Switchgear - Breaker Phase Currents
~~36.~~80. Switchgear - Breaker Phase Voltages
~~37.~~81. Switchgear - Breaker Status
82. Switchgear - Relay Fault Codes
83. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics
84. Tower – Status Code

~~1.1.14~~**4.3 PV FIELD**

~~A.~~1. Combiner Box - DC Output Voltage
~~B.~~2. Combiner Box - DC Output Current
~~C.~~3. Combiner Box - DC Current per String
~~D.~~4. Combiner Box - Combiner Box Interior Temperature

~~E.~~5. Inverter - DC Input Voltage
~~F.~~6. Inverter - DC Input Current
~~G.~~7. Inverter - AC Output Voltage
~~H.~~8. Inverter - AC Output Current

~~I.~~9. Inverter - AC Power
~~J.~~10. Inverter - AC Frequency
~~K.~~11. Inverter - AC Reactive Power
~~L.~~12. Inverter - Energy Totalizer
~~M.~~13. Inverter - Inverter Temperatures
~~N.~~14. Inverter - Inverter Status
~~O.~~15. Inverter - Faults/Alarms
16. Inverter - Ground Current
~~P.~~17. Inverter – Operational State
~~Q.~~18. Meteorological Station - Air Temperature
~~R.~~19. Meteorological Station - Cell Temperature
~~S.~~20. Meteorological Station - Relative Humidity
~~T.~~21. Meteorological Station - Wind Speed
~~U.~~22. Meteorological Station - Global Irradiance
~~V.~~23. Meteorological Station - Plane of Array Irradiance
~~W.~~24. Meteorological Station - Solar Module Back Panel Temperature(s) - 10% of Modules
~~X.~~25. Switchgear - Breaker Phase Currents
~~Y.~~26. Switchgear - Breaker Phase Voltages
~~Z.~~27. Switchgear - Breaker Status BB~~AA~~. Switchgear - Relay Fault Codes
28. ~~BB~~Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

~~1.1.15~~4.4 OIL-COOLED TRANSFORMERS

~~A.~~1. Active Power
~~B.~~2. Reactive Power
~~C.~~3. High Side Amps (by phase)
~~D.~~4. High Side Voltage (by phase)
~~E.~~5. Ground Current
~~F.~~6. Low Side Voltage (by phase)
~~G.~~7. Control Voltage
~~H.~~8. Control Panel Temperature
~~I.~~9. LTC Tap Position
~~J.~~10. Oil Pump Amps
~~K.~~11. Oil Pump Discharge Pressure
~~L.~~12. Fan Bank Amps
~~M.~~13. LTC Tank Oil Temperature
~~N.~~14. Main Tank Oil Temperature
~~O.~~15. Top Oil Temperature
~~P.~~16. High Voltage Winding Temperature
~~Q.~~17. Low Voltage Winding Temperature
~~R.~~18. Nitrogen Pressure
~~S.~~19. Local Ambient Temperature

~~T.~~20. Moisture Percentage

U.21. Gas Analyzer H2
V.22. Gas Analyzer O2
W.23. Gas Analyzer N2
X.24. Gas Analyzer CO
Y.25. Gas Analyzer CO2
38.26. Gas Analyzer CH4
39.27. Gas Analyzer C2H6
40.28. Gas Analyzer C2H4
41.29. Gas Analyzer C2H2
42.30. Gas Analyzer H2O
31. Infrared Camera Temperatures

1.1.164.5 DRY TRANSFORMERS

A.1. Active Power
B.2. Reactive Power
C.3. High Side Amps (by phase)
D.4. High Side Voltage (by phase)
E.5. Ground Current
F.6. Low Side Voltage
G.7. Low Side Amps
H.8. Control Voltage
I.9. Control Panel Temperature
J.10. Cooling Fan Amps
K.11. High Voltage Winding Temperature
L.12. Low Voltage Winding Temperature
M.13. Local Ambient Temperature

1.1.174.6 SWITCHGEAR / MOTOR CONTROL CENTERS

A. Control Panel

1. Control Panel Voltage
2. Control Panel Temperature

B. 4160 VAC and Higher Bus

1. Connected Joints Temperature Via Fiber Optic Infrared Measurement

C. MCC Bucket

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

~~1.1.18~~4.7 HEAT EXCHANGERS

~~A.~~1. Inlet/Outlet Temperatures
~~B.~~2. Process Flows

~~1.1.19~~**4.8 PUMP / FAN MOTORS GREATER THAN 100 HP**

~~A.~~1. Motor Stator Temperature
~~B.~~2. Local Ambient Temperature
~~C.~~3. Motor Amps
~~D.~~4. Motor Power Factor
~~43.~~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	

1.0 GEN-TIE LINE

This specification defines the ~~technical and performance~~ 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

~~1.1.1~~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.

~~1.1.2~~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.

~~1.1.3~~C. Expected service life of Gen-Tie line is minimum 50-years.

~~1.1.4 The Project specific Project Description provides details specific to the Project.~~

~~1.1.5~~D. Contractor shall be responsible for obtaining and maintaining all necessary permits and / or easements for the Work. ~~Reference other Sections as applicable.~~

~~1.1.6~~E. All access and site civil work for the Gen-Tie line shall comply with all local ordinances, Section ~~other Sections~~M-~~0~~1-02-01, and these contract documents as applicable.

~~1.1.7~~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.

~~1.1.8~~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

~~1.2.1~~ M1-05-05-07 LiDAR

7. 57~~/~~

~~1.1.1.1~~C. 115 kV Transmission

~~1.1.1.2~~1. Project shall be designed as per Portland General Electric (PGE) Standards and Work Practices.

~~1.1.1.3~~2. Reference Attachment M1-05-05-01 for list of PGE Standards.

~~1.1.1.4~~3. Reference Attachment M1-05-05-02 for list of PGE Work Practices.

~~1.2.2~~D. 230 kV Transmission

~~1.1.1.5~~ Project shall be designed as per PGE 230 kV Design Criteria Document (DCD), PGE Standards and Work Practices.

~~1.1.1.6~~1. Reference Attachment M1-05-05-03 for PGE 230 kV DCD.

~~1.2.3~~E. Drilled Pier and Direct Embed Foundations

~~1.1.1.7~~1. Reference Attachment M1-05-05-~~0X~~ 05 for PGE drilled pier and direct embed design standards.

~~1.2.4~~F. Communications

~~1.1.1.8~~1. Reference Section ~~XX~~ M1-05-04 for Communications requirements.

~~1.1.1.9~~2. Gen-Tie will require a minimum of one (1) communications cable. Additional cables may be required depending on NERC CIP or other requirements.

~~1.1.1.10~~3. 57/115 kV Projects shall use All Dielectric Self Supporting (ADSS) cable(s) for communications.

~~1.1.1.11~~4. 230 kV Projects may request PGE approval for use of Optical Ground Wire (OPGW) cable(s) for communications.

~~1.1.1.12~~5. ADSS communications cables shall be designed outside the “Supply Space”. Exception to this requirement will require PGE approval.

~~1.2.5~~G. Miscellaneous

~~1.1.1.13~~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

~~1.3.1~~A. Refer to M1-05-07 ~~Attachment XX~~ 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. ~~-~~

~~1.3.2~~B. Conductor

~~1.1.1.14~~1. Contractor shall utilize a standard PGE conductor for the Project. Reference PGE Standards for list of standard conductors.

~~1.1.1.15~~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.

~~1.3.3~~C. 57/115 kV and ADSS Hardware

~~1.1.1.16~~1. All 57/115 kV and ADSS materials shall be per PGE Standards and current PGE approved parts.

~~1.1.1.17~~2. Transmission voltages below 115 kV shall be framed as 115 kV.

~~1.3.4~~D. 230 kV and OHSW Hardware

~~1.1.1.18~~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.

~~1.1.1.19~~2. Contractor is required to complete Project specific electrical design to validate PGE 230 kV assembly.

~~1.1.1.20~~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.

~~1.3.5~~E. OPGW Hardware

~~1.1.1.21~~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.

~~1.3.6~~F. Material Specification(s) and Vendor Drawings

~~1.1.1.22~~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.

~~1.1.1.23~~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.

~~1.3.7~~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.

~~1.4.1~~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:

~~1.1.1.24~~1. Proposed project routing and anticipated easement width(s).

[1.1.1.25]2. Project vertical and horizontal datum.

[1.1.1.26]3. Project conductor type; shall be as per PGE standard conductors.

[1.1.1.27]4. Project communications cable type; shall be as per [PGE standards and Section XX]M1-01-05.

[1.1.1.28]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.

[1.1.1.29]6. Project proposed hardware assemblies; shall match PGE standards.

[1.1.1.30]7. Engineering milestone schedule so that PGE can plan resources for design review.

[1.4.2]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.

[1.4.3]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

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

[1.5.2]B. Construction of Gen-Tie line and all related facilities shall be [completed]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[one of the Owner's approved subcontractors. Reference Section XX].

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

1.6 GENERAL

[1.6.1]A. Geotechnical Investigation

[1.1.1.31]1. Reference Attachment M1-05-05-06[X] for PGE geotechnical investigation standard.

[1.6.2]B. Survey. [Reference also Section XX.]

[1.1.1.32]1. Project Datum (design and construction) shall be approved by PGE.

[1.1.1.33]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.

[1.6.3] Outages. Reference also Section M1-01-05[XX].

C.

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

~~1.1.1.35~~1. Contractor shall develop overall Project schedule with consideration for outages.

~~1.1.1.36~~2. 230 kV outages, with exact dates, shall be submitted for PGE review and approval (120) days ahead of outage.

~~1.1.1.37~~3. 115 kV outages, with exact dates, shall be submitted for PGE review and approval (60) days ahead of outage.

~~1.1.1.38~~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.

~~1.1.1.39~~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.

~~1.6.4~~E. Energization. Reference also Section M~~XX~~1-01-05.

~~1.1.1.40~~1. Contractor shall prepare construction sequencing plan and identify all outages necessary to complete the Work.

~~1.1.1.41~~2. Contractor shall test, commission, start-up and place into successful operation the Gen-Tie line, including the electrical and communications infrastructure.

~~1.1.1.42~~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.

~~1.1.1.43~~ Contractor shall expect extensive coordination with PGE.

4.

M1 05 06

APPENDIXppendix M1
ATTACHMENTttachment 05
EXHIBITxhibit 06

APPLICABLE STANDARDSpplicable Standards

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	

~~From M3 Wind~~

~~Applicable Standards~~

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

~~A.~~ **GENERAL REQUIREMENTS~~:~~

1.1

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

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

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

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

~~1.~~ Unless otherwise specified herein, in the case of conflict between any Applicable Standards, the more stringent requirement shall apply.

B. **APPLICABLE STANDARDS:**

B.

1.2

1. Air Movement and Control Association (“AMCA”)
1.
1.
2. Aluminum Association (“AA”)
2.
2.
3. American Association of State Highway and Transportation Officials (“AASHTO”)
3.
3.
4. American Bearing Manufacturer Association (“ABMA”)
4.
5. American Concrete Institute (“ACI”)
5. Americans with Disabilities Act (“ADA”)
6.
6.7. American Institute of Constructors (“AIC”)

7. American Institute of Steel Construction (“AISC”)
8.
8. American Iron and Steel Institute (“AISI”)
9.
9. Association of Iron and Steel Engineers (“AISE”)
10.
10. Association of Edison Illuminating Companies (“AEIC”)
11.
11. American Gear Manufacturer Association (“AGMA”)
12.
12. American Land and Title Association (“ALTA”)
13.
13. American National Standards Institute (“ANSI”)
14.
14. American Society of Civil Engineers (“ASCE”)
15.
15. American Society of Heating, Refrigeration, and Air Conditioning Engineers (“ASHRAE”)
16.
16. American Society of Mechanical Engineers (“ASME”)

~~17.~~ -
~~17.~~ American Society of Nondestructive Testing (“ASNT”)
~~18.~~ -
~~18.~~ American Society of Testing and Materials (“ASTM”)
~~19.~~ -
~~19.~~ American Water Works Association (“AWWA”)
~~20.~~ -
~~20.~~ American Welding Society (“AWS”)
~~21.~~ -
~~21.~~ Avian Power Line Interaction Committee (“APLIC”)
~~22.~~ -
23. Bonneville Power Administration (“BPA”) Master Specifications
24. Clean Air Act and Amendments (“CAA”)
~~22.~~ Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (“CERCLA”)
~~25.~~ -
~~23.~~ Code of Federal Regulations (“CFR”)
~~26.~~ -
~~24.~~ Concrete Reinforcing Steel Institute (“CRSI”)
~~27.~~
28. Crane Manufacturer Association of America (“CMAA”)
~~25.~~ Clean Water Act (“CWA”)
~~29.~~ -
~~26.~~ Department of Transportation (“DOT”)
~~30.~~ -
~~27.~~ Det Norske Veritas Germanischer Lloyd (“DNV GL”)
~~31.~~ -
~~28.~~ Expansion Joint Manufacturer Association (“EJMA”)
~~32.~~ -
~~29.~~ Electric Power Research Institute (“EPRI”)
~~33.~~ -
~~30.~~ United States Environmental Protection Agency (“EPA”)
~~34.~~ -
~~31.~~ Federal Aviation Agency, Department of Transportation (“FAA”)
~~35.~~ -
~~32.~~ Federal Energy Regulatory Commission (“FERC”)
~~36.~~ -
37. Federal Highway Administration (“FHWA”)
~~33.~~ Federal Power Act (“FPA”)
~~38.~~ -
~~34.~~ FM Global (“FM”)

~~39.~~ -
~~35.~~ Hydraulic Institute (“HI”)
~~40.~~ -
~~36.~~ IAPMO Uniform Plumbing Code
~~41.~~ -
~~37.~~ Illuminating Engineering Society (“IES”)
~~42.~~ -
~~38.~~ Institute of Electrical and Electronic Engineers (“IEEE”)
~~43.~~ -
~~39.~~ Instrumentation Society of America (“ISA”)
~~44.~~ -
~~40.~~ Insulated Cable Engineering Association (“ICEA”)
~~45.~~ -
~~41.~~ International Building Code (“IBC”)
~~46.~~ -
~~42.~~ International Electrotechnical Commission (“IEC”)
~~47.~~ -
~~43.~~ International Federation for Structural Concrete (“FIB”)
~~48.~~ -
~~44.~~ International Fire Code (“IFC”)
~~49.~~ -
~~45.~~50. International Network for Harmonised~~x~~ and Recognized Measurements in Wind Energy (“MEASNET”)

~~46.~~ International Organization for Standardization (“ISO”)
~~51.~~ -
~~47.~~ International Society of Automation (“ISA”)
~~52.~~ -
~~48.~~ Applicable state requirements, including State Department of Transportation
~~53.~~ -
54. Metal Building Manufacturers Association (“MBMA”)
55. Migratory Bird Treaty Act (“MBTA”)
~~49.~~ MESA – Open Standards for Energy Storage
~~56.~~ -
~~50.~~ Manufacturer’s Standardization Society of the Valve and Fittings Industry (“MSS”)
~~57.~~ -
~~51.~~ National Association of Corrosion Engineers (“NACE”)
~~58.~~ -
~~52.~~ National Electric Code (“NEC”)
~~59.~~
~~53.~~ National Electrical Contractors Association (“NECA”)

60. -
54. National Electric Safety Code (“NESC”)
61. -
55. National Electrical Manufacturers Association (“NEMA”)
62. -
56. National Electrical Testing Association (“NETA”)
63. -
57. National Fire Protection Association (“NFPA”)
64. -
58. National Safety Council (“NSC”)
65. -
66. National Institute of Standards and Technology (“NIST”)
59. National Institute of Standards and Technology Internal or Interagency Reports (“NISTIR”)
67. -
60. North American Electric Reliability Corporation (“NERC”)
68. -
61. Occupational Safety and Health Administration (“OSHA”)
69. -
62. Post-Tensioning Institute (“PTI”)
70. -
71. Pipe Fabrication Institute (“PFI”)
63. Resource Conservation and Recovery Act (“RCRA”)
72. -
73. Scientific Apparatus Makers Association (“SAMA”)
64. Safe Ddrinking Water Act (“SDWA”)
74. -
75. Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)
65. Solid Waste Disposal Act (“SWDA”)
76.
66. Society for Protective Coatings (“SPC”)
77. -
67. Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)
78. -
79. Thermal Insulation Manufacturer Association (“TIMA”)
68. Toxic Substances Control Act (“TSCA”)
80. -
69. Underwriter’s Laboratories (“UL”)
81. -
70. United States Department of Agriculture (“USDA”)
82. -
Welding Research Council (“WRC”)

83.
84. DNV OS C502, Offshore Concrete Structures
71. Electric Tariff Rule 21 – Generating Facility Interconnections
85.
C. Applicable Standards (Oregon Projects only):
86.
1. Oregon Structural Specialty Code (based on the International Building Code)
87.
2. Oregon Mechanical Specialty Code (based on the International Mechanical Code)
88.
3. Oregon Electrical Specialty Code (based on the National Electrical Code)
89.
4. Oregon Plumbing Specialty Code (based on the Uniform Plumbing Code)
90.
5. Oregon Fire Code (based on the International Fire Code)
91.
6. Oregon State Occupational Safety and Health Act
92.
4. Oregon Health Authority
93.

C. Oregon Occupational Safety and Health Act (OR-OSHA) - 29 CFR 1910, 1926
94.

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

1. 1, ANSI/IEEE C2, National Electric Safety Code
2. 2, IEEE 519, IEEE Recommended Practices and Requirements for harmonic Control in Electrical Power Systems
3. 3, IEEE 1815-2012, IEEE Standard for Electric Power Systems Communications—Distributed Network Protocol (DNP3)
4. 4, IEEE 1547-2018, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems
5. 5, IEEE 1547.1, Standard Conformance Test Procedure for Equipment Interconnecting Distributed Resources with Electric Power Systems
6. 6, IEEE 1547.2, Interconnecting Distributed Resources with Electric Power Systems
7. 7, IEEE 1547.3, Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
8. 8, ANSI Z535, Product Safety Signs and Labels
9. 9, ANSI C57/IEEE, Transformer Standards, whenever applicable

10. ~~10 ,~~ ANSI C37/IEEE~~ ,~~ Surge withstand capabilities, whenever applicable
11. ~~11 ,~~ UL 1642/IEC 62133~~ ,~~ Applicable sections related to battery cell safety, where applicable
12. ~~12 ,~~ UL 1741~~ ,~~ Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
13. ~~13 ,~~ NFPA 704~~ ,~~ Standard System for the Identification of the Hazards of Materials for Emergency Response
14. ~~14 ,~~ UL 1642~~ ,~~ Standard for Lithium Batteries
15. ~~15 ,~~ UL 1778~~ ,~~ Underwriters Laboratories' Standard for Uninterruptible Power Systems for up to 600 Volts AC
16. ~~16 ,~~ UL 1973~~ ,~~ Standards for Batteries for Use in Light Electric Rail Applications and Stationary Applications
17. ~~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. ~~18 ,~~ Electric Tariff Rule 21~~ ,~~ Generating Facility Interconnections
19. ~~19 ,~~ NISTIR 7628~~ ,~~ Guidelines for Smart Grid Cyber Security

~~20 , NEC , National Electric Code~~
~~21 , NESC , National Electric Safety Code~~
~~22 , ASHRAE , American Society of Heating, Refrigerating and Air- Conditioning Engineers~~
~~23 , CAA , Clean Air Act and Amendments~~
~~24 , CERCLA , Comprehensive Environmental Response, Compensation, and Liability Act of 1980~~
~~25 , EPA , Environmental Protection Agency regulations~~
~~26 , FAA , Federal Aviation Administration regulations~~
~~27 , FERC , Federal Energy Regulatory Commission regulations~~
~~28 , FPA , Federal Power Act~~
~~29 , RCRA , Resource Conservation and Recovery Act~~
~~30 , SDWA , Safe Drinking Water Act~~
~~31 , SWDA , Solid Waste Disposal Act~~
~~32 , TSCA , Toxic Substances Control Act~~
~~33 , ADA , Americans with Disabilities Act~~
~~34 , MBTA , Migratory Bird Treaty Act~~
~~35 , CWA , Clean Water Act~~
~~36 , ANSI , American National Standards Institute~~
~~37 , IEEE , Institute of Electrical and Electronics Engineers~~
~~38 , NEMA , National Electrical Manufacturers Association~~
~~39 , ASTM , American Society for Testing and Materials~~
~~40 , ASME , American Society of Mechanical Engineers~~

20. ~~41 ,~~ IEEE 1881~~ ,~~ Standard Glossary of Stationary Battery Terminology
21. ~~42 ,~~ IEEE 519~~ ,~~ Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

22. ~~43 ,~~ IEEE 142~~,~~, Recommended Practice for Grounding of Industrial and Commercial Power Systems
23. ~~44 ,~~ IEEE 242~~,~~, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
24. ~~45 ,~~ IEEE 2030.3~~,~~, Standard Test Procedures for Electric Energy Storage Equipment and Systems for Electric Power Systems Applications
25. ~~46 ,~~ EPRI 3002009313~~,~~, Energy Storage Integration Council Energy Storage Test Manual 2016
26. ~~47 ,~~ IEEE 1881~~,~~, Standard Glossary of Stationary Battery Terminology
27. ~~48 ,~~ Owner S-76~~,~~, Below Grade Substation Standards
28. ~~49 ,~~ MESA~~,~~, Open Standards for Energy Storage
29. ~~50 ,~~ NFPA 855~~,~~, Standard for the Installation of Stationary Energy Storage Systems
30. ~~51 ,~~ OSSC~~,~~, 2014 Oregon Structural Specialty Code
31. ~~52 ,~~ International Building Code~~,~~, 2012 International Building Code
32. ~~53 ,~~ ACI-318~~,~~, American Concrete Institute 318-11
33. ~~54 ,~~ AWS~~,~~, American Welding Society D1.1 Structural Welding Code - Steel
34. ~~55 ,~~ OFC~~,~~, 2019 Oregon Fire Code
35. ~~56 ,~~ IEEE 2800~~,~~, IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems

~~M1-05-07~~

APPENDIXppendix M1
ATTACHMENTttachment 05
EXHIBITxhibit 07

APPROVEDpproved VENDORSendors

RENEWABLE ENERGY RESOURCES

PORTLAND GENERAL ELECTRIC

2025

REQUEST FOR PROPOSAL

NO.	DATE	REVISION	BY	CHK'D	APPROVALS	

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

v)

2) Generator Step-up Transformer (Ssubstation Mmain Ppower Ttransformer)

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

b) Wind
i) ABB, Varennes, Canada shop
ii) ABB, St. Louis, Missouri shop
iii) ABB, Bad Honnef, Germany shop
iv) ABB, South Boston, Virginia shop
v) HICO, ChangWon, South Korea shop
vi) Hyundai, Montgomery, Alabama shop
vii) Hyundai, Ulsan, South Korea shop
viii) Smit, Nijimegen, The Netherlands shop
ix) SPX Waukesha, Waukesha, Wisconsin shop
x) EFACEC, Arroteia, Portugal shop
xi) Siemens, Guanajuato, Mexico shop
xii) GE Prolec, Monterrey, Mexico shop
xiii) Shihlin, Taipei, Taiwan shop

c) Solar

i) ABB, Varennes, Canada shop
ii) ABB, St. Louis, Missouri shop
iii) ABB, Bad Honnef, Germany shop
iv) ABB, South Boston, Virginia shop
v) HICO, ChangWon, South Korea shop
vi) Hyundai, Montgomery, Alabama shop
vii) Hyundai, Ulsan, South Korea shop
viii) Smit, Nijimegen, The Netherlands shop
ix) SPX Waukesha, Waukesha, Wisconsin shop
x) EFACEC, Arroteia, Portugal shop
xi) Siemens, Guanajuato, Mexico shop
xii) GE Prolec, Monterrey, Mexico shop
xiii) 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) Energy StorageAll Technologies
   i) Hitachi
   ii) ABB (Except for MV Potential Transformers)
   iii) Trench Ltd
   iv) GE/Alstom
   v) Arteche

b) Wind

~~i) ABB (Except for MV Potential Transformers)~~
~~ii) Trench Ltd~~
~~iii) GE/Alstom~~
~~c) Solar~~
~~i) ABB (Except for MV Potential Transformers)~~
~~ii) Trench Ltd~~
~~iii)~~v) ~~GE/Alstom~~

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 ~~and Revenue Meters~~

a) ~~Energy Storage~~All Technologies
~~i)~~ Schweitzer Engineering Laboratories (SEL)
i)
~~ii) Schneider Ion 8650~~
(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

~~b) Wind~~
~~i) Schweitzer Engineering Laboratories (SEL)~~
~~ii) Schneider Ion 8650~~
~~iii) * 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~~

~~c) Solar~~
~~i) Schweitzer Engineering Laboratories (SEL)~~
~~ii) Schneider Ion 8650~~

10) ~~* 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~~**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

~~iii)~~

~~10)~~11) **Relay Panels**

a) Energy Storage
   i) Electrical Power Products (EP2)
b) Wind
   i) Electrical Power Products (EP2)
c) Solar

~~11)~~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)

~~12)~~13) **Single Mode Fiber Cable & Attachment Hardware**

a) Energy Storage
   i) AFL– ADSS and OPGW
   ii) OFS– ADSS
   iii) Preformed Line Products
   ~~iii)~~iv) Tyco/Commscope FOSC splice cases
   ~~iv)~~v) Anixter
b) Wind
   i) AFLADSS and OPGW
   ii) OFS-ADSS
   iii) Preformed Line Products
   ~~iii)~~iv) Tyco/Commscope FOSC Splice Cases
   ~~iv)~~v) Anixter
c) Solar
   i) AFL ADSS and OPGW
   ii) OFS ADSS
   iii) Preformed Line Products
   ~~iii)~~iv) Tyco/Commscope FOSC Splice Cases

~~iv)~~v) Anixter

~~13)~~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

~~14)~~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

~~15)~~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

~~16)~~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)

~~17)~~18) **Substation Human/Machine Interface**
- a) Energy Storage
  - i) Schneider Electric
- b) Wind
  - i) Schneider Electric
- c) Solar
  - i) Schneider Electric

~~18)~~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

~~19)~~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

~~20)~~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

~~21)~~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

~~22)~~23) **Transformer Bushings**
- a) Energy Storage
  - i) PCORE
  - ii) Hitachi
- b) Wind
  - i) PCORE
  - ii) ABB
- c) Solar
  - i) PCORE
  - ii) ABB

~~23)~~24) **Uninterruptible Power Supply System (UPS)**

a) Energy Storage
~~i) *Vertiv Chloride (formerly Emerson Network Power)~~
~~ii)~~i) Ametek Solidstate Controls
~~iii)~~ii) CEG
~~iv)~~iii) Gutor/Schneider
b) Wind
~~i) *Vertiv Chloride (formerly Emerson Network Power) – was comment on issues with Vertiv on another project, and that Amestek should be the recommended supplier~~
~~ii)~~i) Ametek Solidstate Controls
~~iii)~~ii) CEG
~~iv)~~iii) Gutor/Schneider
c) Solar
i) ~~*Vertiv Chloride (formerly Emerson Network Powe~~
ii) Ametek Solidstate Controls
iii) CEG
iv) Gutor/Schneider

~~24)~~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~~Valere~~
~~iii)~~iv) SENS
c) Solar
i) East Penn Manufacturing
ii) C&D Technologies
iii) Delta/Eltek
~~iii)~~iv) SENS

~~25)~~26) **125 VDC Chargers**
a) Energy Storage
i) *SENS
~~ii) *Vertiv Chloride (formerly Emerson Network Power)~~
~~iii)~~ii) Ametek Solid State Controls
~~iv)~~iii) Cyberex
~~v)~~iv) Hindle Power
b) Wind
i) *SENS
~~ii) *Vertiv Chloride (formerly Emerson Network Power) –~~
~~(1) Comment on issues with Vertiv - The charger is working fine, but wondering if we should prefer SENS or Ametek over Vertiv. Check with the consultant if SENS and Ametek makes chargers large enough for the applications.~~
~~iii)~~ii) Ametek Solid State Controls
~~iv)~~iii) Cyberex
~~v)~~iv) Hindle Power
c) Solar
i) *SENS
~~ii) *Vertiv Chloride (formerly Emerson Network Power)~~

~~iii)~~ii) Ametek Solid State Controls
~~iv)~~iii) Cyberex
~~v)~~iv) Hindle Power

~~26)~~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

~~Just in~~ Energy Storage Project ~~Spec~~Equipment Vendors:

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

2) BESS Suppliers, Inverters
a) Energy Storage
i) Power Electronics
ii) SMA
iii) Sungrow
iv) Tesla
v) TMEIC
vi) EPC

Just in Wind SpecWind Project Equipment Vendors:

1) **Climb Assist Power Systems/Lift System**
2) 3S Lift, Climb Auto SystemPowerClimber, IBEX, 3S Climb Assist
   a)
3) **Collection System Cable**
   a) Southwire
   b) Prysmian Power Cables and Systems
   c) Okonite
4)2) **Transmission Line Type Grips**
   a) *Chicago
   b) Alcoa Pocket
   c) Kellum (for stringing operation)
5)3) **Transmission Tubular Steel Towers**
   a) Valmont
   b) Sabre
   c) TAPP
6)4) **Transmission Overhead Conductor and Cables**
   a) Southwire
   b) Prysmian
   c) Nehring
7) **Optical Ground Wire (OPGW)**
   a) AFL
8) **All Dielectric Self Supporting (ADSS)**
   a) To be determined
9)5) **Wind Turbine GeneratorsOEM**
   a) General Electric
   b)a) Siemens Gamesa
   b) Vestas
   General Electric
   c)
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
10)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

~~Just in Solar Spec~~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

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