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**Loretta I. Mabinton**
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March 9, 2018

*Via Electronic Filing and U.S. Mail*

Oregon Public Utility Commission
Attention: Filing Center
201 High Street, Ste. 100
Salem OR 97301-3612

Re: UM 1934 – Portland General Electric Company's 2018 Request for Proposals for Renewable Resources

Attention Filing Center:

Pursuant to Oregon Public Utility Commission (Commission) Order No. 06-446, and Order No. 14-149, as modified, Portland General Electric Company (PGE) hereby submits its Final Draft 2018 Request for Proposals (RFP) for renewable energy resources. The RFP will be issued to fulfill the renewable resource actions identified by PGE in its 2016 Integrated Resource Plan (IRP) Revised Renewable Action Plan, acknowledged by Commission Order No. 18-044. On February 27, 2018, the Commission issued a General Protective Order in this docket (Order No. 18-063).

PGE is providing copies of this filing to all parties and interested persons in the utility's most recent general rate case, RFP (that had a service list) and IRP dockets. PGE is also providing five copies of this filing to OPUC.

Please contact me at (503) 464-7822 or Jimmy Lindsay at 503 464-8311 if you have any questions concerning this filing. Please direct any formal correspondence or requests to the following email addresses: loretta.mabinton@pgn.com and pge.opuc.filings@pgn.com.

Sincerely,

Loretta I. Mabinton
Associate General Counsel

LM: bp

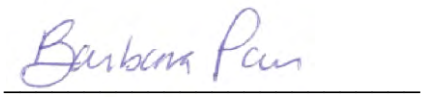
Enclosures

cc: Service Lists (LC 66, UE 335, UM 1613)

## CERTIFICATE OF SERVICE

I hereby certify that I served the foregoing **PORTLAND GENERAL ELECTRIC COMPANY'S 2018 REQUEST FOR PROPOSALS (RFP) FINAL DRAFT FOR RENEWABLE ENERGY RESOURCES AND APPENDICES** on the following named persons on the date indicated below by email to said persons whose email addresses appear on the attached OPUC service list for Docket Nos. LC 66, UE 335 and UM 1613.

Dated this 9th day of March, 2018.



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Portland General Electric Company

# REQUEST FOR PROPOSALS – FINAL DRAFT**

## Renewable Energy Resources

****NOTE: PGE's issuance of the final 2018 Request for Proposals (RFP) for Renewable Energy Resources is subject to Oregon Public Utility Commission approval of the draft RFP.**

March 9, 2018

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# 1 Purpose and Scope

Portland General Electric Company (PGE), an investor-owned electric utility in Oregon, is soliciting bids through this Request for Proposals (RFP) for the renewable electric energy products described in section 1.1 below.

The timing of the RFP is intended to enable resources to capture for customers the value of federal renewable electricity tax credits including the Production Tax Credit (PTC) and Investment Tax Credit (ITC). PGE will consider proposals from a diverse range of renewable energy resources that comply with Oregon's Renewable Portfolio Standard (RPS).

This competitive RFP is being conducted in accordance with the OPUC Competitive Bidding Guidelines set forth in Appendix A of OPUC Order 06-446, dated August 10, 2006, as modified by OPUC Order 14-149, dated April 30, 2014 (Docket UM-1182) (Competitive Bidding Guidelines).

## 1.1 Resource Targets

PGE is seeking to acquire approximately 100 average megawatts (MWa)[1] of long-term renewable energy supply, bundled with the associated renewable energy credits (RECs). Renewable resources must meet the requirements of Oregon's RPS, as defined in Oregon Revised Statutes (ORS) Section 469A. PGE will consider proposals based on different commercial structures and commercially viable resource technologies. Acceptable bids for renewable resources include power purchase agreements (PPA), as well as a range of ownership structures, including PPAs with purchase options or obligations, sales of existing assets, acquisition of project development assets and rights, joint ownership, and build-own-transfer agreements. PGE intends to submit a benchmark proposal for the renewable RFP. PGE will evaluate and select renewable energy supplies consistent with the criteria and methodology contained herein.

Notwithstanding the above preferred target, PGE reserves the right to vary from this target[2] energy quantity based on evaluation of price and risk factors of received bids.

[1] An average megawatt is a unit of energy equal to 8,760 MWh during a common year.

[2] Including not procuring any energy through this RFP process.

## 1.2 About PGE

Headquartered in Portland, Oregon, PGE serves approximately 863,000 retail customers within a 4,000 square mile service territory (see Figure 1).

- Service territory population 1.9 million, about 46% of the state's population.
- Serves 51 cities, the largest being Portland and Salem.
- 28,000 miles of transmission and distribution lines.
- Net plant-in-service, $9.9 billion.
- Forecast average annual demand in 2021, approximately 2,450 MWa.
- Peak load in 2016, 3,726 MW.
- Generation assets including seven hydro generation facilities, five gas-fired thermal plants, the Biglow Canyon and Tucannon River wind farms, majority ownership of one coal-fired thermal plant, and joint ownership in two units of another coal plant facility. PGE also holds long-term contracts for energy from the Mid-Columbia hydroelectric projects on the Columbia River, two wind farms, and regularly enters into short and mid-term wholesale power supply contracts.

**Figure 1. PGE Service Territory**

For more information, see PGE's Internet site: www.portlandgeneral.com.

## 1.3 Independent Evaluator

The Oregon Public Utility Commission has selected Bates White as an independent, third-party evaluator (IE), to help ensure the RFP is conducted in accordance with the OPUC Competitive Bidding Guidelines and that all bids are evaluated consistently and impartially. The IE will report to the OPUC. Bates White will:

- Consult with PGE during PGE's in preparation of the RFP and submit its assessment of the final draft RFP to the OPUC when PGE files for RFP approval.
- Review final scoring and evaluation criteria that are consistent with the OPUC Competitive Bidding Guidelines and review of "mock bids" to test the integrity of the evaluation models.
- Will confer with OPUC staff in accordance with the Competitive Bidding Guidelines.
- Oversee the RFP process to ensure it is administered fairly.
- Will evaluate and score PGE's Benchmark Resource bid.
- Independently score all, or a sample, of the bids to determine whether the selections for the initial and final short-lists are consistent with the bid evaluation criteria.
- Compare the results of the IE's scoring with PGE's scoring and work with PGE to reconcile and resolve scoring differences, if any.
- Prepare a Closing Report for the OPUC after PGE has selected the final short-list.
- In its Closing Report, provide its assessment of all aspects of the solicitation process and the IE's involvement, including detailed bid scoring and evaluation results, to PGE, non-bidding parties and the OPUC subject to the terms of the Protective Order.

## 1.4 Staffing Principles

Portland General Electric Company (PGE) has put in place certain measures, including separation of functions and restrictions on information sharing, that

1. Are designed to provide a comparable and unbiased evaluation of all third party bids and any PGE Benchmark Resource consistent with the OPUC Competitive Bidding Guidelines for major resources.
2. Staff the RFP Team and the Benchmark Resource Team with the appropriate levels of expertise and technical knowledge.
3. Make efficient use of the limited number of PGE employees qualified to assist with power supply resource development, evaluation and procurement.

In addition, as a transmission provider, PGE complies with the Standards of Conduct adopted by the Federal Energy Regulatory Commission (FERC) which govern interactions between PGE's Transmission Function Employees (TFEs) and PGE's Marketing Function Employees (MFEs) and requires these employees to function independently of each other. Also, employees who are neither MFEs nor TFEs cannot share transmission information with MFEs under FERC's "no-conduit rule."

PGE's senior leadership team will continue to provide oversight and guidance, but will not directly participate in either the development of the Benchmark Resource or the RFP.

The Benchmark Resource is described in Appendix J.

# 2 RFP Schedule

The schedule listed below may be revised throughout the RFP process:

- Friday March 2nd 2018 — Pre-issuance stakeholder and bidder RFP workshop.
- Friday March 9th 2018 — PGE submits final draft Renewable RFP to OPUC for approval.
- Friday March 23rd 2018 — IE submits assessment of the final draft renewable RFP to OPUC.
- Tuesday May 8th 2018 — PGE issues Final RFP.
- Monday May 28th 2018 – Benchmark bid due
- Wednesday June 13th, 2018 – Benchmark Bid scored and sealed
- Friday June 15th 2018 — RFP proposals from Bidders due.
- Tuesday October 2nd 2018* — PGE submits request for acknowledgment of shortlist to OPUC.
- Tuesday October 2nd 2018* — IE issues final closing report to OPUC.
- Tuesday October 30th 2018* – OPUC considers PGE's request for acknowledgment of shortlist
- Monday December 31, 2018* – Final contracts with winning Bidders, PGE issues notice to proceed (as applicable).

** These dates are subject to change depending on the quantity and complexity of bids received. However, given the time-sensitive nature of this RFP, PGE will use best efforts in working with Bidders, stakeholders, the IE and the OPUC to achieve the milestones in this timeline.*

# 3 Guidelines for Submitting Proposals

This section describes the guidelines that parties submitting bids under this RFP (Bidders) must follow when submitting proposals.

## 3.1 Registration on PGE's RFP Website

PGE's RFP website, hosted by the IE, is the platform for communication and bid materials exchanges between Bidders and PGE. All prospective Bidders, stakeholders, and other interested parties may register on PGE's RFP website at www.PortlandGeneralRFP2018.com. The website is secure and password protected so that confidential information can be posted on and exchanged via the site.

Other features of the site include:

- The ability to download all public RFP documents, including copies of this document and all related contracts, term sheets and appendices.
- An announcement board for posting of information for the public and Bidders.
- The capability for Bidders to anonymously post questions and comments that can be seen by all users.
- Confidential bid folders for each bid, for the retention and exchange of bid-specific data.
- Confidential evaluation folders for bid evaluation and retention of data for use during regulatory proceedings.

## 3.2 Procedural and Commercial Questions

All correspondence regarding procedural questions, bid submissions and questions related to product characteristics, terms and conditions should be submitted to PGE's RFP website at www.PortlandGeneralRFP2018.com. PGE, in consultation with the IE, as appropriate, will post answers to questions from Bidders, stakeholders, and other interested parties on the site.

## 3.3 Submitting Bids

Bidders may submit one or more bids responding to the requested renewable energy product (see the Requested Power Products section below). All bids must be submitted online using the bid form that PGE will provide on the RFP website, www.PortlandGeneralRFP2018.com, no later than 12:00 p.m. Pacific Time on June 15, 2018. The bid form will require Bidders to submit information in support of their bids, including but not limited to project description, transaction type and price, project development criteria and developer experience, interconnection and scheduling services, tax benefits, permitting,

project resource characteristics, operating costs, credit and financial, etc. Bidders may edit their online bid form until the bid submission deadline. At 12:00 p.m. Pacific Time on June 15, 2018, bid forms will be closed to edits, and will be considered to be final submissions.

PGE's Benchmark Bid must also be submitted online no later than 12:00 p.m. Pacific Time on May 28th. PGE's benchmark bid will be considered final and complete following this deadline.

### 3.4 Bid Fee

To help defray the costs of the IE and encourage high quality proposals and qualified Bidders, each Bidder in this RFP must pay a non-refundable bid fee of $10,000. A bid may consist of one base proposal in addition to two alternatives for the same bid fee. The alternatives may consist of a different bid size, contract term, in-service date, and/or pricing structure for the same resource at the same location.

A proposal for a different resource at a different site will be considered a separate proposal and will be subject to a separate bid fee.

Fees are to be remitted via electronic funds transfer to PGE facilitated through the IE website. For purposes of assessing bid fees, the IE, in consultation with PGE, shall confirm whether a Bidder's submission constitutes one or more proposals based on the criteria described above.

### 3.5 Submitting a Confidentiality and Non-Disclosure Agreement

The Confidentiality and Non-Disclosure Agreement is available for completion at www.PortlandGeneralRFP2018.com (and is included as Appendix F to this RFP). Bidders are required to complete and sign the confidentiality agreement prior to the bid submission deadline (12:00 PM on June 15, 2018). The confidentiality agreement is to be submitted to PGE through the IE website. Due to the need to ensure uniform treatment of all confidential information, PGE will not accept changes to the Confidentiality and Non-Disclosure Agreement.

PGE will treat any proprietary and confidential information contained in a bid, in a manner consistent with the terms of the Confidentiality and Nondisclosure Agreement and any Protective Orders issued by the OPUC, provided that such information is clearly identified by the Bidder on each confidential page as "Confidential" or "Confidential Information." Each Bidder must execute and deliver a copy of the Confidentiality and Nondisclosure Agreement, as soon as possible, but no later than the time of the submission of its bid or bids. Confidentiality and Non-Disclosure Agreements received prior to June 1st 2018 will be countersigned and returned to bidder before June 15th 2018. *It is the Bidder's responsibility to indicate clearly in its proposal what materials and what pages it*

*deems to be "confidential" and subject to the Confidentiality and Nondisclosure Agreement*.

## 3.6 Validity of Price and Offer

By submitting a bid, the Bidder acknowledges and agrees that the terms of its proposal shall remain irrevocable for the earlier of 200 days after the bid responses are due or when PGE issues a written release of the bid at or before the time the short list is issued.

## 3.7 Bid Evaluation Criteria

Bids will be assessed by PGE and the IE on the project's economic competitiveness, project specific commercial and performance risks, and portfolio economic risk. All bids will be evaluated within an individual offer analysis to assign a bid price and non-price score. Consistent with prior practice, PGE's price score comprises 60 percent of our evaluation criteria, reflecting PGE's desire and commitment to obtain the best possible value for our customers. Non-price factors comprise the other 40 percent and reflect commercial and performance risks in addition to operational attributes of the bid proposals. Additional description of the bid evaluation criteria is provided in Section 8 of this document "Criteria Used for Scoring Qualified Bids".

## 3.8 Reservation of Rights

This RFP is not, and shall not be construed to be, an offer by PGE. PGE is not bound to enter into negotiations or execute an agreement with, or purchase any products from, any Bidder as a result of this RFP. No rights shall be vested in any Bidder, individual or entity by virtue of its preparation to participate in, or its participation in, this RFP. No binding commitment shall arise on the part of PGE to any Bidder under this RFP until and unless the parties execute definitive agreements that become effective in accordance with their terms.

Each Bidder shall be solely responsible for all costs it incurs in preparing to participate in, participating in, or responding to this RFP.

The bids received will be evaluated and selected based on the information supplied by each Bidder pursuant to this RFP. PGE reserves the right to modify or withdraw from this RFP process, or modify the schedule and any provisions contained herein, for any reason. PGE also reserves the right, consistent with the Competitive Bidding Guidelines, to make purchase commitments at any time to suppliers not participating in this RFP process.

PGE reserves to itself:

- The selection of final short-listed bids and the awarding of contracts, if any, in the exercise of its sole discretion.

- The right to short-list projects with energy amounts in excess of its target to ensure sufficient back-up proposals are available should other bidders materially depart from their bids during the negotiation phase. PGE anticipates short-listing a minimum of approximately 150% of its targeted energy amounts.
- The right to reject any and all bids, and any portion of a specific bid for any reason.
- The right to waive any immaterial non-conformity in any bid received.
- The right to award a contract to a Bidder based on a combination of price and non-price factors, a quantitative and qualitative assessment of portfolio fit, and post-bid negotiations.

## 3.9 Document Retention

All bids and exhibits supplied to PGE during the RFP process will become the property of PGE. PGE will retain all bid materials supplied to it and pertinent information generated internally by it in connection with the RFP process in accordance with PGE's document retention policies.

# 4 Requested Power Products

PGE requests proposals for renewable energy products, as described in this RFP.

Renewable resources must meet the requirements of Oregon's RPS, as defined in ORS 469A. In addition, renewable bids must include all environmental attributes, including Renewable Energy Certificates (RECs). Bidders will be responsible for ensuring RECs from projects are bundled as defined in ORS 469A.005. Bidders will also be responsible for ensuring that RECs are established through Western Renewable Energy Generation Information System (WREGIS) consistent with OAR 330-160-0020.

PGE is targeting approximately 100 MWa of renewable energy resources in this RFP. However, PGE reserves the right to vary from the target based on evaluation of price and risk factors of received bids.[3] PGE has expedited the RFP to enable capture of federal renewable tax credits including the PTC and ITC given the planned decline for each. Preference will be given to RFP resources and bids that offer the ability to maximize cost savings to customers.

**Table 1: Summary of Requested Renewable Energy Products**

| Product | Capacity | Online/Contract Start Date | | Term |
|---|---|---|---|---|
| | Minimum | Preferred - No later than | No later than | Minimum |
| Power Purchase Agreement | 10 MW | Dec 31, 2020 | Dec 31, 2021 | 20 years |
| Ownership | 10 MW | Dec 31, 2020 | Dec 31, 2021 | NA |

## 4.1 Renewable Electric Energy Products Requested

*Physical Energy Purchase* – PGE will consider proposals for the long-term purchase of renewable energy from an existing or to-be-constructed renewable facility, with energy to be delivered to PGE. The minimum bid capacity under this RFP is 10 MW, and the minimum term duration is twenty years.

*Ownership Position in a Renewable Energy Resource* – PGE will consider acquiring ownership positions in renewable energy resources. Ownership proposals may include (but are not limited to) the sale of existing plants, acquisition of project development rights, joint ownership, and build-own-transfer agreements.

[3] Including not procuring any energy resources through this RFP process.

PGE will also consider hybrid structures that include both an ownership component and a PPA (e.g. the sale of a phase or portion of a project with an off-take agreement for the balance or a PPA with purchase option or obligation).

## 4.2 Scheduling Requirements

Renewable energy sold to PGE via a long-term power purchase agreement must be delivered firm for each 60-minute scheduling interval. Alternate proposals delivered firm for periods longer than 60 minutes (i.e. day ahead, firm blocks, etc.) will also be considered, if proposed. For the purposes of this RFP, delivered firm energy means the only excuse for failure to deliver or receive is force majeure, as defined in the purchase agreement. Firm energy includes reserves and ancillary services to ensure that energy schedules are certain and delivered intact throughout the 60-minute interval.

## 4.3 Delivery Point and Transmission

PGE is electrically connected to both Bonneville Power Administration (BPA) and PacifiCorp West. However, at this time and for the purposes of this RFP, the PacifiCorp West interface has been determined to have insufficient available capacity and is unavailable. For Bidders with projects outside of PGE's Balancing Authority Area (BAA), it is the Bidders' responsibility to provide as part of the bid submittal a reasonable and achievable plan to obtain annual long-term firm transmission from the resource to the delivery point prior to project Commercial Operation Date (COD). Bidders relying on BPA for Transmission Service are required, at a minimum, to have completed phase four (Record of Decision issued) of the TSR Study and Expansion Process (TSEP)[4] and require near-term viable upgrades to receive long-term firm service. Long-Term Firm transmission rights must match the duration of the contract term or include rollover rights. PGE's evaluation process will determine if there are additional costs or risks to deliver the resource to PGE load.

Bidders proposing to interconnect a resource within PGE's Balancing Authority Area will need to include all incremental costs to deliver, or sink, energy from the resource to PGE's load. Bidders can determine these costs by requesting Network Resource Interconnection Service and Network Integration Transmission Service under PGE's Open Access Transmission Tariff (OATT) from PGE's Transmission and Reliability Services Department (T&RS) or Bidders can request Energy Resource Interconnection Service and Point-to-Point Transmission Service under PGE's OATT from T&RS. Either process will enable T&RS to study whether any system upgrades are needed to accommodate transmission service for the bid. Questions concerning the various types of Interconnection and Transmission Service available under PGE's OATT should be directed to T&RS.

[4] Transmission Service Request Study and Expansion Process

Bidders relying on PGE transmission are required to have completed Facilities Studies for Transmission Service and subsequent Construction Agreements.

If during the evaluation, PGE determines that a Bidder's proposed transmission plan cannot demonstrate firm delivery to an acceptable delivery point, the proposal may be rejected. Long-Term Firm delivery capability or other demonstrable transmission rights to enable delivery to PGE's load, are subject to negotiation and confirmation prior to execution of any contracts in connection with this RFP.

For the purposes of scoring bids in this RFP, for resources outside PGE's BAA, acceptable delivery point is:

- BPAT.PGE

When requesting transmission service from BPA, the BPAT.PGE Point of Delivery is associated with the following substations or "sinks":

- PGE Contiguous
  - Pearl 230 kV (Sherwood)
  - McLoughlin 230 kV
  - Keeler 230 kV (St. Marys)
  - Rivergate 230 kV
- Bethel 230 kV
- Troutdale 230 kV (Blue Lake)

# 5 Contract Terms and Conditions

## 5.1 Energy Purchase Agreement

The contract template for power purchases is included in Appendix A – Wholesale Renewable Power Purchase Agreement ("Form PPA"). Bidders must review the Form PPA included in this RFP, and are required to include any proposed revisions to contract terms by providing a mark up to the PPA Form. Bidders are required to identify, through comments, exceptions to any term or condition. Additionally, Bidders are **required** to propose alternative terms and conditions in redline format to the highlighted terms and conditions in the Form PPA. Should proposed revisions to highlighted terms and conditions increase PGE's exposure to risks related to project schedule, performance or cost then PGE will adjust the Bid's non-price score consistent with Appendix H. PGE will evaluate all proposed revisions, but is under no obligation to accept any revisions or adopt any changes. Changes, if any, to the terms and conditions of the term sheet and the Form PPA will be discussed with Bidders on the final short list.

The Form PPA invites bidders to offer a purchase option for the facility. If Bidders elect to propose an end of term or during term option for PGE to purchase the facility, or an option for PGE to extend the term of the PPA, it should include such proposed option in its mark-up of the agreement. Proposed purchase options and/or term extensions will be evaluated in PGE's price scoring assessment and non-price scoring assessment consistent with Appendix H.

PGE recognizes that alternative firm energy sale structures may be available and Bidders proposing such alternatives must offer revisions to the Form PPA and also propose a new term sheet.

## 5.2 Ownership Position in a Renewable Energy Resource

PGE invites Bidders to submit proposals for various types of asset sale and ownership transfer or service agreements. The contract templates are included in Appendix B and C – Asset Purchase Agreement ("Form APA") and Engineering Procurement and Construction Agreement ("Form EPC"). Bidders are required to identify, through comments, exceptions to any term or condition in the form contracts. Additionally, bidders are **required** to propose alternative terms and conditions in redline format to the highlighted terms and conditions in the Form APA and Form EPC. Should proposed revisions to highlighted terms and conditions increase PGE's exposure to risks related to project schedule, performance or cost then PGE will adjust the Bid's non-price score consistent with Appendix H.

PGE recognizes that alternative ownership structures may be available and Bidders proposing such alternatives must offer revisions to the Form APA and EPC and also propose a new term sheet. Changes to terms and conditions and/or new terms and conditions will be discussed with Bidders selected for final short list negotiations.

Ownership proposals may include (but are not limited to) sales of existing assets, acquisition of project development rights, build-own-transfer (BOT) agreements or joint ownership. We will also consider hybrid structures that include both an ownership component and a power purchase agreement (e.g. the sale of a phase or portion of a project with an off-take agreement for the balance or a PPA with purchase option or obligation).

Lastly, bids for new, utility ownership resources are expected to be procured and constructed in accordance with PGE's established technical requirements. Appendix G details PGE's technical requirements for the purchase of new wind and solar facilities in addition to general specification applicable to all new generation technologies. Bidders submitting ownership bids must review the technical specifications to ensure that the bid and associated price reflects PGE's identified requirements. Should a Bidder wish to offer a product different than that suggested by the technical specifications, the Bidder is required to identify through a template exception log which specifications the Bidder takes exception to and identify a cost estimate necessary to align the Bid with the technical specifications. PGE will consider whether the proposed exception is acceptable before applying any owner's cost adjustment necessary to align the Bid with the technical specifications.

# 6 Bid Pre-Qualifications

To be considered for evaluation, all proposals must meet the requirements specified below.

## 6.1 General

The following general pre-qualifications apply to all bids to be evaluated in this RFP.

### 6.1.1 Minimum Bid Quantity

The minimum bid amount is 10 MW. PGE has specified a low minimum bid size to encourage the submission of a variety of renewable bid technologies in this RFP. Renewable projects 10 MW or under may be eligible for PGE's Schedule 201 Qualifying Facilities Standard Contract Power Purchase Agreement. PGE is not accepting Schedule 201 Standard Contracts or Schedule 202 contracts in this RFP. Additional information about Schedule 201 contracts can be found here: https://www.portlandgeneral.com/business/power-choices-pricing/renewable-power/install-solar-wind-more/sell-power-to-pge

### 6.1.2 Minimum Bid Term

The minimum bid term is twenty years. The resource must be delivered to PGE no later than December 31, 2021. PGE prefers resources delivered to PGE after December 31 2019 and on or before December 31, 2020.

### 6.1.3 Qualifying Product

Bids must sell to PGE output from or title to an identified renewable resource. Renewable resources must meet the requirements of Oregon's RPS, as defined in ORS 469A. In addition, renewable bids must include all environmental attributes, including Renewable Energy Certificates (RECs). Bidders will be responsible for ensuring RECs from projects are bundled as defined in ORS 469A.005. The Bidder will also be responsible for ensuring that RECs are established through Western Renewable Energy Generation Information System (WREGIS) consistent with OAR 330-160-0020.

### 6.1.4 Credit and Bidder Qualifications

To be eligible for bidding a Bidder must be demonstrate an ability to secure necessary pre-COD performance assurances in the form of a letter of credit from a qualified institution. Furthermore, a Bidder offering a utility owned resource will also be required to secure a guarantee if the Bidder is not investment grade. Appendix D includes PGE's Guarantee

Form. To be considered investment grade, Bidder's or Bidder's credit support provider's (if any) long-term, senior unsecured debt, that is not supported by third-party credit enhancement, must be rated by one or more of the following agencies as follows: BBB- or higher by Standard & Poor's and Fitch, BBB (low) by DBRS, or Baa3 or higher by Moody's Investor Services, Inc. If the Bidder or Bidder's credit support provider is rated by more than one agency, PGE will consider the lowest rating.

All transactions are contingent upon the Bidder meeting and maintaining the credit requirements established by PGE's Credit Risk Management Department. PGE's Risk Management credit requirements provide PGE reasonable assurance that PGE will be able to readily recover its actual damages in the event of default by the Bidder. Final collateral requirements will be determined prior to execution of an agreement.

Additional detail on the PGE's Credit Requirements, including necessary documentation of guarantor commitments can be found in Appendix E.

### 6.1.5 PURPA Status

Bidders with projects that are QFs under FERC rules are welcomed to bid such projects into this RFP under the terms and conditions of this RFP, and not as QFs. In any event, Bidders with projects that have an executed contract with PGE or are actively negotiating a contract under Schedule 202 are not eligible to bid the project in this RFP . If a Bidder wishes to withdraw its project from negotiations under Schedule 202, PGE invites the Bidder to bid the project into this RFP, provided the Bidder has notified PGE accordingly. Importantly, agreements entered into with any counterparty as a result of PGE's competitive solicitation will be consistent with the pricing and Form Contract term and conditions provided at time of bidding and reviewed through post-bid negotiations. For the avoidance of doubt, Bidders will not be awarded contracts with standard avoided cost pricing or standard contract terms and conditions.

### 6.1.6 Transmission

For those resources located outside PGE's BAA, Bidders must provide a reasonable, achievable plan for acquiring long-term firm transmission service to deliver to an acceptable delivery point prior to project COD.

Bidders interconnecting directly to PGE should meet the requirements in Section 4.3 above.

PGE will not entertain Bids that propose assignment of PGE's transmission rights to deliver to an acceptable delivery point.

### 6.1.7 Resource Delivery

For those resources located outside PGE's BAA, resource output must be delivered firm for each 60-minute scheduling interval. Alternate proposals to deliver firm for periods longer than 60 minutes (i.e. day ahead, firm blocks, etc.) will also be considered. For the purposes of this RFP, delivered firm energy means the only excuse for failure to deliver or receive is force majeure, as defined in the purchase agreement. Firm energy includes reserves and ancillary services to ensure that energy schedules are certain and delivered intact throughout the 60-minute interval.

### 6.1.8 Resource Availability

Bidders must include evidence substantiating the Bid's forecasted energy deliveries. Wind, solar and hydro bids must include at least three years of forecasted facility level generation consistent with a contemporaneous period of historical wind, irradiance or stream flow observations. Bidders must also provide average, expected generation for each month-hour (presented in a 12x24 table). The historical and average energy output estimates must be produced by a qualified independent third-party or consistent with an included energy assessment.

Geothermal Bids must have completed and included the resource's feasibility report based on a year or more of test data from full diameter production wells.

Biomass Bids must demonstrate physical and commercial access to fuel supplies and fuel transportation for the term of the contract proposed in the bid. PGE will not accept Bids for biomass or biogas projects that pass fuel obligations to PGE.

### 6.1.9 Other Bidder Pre-qualification

As applicable, the Bidder must provide documentation, satisfactory to PGE, that it is authorized under the law to sell power, and able to schedule power and operate under industry standards established by the Federal Energy Regulatory Commission (FERC), Western Electricity Coordinating Council (WECC), and the North American Energy Reliability Council (NERC), or other applicable regulatory body or government agency.

## 6.2 For New Projects

The following new project pre-qualifications apply to Bids for projects not yet constructed.

### 6.2.1 Site Control

Bidders must support the Bid by demonstrating dependable site control. At the time of bid submission, Bidders must possess title to the site, have executed a lease agreement, or executed an option agreement applicable to a minimum of 80% of the project site. Prior to placement on PGE's final shortlist, Bidders will be required to demonstrate site control for 100% of the project site.

### 6.2.2 Permitting

Bidders must prepare a detailed plan that lists all required site-specific permits and have a plan or schedule for obtaining all permits and licenses. PGE will assess the probability of successfully completing the permitting process as part of its evaluation. If at any point it is determined that a project cannot obtain the required permits as designed, PGE reserves the right to reject the Bid.

In addition, at time of bid submission Bidders must have received approval of many material permits. A complete list of the permitting threshold requirements can be found in Appendix H.

### 6.2.3 Financing

As applicable, Bidders must provide a reasonable plan to obtain project financing. Those Bidders who are unable to internally or balance sheet finance the proposed project (supported by appropriate financial statements) must provide evidence of a good faith commitment from a financial institution or lender prior to placement on PGE's final shortlist.

### 6.2.4 Technology

Proposals shall use utility-scale, commercially viable generation technology currently deployed in the western United States. PGE will only consider Bids that use widely deployed generating technologies with proven records of reliability. For new, utility-ownership resources the major equipment as defined in Appendix H and Appendix G must be supplied by one of the identified preferred vendors.

PGE will not accept generation technology shown to have serial defects. Serial defects are considered to be a design or manufacturing problem that has affected 10% or more of the installed models. Generation technology must comply with all current applicable Codes and Standards for a USA-based resource.

Bidders may contact the IE in the event that they are uncertain whether their choice of specific generation technology is acceptable to PGE. Such

requests need to be received by the IE no later than May 15 2018.[5] PGE will review any such information as to their suitability for meeting our renewable energy requirements. PGE and the IE will respond to such requests within two weeks of receipt.

### 6.2.5 Equipment and Construction Costs

To be eligible to bid, Bidders must include a quote, commitment, or documentation of purchase from a wind turbine, photovoltaic panel, or steam turbine manufacturer. For utility-ownership projects, bids must also include EPC quotes to construct the facility. For utility-ownership projects the bid price estimate must be consistent with the equipment supplier and EPC contractor (or BOT agreement) documentation.

### 6.2.6 Tax Credit Eligibility

Offers that intend to utilize PTC federal tax credits will need to demonstrate the project's eligibility for the specified credit. PGE requires a narrative and plan describing the timeline to achieve the associated federal tax benefit. In addition, PGE requires a tax opinion from a qualified tax expert to further substantiate the Bidder's plan to generate PTCs. Offers that intend to utilize ITC federal tax credits must demonstrate a reasonable plan to obtain the credits.

### 6.2.7 Interconnection

All Bidders must have executed a System Impact Study Agreement prior to bid submittal in order to be evaluated in the RFP. Bidders that have not completed an Interconnection Study Agreement prior to placement on PGE's Final Shortlist will be deemed unready for construction and will be disqualified from the evaluation.

[5] The IE can be contacted through the RFP website. The notification should identify the manufacturer and model the Bidder intends to include in a bid and include preliminary design studies – completed in sufficient detail to identify all major equipment and components.

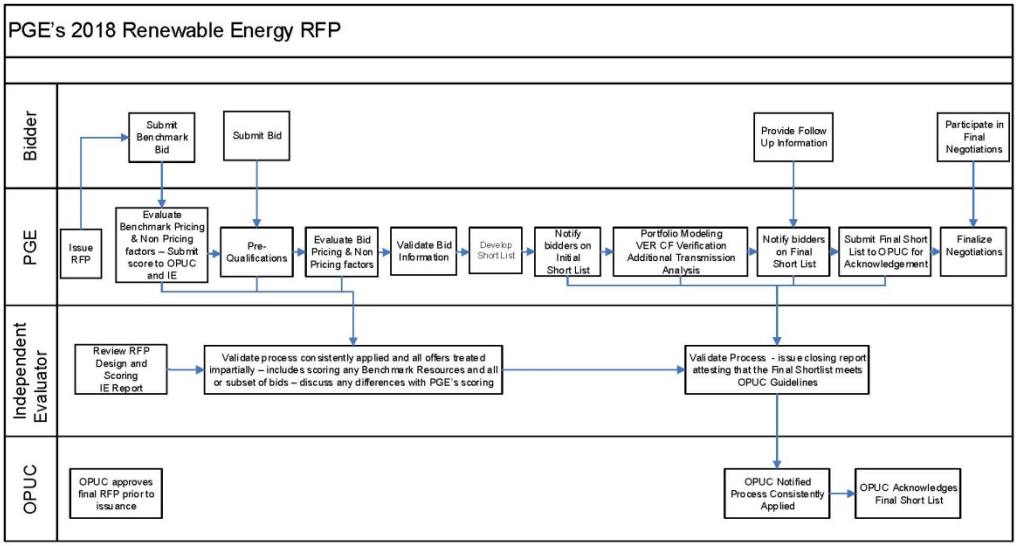
# 7 Bid Evaluation Process

This section describes PGE's process for evaluating Bids received in response to this RFP. For details about our scoring criteria, see the sections, "Bid Pre-Qualifications," and "Criteria Used for Scoring Qualified Bids."

## 7.1 Reviewing, Ranking and Selecting Bids

In selecting the RFP short list, PGE will use a first-price, sealed-bid format. Under this format, Bidders may not update pricing during the scoring and evaluation period. PGE's evaluation of offers will be based on prices submitted within Bidders' delivered bids, in conjunction with specified non-price criteria to select PGE's initial short list. As stated in more detail in Section 5 and below, certain differences from PGE's proposed contract terms and conditions may be addressed during post-bid negotiations. The scoring process is illustrated in Figure 2, below.

**Figure 2. Resource Selection Process**




Bids will be evaluated using a three-step process.

- *Assessment of Pre-Qualifications* – First, PGE will screen bids according to pre-established qualifying criteria described in Section Six and enumerated in Appendix M.
- *Individual Offer Analysis* – Next, PGE will score all Bids that meet the pre-qualification standards. Individual Overall scores will be comprised of price and non-price factors.

- *Short-list Analysis* - Resources selected for the initial short list will be included in PGE's portfolio analysis. Portfolio analysis will evaluate how short-listed resources affect overall system costs and risks when combined with other resources to meet PGE's resource target. Shortlisted resources will also be subjected to additional capacity factor and energy assessments review, owner's cost analysis, accounting treatment analysis, and final shortlist stage pre-qualification assessment, each as applicable.

PGE reserves the right to request additional information regarding any Bids submitted.

## 7.2 Bidder Feedback

Upon request, PGE will offer feedback to unsuccessful Bidders on the competitiveness of their proposals. PGE will make available this feedback after executing all agreements with successful Bidders, or after announcing the termination of the solicitation. PGE will not disclose any third-party confidential information through this voluntary feedback process. PGE will identify the relative performance of their Bid by identifying a Bid's quartile performance in price, non-price and total score. Furthermore, as appropriate, PGE will identify all minimum thresholds the Bid did not achieve.

# 8 Criteria Used for Scoring Qualified Bids

This section summarizes the criteria PGE will use to evaluate Bids submitted in response to the RFP.

Price represents a significant portion of the overall score. The price score will be calculated as the ratio of the bid's projected total cost per MWh to forecast market value using real-levelized or annuity methods (per Guideline 9a. of the Competitive Bidding Guidelines). The price scoring will incorporate benefits related to the expected energy value, capacity value and flexibility value associated with the offers.

Many project specific risks and benefits cannot be captured or quantified by evaluating resource price or resource portfolio cost benefit. For those projects, PGE evaluates and assigns a non-price score for specific development criteria, physical characteristics, performance certainty, and credit factors consistent with the detailed non-price scoring rubric included in Appendix H.

## 8.1 Determination of the Offer Cost

An offer's cost reflects the total cost, fixed and variable, associated with the project's delivery of energy and forecasted economic dispatch.

An offer's fixed costs include all revenue requirement components including, for resources to be owned by PGE: total depreciation, salvage, return, income taxes, deferred income taxes, property taxes, fixed O&M, wheeling charges, and ancillary services. For resources contracted for by PGE, an offer's fixed cost includes all forecasted fixed payments, capacity charges, ancillary services, if appropriate, and PGE system upgrade costs, if applicable.

An offer's variable costs include for resources to be owned by PGE: all fuel costs, variable O&M, emissions costs, start-up costs. For resources contracted for by PGE, an offer's variable cost includes all energy payments, additional variable O&M costs, emission costs passed onto the buyer, and start up charges, if applicable. The magnitude of an offer's variable costs will be determined by the offer's simulated dispatch against forecasted market prices using PGE's IRP economic dispatch AURORA software.

To evaluate Bids containing different product characteristics on a comparable basis, prices submitted by the Bidder may be subject to adjustment to ensure Bids are evaluated on a comparable basis.

An offer's total cost for the duration of the offer's term is expressed on a present value basis and included in the numerator of the offer's price scoring ratio.

## 8.2 Determination of the Energy Value

An offer's energy value reflects the value of energy generated throughout the offer's economic life or term. Energy value for the duration of the offer's term is expressed on a present-value basis and included in the denominator of an offer's cost to benefit price score ratio. The energy value will be based on the offer's simulated dispatch and the projected revenue associated with PGE's hourly market price forecast. The market price forecast is developed as follows:

- The hourly spot electricity price forecast is developed using a fundamental market simulation in AURORA, the principles of which are described in Chapter 10 of PGE's 2016 IRP. Electricity prices are simulated for the period 2018–2050.
- AURORA will use natural gas price inputs consistent with PGE's 2016 IRP Update reference case methodology forecast.

## 8.3 Determination of Capacity Benefits

An offer's capacity benefit reflects PGE's need to acquire new, physical capacity resources due to the offer's estimated system capacity value. PGE is facing a capacity deficit, and requires capacity products, to otherwise displace the need to contract with or construct new peaking generating facilities. The capacity benefit will be included in the denominator of the offers cost to benefit price score ratio.

An offer's capacity benefit will be calculated as the product of the offer's capacity value and the avoided capacity cost. The product's capacity value will be calculated annually using the Renewable Energy Capacity Planning (RECAP) model. RECAP is described in Chapter 5 of the 2016 IRP. The model has been updated to accurately reflect the assumptions included in PGE's 2016 IRP Update filed in March 2018. The offer's capacity value will be expressed as the quantity of avoided simple-cycle combustion turbine (SCCT) needed to meet PGE's long-term capacity targets. The avoided capacity cost will be based on a per kilowatt, real-levelized cost (net of wholesale revenues) of a simple-cycle combustion turbine (SCCT). The assumed costs and performance of the SCCT are consistent with 2016 IRP capital costs and performance metrics (described in Chapter 7) operated under the updated reference case gas and wholesale power prices. The product of the offer's annual capacity value and levelized avoided capacity cost constitute the offers annual capacity benefit. Capacity benefit for the duration of the offer's term is expressed on a present value basis and included in the denominator of the price score ratio.

## 8.4 Determination of Flexibility Benefits

The flexibility value associated with an offer reflects any additional value that the offer may bring to PGE's generation portfolio due to its ability to ramp, respond to

forecast errors, and/or provide ancillary services that is not captured by its energy value. For example, a resource that can provide ancillary services at a lower cost than PGE's current resource fleet is recognized for the associated reduced cost of existing PGE resources. PGE approximates flexibility benefits using the Resource Optimization Model (ROM), which the Company relied on in the 2016 IRP to quantify flexibility value associated with energy storage systems and the costs due to flexibility challenges (i.e., integration costs) associated with variable renewable resources. An offer's flexibility benefit is calculated using a methodology further explained in Appendix E. The flexibility benefit for the duration of the offer's term is expressed on a present value basis and is included in the denominator of the offer's cost to benefit price score ratio.

## 8.5 Adjustments to Prices Submitted by Bidders

Price represents a significant portion of the overall score. To evaluate offers containing different product characteristics on a comparable basis, prices submitted by the Bidder will be subject to adjustment for the following considerations:

*Delivery Point* – Applicable transmission service costs will be applied in order to capture the incremental cost of delivering energy to PGE. These costs include wheeling, losses, and required ancillary services as prescribed in applicable tariffs, as well as any incremental costs for transmission or distribution system improvements necessary to deliver the energy to PGE.

However, for Bids where the Bidder has secured and is paying for point-to-point transmission services for delivery from the generation facility to an acceptable delivery point and the offer contains all applicable service costs identified above, no other transmission costs for those point-to-point services will be applied.

*Interconnection* – Applicable interconnection costs will be applied in order to capture the identified interconnection upgrade costs identified in a System Impact Study and updated following completion of an Interconnection Facility Study.

However, for Bids where the Bidder has secured an interconnection agreement and included the appropriate interconnection costs into the Bid price, no other interconnection costs will be applied.

*PGE line loss* – All bids, regardless of their point of interconnection, will be applied a generic line loss consistent with PGE's OATT Schedule 11.

*Ancillary Services* – If ancillary services are not included in product pricing, Bids will, at a minimum, be adjusted to account for ancillary services (where applicable) to meet control area operations and transmission provider requirements.

Bidders shall provide a comprehensive list of all ancillary services they are planning to provide in delivering the power product to the point-of-delivery. To the extent that any of these required ancillary services are not being supplied by the Bidder, PGE will, for scoring purposes, adjust the price provided by the Bidder to reflect the cost of acquiring additional ancillary services required. Price adjustments will be consistent with tariffed rates or PGE study results consistent with IRP methodology.

*Owner's Costs –*

During PGE's initial offer analysis, PGE will assign generic owner's costs to all utility-ownership resources. These costs reflect estimated PGE project management, execution, oversight, and integration costs, as applicable.

*Operations and Maintenance-*

Utility-ownership Bids are required to detail expected operations and maintenance costs and provide quotes or contracts for long-term maintenance agreements, if available. If the long-term maintenance agreement costs are not provided PGE will compare Bidder supplied O&M costs to the estimated generic O&M costs for like resource in the most recently published IRP. Should Bidder's expected costs significantly differ from the generic estimates, Bidders will be asked to further substantiate their O&M costs. Should PGE find Bidder evidence inadequate, PGE will instead apply generic O&M costs from the most recently published IRP.

*Performance Assurances -*

PGE retains the right to adjust the Bid price to include performance assurance costs should the Bidder take exception to and redline pre and post COD performance assurances identified in PGE's Form Contracts.

*Tax Credit Carrying Costs –*

For those resources eligible for federal tax credits and bid a utility-ownership proposal, PGE will evaluate PGE's customer costs associated with PGE's utilization of the incremental tax credits. PGE intends to pass the revenue requirement benefit of the tax credits to customers on an as-generated basis for PTCs and over the life of the asset – due to normalization rules – for ITCs. To the extent that PGE cannot utilize a tax credit on its federal return in the same year it is credited to customers, PGE will incur a carrying cost. The ongoing carrying cost of forecasted incremental tax credit carrying costs will be assigned to the applicable Bids.

## 8.6 Detailed Offer Price Scoring

Following the quantification of offer costs and benefits, including any necessary offer price adjustments described above, each offer's component cost and benefits will be converted to a cost to benefit price score ratio. Real-levelized offer costs, divided by the equivalent real-levelized benefits value (incorporating energy, capacity, and flexibility benefits) will be the basis for the offer's price ratio. The 600 points associated with the price scoring section will be allocated on a scaled basis, with the lowest price ratio offer receiving 600 Points.

## 8.7 Offer Price Screen

Consistent with PGE's 2016 IRP Addendum, PGE requires all Bids to pass a cost-containment screen in order to be considered for the short list. The cost containment screen requires Bids to be cost-effective under Reference Case conditions considering only the resource's forecasted energy and capacity values.

PGE's cost-containment screen compares the levelized cost of a renewable resource to the levelized energy, capacity and flexibility value of the renewable resource. To measure levelized costs, PGE will annuitize the present value revenue requirement of the proposed resource. To measure levelized value, PGE will first calculate the energy value of the proposed resource using resource specific generation profiles. Because each resource occupies a unique location with a different generating technology, each resource will be assigned a specific energy value in each year of operation using the hourly forecasted energy price under Reference Case conditions. The resource's levelized energy value reflects the annuitized present value of the resource's generated energy. Each resource will also have a calculated capacity value that reflects the product of the resource's capacity contribution, as calculated using the RECAP methodology, and the avoided costs associated with a generic capacity resource. The levelized capacity value reflects the annuitized present value of the resource's avoided generic capacity costs. Each resource will also have a calculated flexibility value that reflects the product of the resource's flexible range and estimated flexibility benefit calculated using ROM and further detailed in Appendix H. The resource's levelized flexibility value reflects the annuitized present value of the resource's annual flexible value. PGE's RFP price screen is consistent with the acknowledged 2016 IRP Addendum and ensures that the levelized energy, capacity and flexibility value of near-term renewable additions exceed the levelized cost of the associated resource.

The cost-containment screen will be unique for each resource evaluated by PGE. The screen will elevate resources that provide more value to PGE customers due to the resource's geographic diversity. For this reason it is possible that a lower priced resource does not pass the economic screen, while a higher priced

resource passes the economic screen due to increased resource value (e.g., higher capacity contribution or more valuable energy production profile).

## 8.8 Non-Price Factors

### 8.8.1 Project Development Criteria

This category scores the likelihood that a project supporting a Bid will be placed in commercial service. The evaluation criteria for this category generally address construction and development risks associated with the completion of projects that are not yet in commercial operation, and which are necessary to support Bids. Plants that are already operating or are sufficiently advanced in construction may be deemed to earn the maximum possible score in this category.

For projects that are less advanced, some of the characteristics we will consider in our scoring are:

- Status of required permits, licenses and environmental studies.
- Project team experience.
- Method and status of project financing.
- Site Control.
- Cost certainty.
  - Status of equipment quotes.
  - Sale or PPA price structure.
- Project life and extension options. Bids that allow PGE to extend the life of a resource beyond the initial term, or Bids allowing for PGE to continue facility operation, provide opportunities for PGE to lower long term energy supply costs and risks.

### 8.8.2 Project Physical Characteristics

This category captures the physical characteristic risks of the Bid products. The evaluation criteria for this category generally address physical and operational risks associated with the production and delivery of power to PGE. Some of the characteristics that we will consider in our scoring are:

- Delivery points (as discussed above), includes interconnection, transmission, and curtailment.
- Remedial action schemes (RAS) – projects that PGE is able to use as a credit for its obligation to support AC intertie RAS will receive additional points. Projects subject to a RAS obligation outside of the AC intertie will have points subtracted.

- Engineering reliability characteristics.
- Resource fuel availability confidence.

### 8.8.3 Project Performance Certainty

This category scores how well the Bid product matches PGE's system operating needs. The evaluation criteria for this category generally address price risk, performance and supply portfolio concentration risks, along with the benefits of operational flexibility. Some of the characteristics that we will consider in our scoring are:

- Quality of power.
  - Firmness of energy.
  - Scheduling period commitment.
- Contract/resource start date
- Performance guarantees and compensation for failure to achieve them.
- Deviations from product term sheet.

### 8.8.4 Credit Evaluation

This category scores the creditworthiness of the Bidder. We will take into account the following credit considerations in our scoring:

- Debt and equity ratings.
- Financial ratio analysis.
- Bond risk.
- Tangible net worth.
- Corporate structure.

# 9 Final Short List Determination

For the short list, PGE intends to include Bids representing a minimum of 150% of the renewable energy requested in this RFP, subject to receipt of a sufficient quantity and quality of Bids. Once the short list has been developed pursuant to the scoring criteria outlined above, PGE will refine bid evaluations in the following areas to determine the final short list:

*Review of Capacity Factor Assumptions* – PGE will contract with an independent third party expert to review capacity factor assumptions for intermittent resources.

*Security for Performance Requirements* – PGE will perform a detailed credit risk evaluation of all Bidders on the shortlist, and will refine performance assurance requirements during this stage. However, performance assurance will only be required at the execution of a definitive agreement with a successful Bidder.

*Portfolio Analysis* – PGE will also take overall system costs and risks into account in its selection of final short list Bids. Portfolio modeling will provide PGE with additional information regarding the cost and risk profile of all offers considered. Portfolio analysis methods, consistent with the 2016 IRP, will demonstrate how resources perform together, on a cost and risk basis, due to their specific size, term, portfolio capacity value, and portfolio flexibility value.

Portfolio analysis begins with the assembly of portfolios evaluating many different unique combinations of resources. The candidate portfolios will be developed through multiple techniques including 1) portfolio size optimization, 2) portfolio net-cost optimization, 3) cost-screened resource permutations, and 4) additional analyst selected portfolios (if necessary).

Each portfolio will include sufficient resources to meet the targeted renewable volume in each year. The unique portfolio capacity value for each portfolio will be calculated using the IRP's RECAP methodology. The portfolio capacity calculation will recognize the resources' capacity diversity included in each portfolio. Any portfolio whose forecasted energy volume does not meet the targeted renewable volume will also include a specified fill resource ('fill'). Including a fill resource ensures the portfolio incorporates the total cost necessary to meet the long-term renewable target. The specified fill resource will be sized to fulfill the energy target in each year of the analysis.

Portfolio analysis will test combinations of resources across multiple futures. The futures will evaluate portfolio exposure to multiple scenarios of gas prices, hydro scenarios and carbon costs. For each portfolio, the relevant resources' variable costs and energy benefits will be calculated in AURORA under multiple

economic and hydro futures. The variable net income for each resource will be reported annually for all futures.

A unique portfolio flexibility value will be calculated using the portfolio flexibility tool. The portfolio flexibility calculation will recognize the flexibility diversity included in each portfolio.

For each portfolio, the portfolio flexibility value and the relevant resources' net incomes will be subtracted from the relevant resources' fixed costs to calculate the portfolio's total net cost for each future.

For each portfolio, the total present value net cost for years 2018 through 2050 under each future will be calculated to estimate the cost impact of the additions on the PGE system. This expected cost impact will be measured as the total portfolio net present value of revenue requirement (NPVRR) under reference case conditions. Portfolio risk will be evaluated using the standard deviation of future results. Portfolios will be ranked according to a blended cost and risk metric - based upon 50% on reference case expected cost and 50% based upon the standard deviation of portfolio costs. In addition, portfolio risk will be characterized using additional IRP risk metrics including severity, variability, and durability as described in the 2016 IRP Chapter 11.

Portfolio results will be stress tested under multiple energy targets and planning horizons.

Portfolio analysis performance will be based on the inclusion of specific offers across multiple top-performing portfolios. Those resources that appear most frequently in top-performing portfolios are those that best reduce portfolio cost and economic risks. However, non-price factors are not evaluated or considered in portfolio analysis.

*Accounting* – The accounting and tax implications of PPA's or asset acquisitions can be complex and the financial statement impacts may vary based on the facts and circumstances of each contract. For example, PPA contracts are commonly accounted for as operating or capital leases (or finance lease)[6], capital tax leases[7], or variable interest entities (VIE)[8]. PGE will not accept proposals that would be subject to VIE treatment, and PGE may require Bidders to make certain

[6] As defined by Accounting Standards Codification (ASC) 840 and 842.

[7] As defined by IRS Code Section 7701(e).

[8] As defined by ASC 810.

representations that all supporting information necessary for PGE to make this determination has been provided by the Bidder.

In order for PGE to properly evaluate and select Bids, PGE will require Bidders to supply adequate information necessary to analyze appropriate accounting treatment and its effects on PGE's financial statements. Examples of such information may include: identification of the asset for which the contract is dependent upon, percentage of output to be obtained by PGE from the asset, pricing (fixed vs. variable), decision-making surrounding design of the asset, length of term of PPA (including proposed extensions), useful life of the asset with supporting documentation, fair market value of the underlying asset, projected cash flows through the life of the underlying asset, executory costs, non-executory costs, tax attributes (e.g. investment tax credits, production tax credits, etc.), minimum production guarantees, debt associated with the underlying asset, financial data contained in the Bidder's financial statements, among others.

*Costs Associated with Direct and Imputed Debt* **-** If the contract is deemed to be an operating or capital (finance) lease, PGE would be required to capitalize on its balance sheet an asset equal to the present value of the non-executory minimum lease payments (or fair market value of the asset, whichever is lower) with a corresponding lease obligation liability. This is referred to as direct debt.

If the contract is deemed to be an executory contract and no amounts are recorded on PGE's balance sheet, credit rating agencies will impute an amount of debt associated with the underlying PPA using a pre-determined methodology. This amount of imputed debt would be incorporated into the determination of credit ratings for PGE. This is referred to as imputed debt.

PGE may take into consideration the impacts of direct and imputed debt into its evaluation and selection process.

# 10 Post-Bid Negotiations

PGE's goal is to conduct an efficient post-bid negotiation process. PGE will initiate negotiations with a short list of Bidders whose proposals rank highest in the evaluation process and whose proposed transactions, PGE believes in its sole discretion, offer value to PGE's energy supply portfolio for customers, and have a reasonable likelihood of being executed and performed.

The number of Bidders with whom negotiations will be held will depend upon the Bids received, the size or quantity of the highest ranked Bids as compared to our resource needs, the results of the scoring process, ability to access federal tax benefits and other factors described more fully in the sections "Bid Evaluation Process", "Criteria Used for Scoring Qualified Bids", and "Final Short List Determination." Selection for the final short-list and initiation of negotiations do not constitute a winning Bid.

PGE shall have no obligation to enter into a definitive agreement with any Bidder to this RFP and, at its sole discretion, may terminate negotiations with any Bidder at any time without liability or obligation to any Bidder. Whether or not, and until, negotiations with Bidders produce final and fully executed contracts satisfactory to PGE for its resource targets under the RFP, PGE reserves the right to pursue any and all other resource options available to it.

# 11 Appendix A - Power Purchase Agreement

APPENDIX A

# WHOLESALE RENEWABLE POWER PURCHASE AGREEMENT

Between

Portland General Electric Company

And

[*Seller*]

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This WHOLESALE RENEWABLE POWER PURCHASE AGREEMENT ("Agreement") is entered into effective as of the _____ day of _____, 201_ ("Effective Date"), by and between [*Seller*], a [*STATE*] limited liability company ("Seller"), and Portland General Electric Company, an Oregon corporation ("PGE"). PGE and Seller are also referred to in this Agreement individually as a "Party" and collectively as the "Parties."

## ARTICLE 1
## DEFINITIONS AND INTERPRETATION

1.1 Definitions.

As used in this Agreement, the following terms, when initially capitalized, shall have the meanings specified in this Section 1.1.

1.1.1 "AAA Procedures" has the meaning set forth in Section 18.2.

1.1.2 "Affiliate" means, with respect to a Party, any Person that, directly or indirectly, through one or more intermediaries, controls, or is controlled by, or is under common control with, such Party. For this purpose, "control" means the direct or indirect ownership of fifty percent (50%) or more of the outstanding capital stock or other equity interests having ordinary voting power.

1.1.3 "Agreement" means this Wholesale Renewable Power Purchase Agreement entered into between Seller and PGE and all incorporated appendices, exhibits, schedules and attachments to this Agreement, as the same may be amended by the Parties from time to time.

1.1.4 "Ancillary Services" means any of the services identified by a Transmission Provider in its transmission tariff as "ancillary services" including, but not limited to, energy imbalance services, generation imbalance services, regulation and frequency response services, reactive supply services, voltage control services, inadvertent energy flow services, control area services, system integration services, operating spinning reserve services, and operating supplemental reserve services.

1.1.5 "As-Available Energy" means any Firm Energy, measured in MWh, scheduled and delivered from the Facility to the Delivery Point during a month that exceeds the Specified Amounts for such month.

1.1.6 "Balancing Authority Area" means an electric power system or combination of electric power systems under the control of an operator who acts to (i) match, at all times, the power output of the electric generators within the electric power system(s) and the capacity and energy purchased from entities outside the electric power system(s), with the load within the electric power system(s), (ii) maintain scheduled interchange with other control areas, within the limits of Prudent Electric Industry Practice, (iii) maintain the frequency of the electric power system(s) within reasonable limits in accordance with Prudent Electric Utility Practice and (iv) provide sufficient generating capacity to maintain operating reserves in accordance with Prudent Electric Industry Practice.

1.1.7 "Bankrupt" means with respect to any entity, such entity (i) files a petition or otherwise commences, authorizes or acquiesces in the commencement of a proceeding or cause of action under any bankruptcy, insolvency, reorganization or similar law, or has any such petition filed or commenced against it and such petition filed or commenced against it is not dismissed after one hundred and eighty (180) days, (ii) makes an assignment or any general arrangement for the benefit of creditors, (iii) otherwise becomes bankrupt or insolvent (however evidenced), (iv) has a liquidator, administrator, receiver, trustee, conservator or similar official appointed with respect to it or any substantial portion of its property or assets, or (v) is generally unable to pay its debts as they fall due.

1.1.8 "Bundled REC" means a REC that, subject to the terms and conditions of this Agreement, is generated by the Facility and delivered simultaneously and directly to PGE together with the equivalent quantity of Energy generated by the Facility as a single bundled Product, as represented by the lesser of the final e-Tag or the actual Facility Output on an hourly basis.

1.1.9 "Business Day" means any day except a Saturday, Sunday, or a Federal Reserve Bank holiday. A Business Day shall open at 8:00 a.m. and close at 5:00 p.m. local time for the relevant Party's principal place of business. The relevant Party, in each instance unless otherwise specified, shall be the Party by whom the notice or payment or delivery is to be received.

1.1.10 "Capacity Attributes" means any current or future attribute, as may be currently defined or otherwise defined in the future, including but not limited to a characteristic, certificate, tag, credit, ancillary service or attribute thereof, or accounting construct, associated with the electric generation capability and capacity of the Facility or the Facility's capability and ability to produce or curtail energy, including any attribute counted towards any current or future resource adequacy or reserve requirements. Capacity Attributes are measured in MW. Notwithstanding any other provision of this Agreement, "Capacity Attributes" do not include: (i) any PTCs, ITCs, or any other tax credits, deductions, or tax benefits associated with the Facility, or (ii) any state, federal, local, or private cash payments or grants relating in any way to the Facility or the electric power output of the Facility.

1.1.11 "Claiming Party" has the meaning set forth in Section 4.2.

1.1.12 "Commercial Operation" means that not less than the Nameplate Capacity is fully operational and reliable and the Facility is fully interconnected, fully integrated, and synchronized with the Transmission System, all of which shall be Seller's responsibility to receive or obtain. Without limiting Seller's other obligations under this Agreement, Commercial Operation occurs when all of the following events (a) have occurred, and (b) remain simultaneously true and accurate as of the time at which Seller gives PGE notice that Commercial Operation has occurred:

(i) PGE has received a certificate addressed to PGE from a Licensed Professional Engineer stating that the Nameplate Capacity of the Facility is able

to generate electric power reliably in amounts and quality expected by this Agreement and in accordance with all other terms and conditions hereof;

(ii) Start-Up Testing of the Facility shall have been completed;

(iii) PGE has received a certificate addressed to PGE from a Licensed Professional Engineer stating that, in accordance with the Interconnection Agreement, all required Interconnection Facilities have been constructed, all required interconnection tests have been completed and the Facility is physically interconnected with the applicable Transmission System in conformance with the Interconnection Agreement and is able to deliver energy at no less than the Nameplate Capacity.

(iv) PGE has received confirmation from the Transmission Provider(s) that (a) the Facility has successfully achieved interconnected operations, and (b) Seller has paid all amounts due under the interconnection agreement, including, but not limited to required network upgrades.

(v) PGE has received confirmation from Seller and the applicable Transmission Provider(s) that Seller has obtained for the Facility long-term, firm, point-to-point transmission service agreement with roll over rights, sufficient to enable Energy to be transmitted from the Facility and delivered to the Delivery Point at no less than the Nameplate Capacity. ***[Note to bidders: Bidders may propose alternative transmission service arrangements. The quality of the proposed transmission service will be considered in PGE's evaluation of the bid.]***

(vi) PGE has received (1) a certificate addressed to PGE from an authorized officer of Seller stating that Seller has obtained or entered into all Facility Documents, and (2) copies of any Facility Documents requested by PGE; provided, however, that Seller may redact or omit confidential or commercial terms from non-public Facility Documents.

(vii) PGE has received an opinion from a Licensed Professional Engineer, or an attorney, licensed to practice in the state in which the Site is situated stating that Seller has all Permits and all other rights and agreements required to operate the Facility as contemplated by this Agreement in accordance with Law.

(viii) PGE shall have received all Performance Assurance required by this Agreement.

Seller shall provide written notice to PGE stating when Seller believes that the Facility has achieved Commercial Operation accompanied by the certificates described above. PGE shall have ten (10) days after receipt of Seller's notice either to confirm to Seller that all of the conditions to Commercial Operation have been satisfied or have occurred, or to state with specificity what PGE reasonably believes has not been satisfied. If, within such ten (10) day period, PGE does not

respond or notifies Seller confirming that the Facility has achieved Commercial Operation, the original date of receipt of Seller's notice shall be the Commercial Operation Date. If PGE notifies Seller within such ten (10) day period that PGE reasonably believes the Facility has not achieved Commercial Operation, the Commercial Operation Date shall not occur until Seller has addressed the concerns stated in PGE's notice to the mutual satisfaction of both Parties.

1.1.13 "Commercial Operation Date" means the date on which the Facility achieves Commercial Operation.

1.1.14 "Contract Termination Damages" has the meaning set forth in Section 3.1.12.

1.1.15 "Contract Year" means any consecutive twelve (12) month period during the Term, commencing at 00:00:00 hours on the Commercial Operation Date or any of its anniversaries and ending at 24:00:00 hours on the last day of such twelve (12) month period.

1.1.16 "Costs" means, with respect to a Party, brokerage fees, commissions and other similar third party transaction costs and expenses reasonably incurred by such Party in entering into new arrangements which replace this Agreement and all reasonable attorneys' fees and expenses incurred by a Party in connection with enforcing its rights under this Agreement. Costs shall not include any expenses incurred by such Party in either entering into or terminating any arrangement pursuant to which it has hedged its obligations.

1.1.17 "Credit Rating" means (i) with respect to any entity other than a financial institution, the (a) current ratings issued or maintained by S&P or Moody's with respect to such entity's long-term senior, unsecured, unsubordinated debt obligations (not supported by third party credit enhancements) or (b) corporate credit rating or long-term issuer rating issued or maintained with respect to such entity by S&P or Moody's, or (ii) if such entity is a financial institution, the ratings issued or maintained by S&P or Moody's with respect to such entity's long-term, unsecured, unsubordinated deposits.

1.1.18 "Credit Requirements" means a senior, unsecured long term debt rating (or corporate rating if such debt rating is unavailable) of (a) BBB or greater from S&P, or (b) Baa2 or greater from Moody's, and if such ratings are split, the lower of the two ratings must be at least 'BBB' or 'Baa2' from S&P or Moody's, respectively.

1.1.19 "Critical Milestone" has the meaning set forth in Section 3.1.9.

1.1.20 "Daily" means any 24-Hour period commencing at 00:00:00 Hours.

1.1.21 "Delay Damages" for any given day are equal to (a) the Nameplate Capacity, expressed in kWs, multiplied by (b) $200 per kW divided by 365, but in no event less than [$___] per day.

1.1.22 "Delivered Energy Quantity" means the sum of the Specified Energy, Un-Specified Energy and As-Available Energy delivered to PGE by or on behalf of Seller to the Delivery Point each hour as represented on the final e-Tag. The Delivered Energy Quantity shall not exceed Net Available Capacity in any given hour.

1.1.23 "Delivery Period" has the meaning set forth in Section 2.3.

1.1.24 "Delivery Period Security" has the meaning set forth in Section 9.2.1.

1.1.25 "Delivery Point" means the BPAT.PGE point of delivery on the BPA side of the BPA-PGE interface.

1.1.26 "Dispute" has the meaning set forth in 18.1.

1.1.27 "Early Termination Date" has the meaning set forth in Section 5.2.1.

1.1.28 "Effective Date" has the meaning set forth in the first paragraph of this Agreement.

1.1.29 "EIM" means the western Energy Imbalance Market, of which PGE is a participating entity.

1.1.30 "Emissions Reduction Credit" is any credit, allowance or instrument issued or issuable pursuant to a state implementation plan under the Clean Power Plan promulgated by the Environmental Protection Agency under the Clean Air Act.

1.1.31 "Energy" means all electric energy, expressed in MWh, generated by the Facility and scheduled to PGE at the Delivery Point as required by this Agreement.

1.1.32 "Environmental Attributes" means any and all claims, credits, benefits, emissions reductions, offsets and allowances, however named, resulting from the avoidance of the emission of any gas, chemical, or other substance to the air, soil or water or otherwise arising as a result of the generation of electricity from the Facility, regardless of whether or not (i) such environmental attributes have been verified or certified, (ii) such environmental attributes are creditable under any applicable legislative or regulatory program, or (iii) such environmental attributes are recognized as of the Effective Date or at any time during the Term. Environmental Attributes include but are not limited to: (a) any avoided emissions of pollutants to the air, soil, or water such as (subject to the foregoing) sulfur oxides (SOx), nitrogen oxides (NOx), carbon monoxide (CO), and other pollutants; (b) all Emissions Reduction Credits; and (c) any avoided emissions of carbon dioxide (CO2), methane (CH4), nitrous oxide, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride and other greenhouse gases (GHGs) that have been determined by the United Nations Intergovernmental Panel on Climate Change, or otherwise by law, to contribute to the actual or potential threat of altering the Earth's climate by trapping heat in the atmosphere; and (3) the reporting rights to these avoided emissions, such as the carbon content of the Energy generated by the Facility and REC Reporting Rights. Environmental Attributes do not include (i) production tax credits associated with the construction or operation of the Facility and other financial incentives

in the form of credits, reductions, or allowances associated with the Facility that are applicable to a state or federal income taxation obligation, (ii) fuel-related subsidies or "tipping fees" that may be paid to Seller to accept certain fuels, or local subsidies received by the generator for the destruction of particular preexisting pollutants or the promotion of local environmental benefits, or (iii) emission reduction credits encumbered or used by the Facility for compliance with local, state, or federal operating and/or air quality permits.

1.1.33 "Equitable Defenses" means any bankruptcy, insolvency, reorganization and other laws affecting creditors' rights generally, and with regard to equitable remedies, the discretion of the court before which proceedings to obtain same may be pending.

1.1.34 "EWG" means an "exempt wholesale generator," as defined under Public Utility Holding Company Act of 1935.

1.1.35 "Event of Default" has the meaning set forth in Section 5.1.

1.1.36 "Facility" means the ***[describe renewable energy technology]*** facility more fully described in Exhibit D, and includes all generators, equipment, devices and associated appurtenances owned, controlled, operated and managed by Seller in connection with, or to facilitate, the production, generation, transmission, delivery, or furnishing of Product to PGE in accordance with this Agreement (including the Interconnection Facilities).

1.1.37 "Facility Documents" means the Permits and other written authorizations, rights and agreements now or hereafter necessary for (i) construction, ownership, operation, and maintenance of the Facility in accordance with Prudent Electric Industry Practices, and (ii) transmission of Energy from the Facility to the Balancing Authority Area (including documents with respect to Balancing Authority Area services). Facility Documents include the Permits and other written authorizations, rights and agreements listed in Exhibit E; provided, however, that nothing set forth in Exhibit E limits the obligations of Seller to obtain all Facility Documents required to enable Seller to perform its obligations under this Agreement in accordance with its terms.

1.1.38 "Facility Meter" means the metering equipment designed, furnished, installed, owned, inspected, tested, maintained and replaced as provided in the Interconnection Agreement.

1.1.39 "Facility Output" means all electric energy, produced by the Facility, less station service (parasitic power and electrical losses), if any, all as measured at the Facility Meter.

1.1.40 "FERC" means the Federal Energy Regulatory Commission or any successor government agency.

1.1.41 "FIN 46" has the meaning set forth in Section 19.11.

1.1.42 "Firm Energy" means Energy that is to be scheduled, delivered, sold, received and purchased on an uninterruptible basis. Firm Energy shall be scheduled in hourly increments and delivered on long-term firm transmission from the Facility to the Delivery Point, in accordance with the provisions in Article Three. Neither Party shall be relieved of its obligations to sell and deliver or to receive and purchase Firm Energy except for any period during which such performance is prevented or delayed by Force Majeure or as otherwise expressly allowed herein.

1.1.43 "Fixed Price" means the respective monthly On-Peak and Off-Peak prices per MWh to be paid by PGE to Seller for Specified Energy scheduled and delivered during each month of the Delivery Period as set forth in the price schedule attached to this Agreement as Exhibit B.

1.1.44 "Forecasting Agent" shall have the meaning set forth in Section 3.8.3.

1.1.45 "Force Majeure" is defined in Section 4.1.

1.1.46 "Gains" means, with respect to a Party, an amount equal to the present value of the economic benefit to it, if any (exclusive of Costs), resulting from the termination of its obligations with respect to this Agreement determined in a commercially reasonable manner.

1.1.47 "Generation Forecast" shall have the meaning given to that term in Section 3.4.1.

1.1.48 "Governmental Authority" means any and all foreign, national, federal, state, county, city, municipal, local or regional authorities, departments, bodies, commissions, corporations, branches, directorates, agencies, ministries, courts, tribunals, judicial authorities, legislative bodies, administrative bodies, regulatory bodies, autonomous or quasi-autonomous entities or taxing authorities or any department, municipality or other political subdivision thereof; provided, however, that "Governmental Authority" shall not in any event include either Party.

1.1.49 "Governmental Charges" means any charges or costs that are assessed or levied by any entity, including local, state or federal regulatory or taxing authorities that would affect the sale and purchase of the Product contemplated by this Agreement, or any component of the Product, either directly or indirectly.

1.1.50 "Guaranteed Commercial Operation Date" means the date that is ninety (90) days after the Scheduled Commercial Operation Date.

1.1.51 "Guarantor" means, with respect to Seller, [_____].

1.1.52 "Guaranty" means an instrument or agreement pursuant to which the Guarantor guarantees the performance of each and all of the obligations of Seller, which instrument or agreement is reasonably acceptable in form and substance to PGE.

1.1.53 "Guaranty Default" means with respect to a Guaranty or the Guarantor thereunder, the occurrence of any of the following events: (i) any representation or warranty made or deemed to be made or repeated by such Guarantor in connection with such Guaranty shall be false or misleading in any material respect when made or when deemed made or repeated; (ii) such Guarantor fails to pay, when due, any amount required pursuant to such Guaranty; (iii) the failure of such Guarantor to comply with or timely perform any other material covenant or obligation set forth in such Guaranty if such failure is not capable of remedy or shall not be remedied in accordance with the terms and conditions of such Guaranty; (iv) a Merger Event occurs with respect to such Guarantor; (v) such Guaranty shall expire or terminate, or shall fail or cease to be in full force and effect and enforceable in accordance with its terms against such Guarantor, prior to the satisfaction of all obligations of the guaranteed Party under this Agreement, in any such case without replacement; (vi) such Guarantor shall repudiate, disaffirm, disclaim, or reject, in whole or in part, or challenge the validity of, its Guaranty, or (vii) such Guarantor becomes Bankrupt; provided, however, that no Guaranty Default shall occur or be continuing in any event with respect to a Guaranty after the time such Guaranty is required to be canceled or returned to Seller in accordance with the terms of this Agreement.

1.1.54 "Indemnitee" has the meaning set forth in Section 12.2.

1.1.55 "Indemnitor" has the meaning set forth in Section 12.2.

1.1.56 "Indemnity Claims" means all third party claims or actions, threatened or filed, whether groundless, false, fraudulent or otherwise, that directly or indirectly relate to the subject matter of an indemnity, and the resulting losses, damages, expenses, attorneys' fees and court costs, whether resulting from a settlement or otherwise, and whether such claims or actions are threatened or filed prior to or after the termination of this Agreement.

1.1.57 "Initial Specified Amounts" means the Specified Amounts set forth on Exhibit C as of the Effective Date.

1.1.58 "Interconnection Agreement" means the generator interconnection agreement between Seller and ***[identify applicable Transmission Provider*] [*if already executed:*** dated [_____, 20__]***.]***

1.1.59 "Interest Rate" means, for any date, the lesser of (a) the per annum rate of interest equal to the prime lending rate as may from time to time be published in The Wall Street Journal under "Money Rates" on such day (or if not published on such day on the most recent preceding day on which published), or (b) the maximum rate permitted by applicable law. Notwithstanding the foregoing, in no case shall the Interest Rate be less than zero (0).

1.1.60 "Interconnection Facilities" means all the facilities installed, or to be installed, for the purpose of interconnecting the Facility to the Transmission System,

including electrical transmission lines, upgrades, transformers and associated equipment, substations, relay and switching equipment, and safety equipment.

1.1.61 "ITCs" means the investment tax credits established pursuant to Section 48 of the Internal Revenue Code, as such law may be amended or superseded.

1.1.62 "Law" means any act, statute, law, regulation, permit (including applicable Permits), ordinance, rule, judgment, order, decree, directive, guideline or policy (to the extent mandatory) or any similar form of decision or determination by, or any interpretation or administration of, any of the foregoing by any Governmental Authority with jurisdiction over Seller, PGE, the Site, the Facility, or the performance of the obligations under the Agreement, and includes any of the same as they may be amended or imposed from time to time.

1.1.63 "Letter(s) of Credit" means one or more irrevocable, transferable, standby letters of credit issued by a major U.S. commercial bank or a U.S. branch office of a major foreign commercial bank with such bank having shareholders' equity of at least $10 billion USD and a Credit Rating of at least A1 from Moody's or A+ from S&P, in a form and substance reasonably acceptable to PGE. The costs of a Letter of Credit shall be borne by Seller.

1.1.64 "Letter of Credit Default" means with respect to a Letter of Credit, the occurrence of any of the following events: (i) the issuer of such Letter of Credit shall fail to be a major U.S. commercial bank or a U.S. branch office of a major foreign commercial bank with such bank having shareholders' equity of at least $10 billion USD and a Credit Rating of at least A1 from Moody's or A+ from S&P; (ii) the issuer of the Letter of Credit shall fail to comply with or perform its obligations under such Letter of Credit; (iii) the issuer of such Letter of Credit shall disaffirm, disclaim, repudiate or reject, in whole or in part, or challenge the validity of, such Letter of Credit; (iv) such Letter of Credit shall be within fifteen (15) Business Days of expiration or termination, or shall fail or cease to be in full force and effect at any time during the Term, in any such case without replacement; (v) the issuer of such Letter of Credit shall become Bankrupt; or (vi) a Merger Event occurs with respect to the issuer of such Letter of Credit; provided, however, that no Letter of Credit Default shall occur or be continuing in any event with respect to a Letter of Credit after the time such Letter of Credit is required to be canceled or returned in accordance with the terms of this Agreement.

1.1.65 "Licensed Professional Engineer" means a Person proposed by Seller and acceptable to PGE in its reasonable judgment who (a) to the extent mandated by Law is licensed to practice engineering in the appropriate engineering discipline for the required certification being made, in the United States, and in all states for which the person is providing a certification, evaluation or opinion with respect to matters or Law specific to such state, (b) has training and experience in the engineering disciplines relevant to the matters with respect to which such person is called upon to provide a certification, evaluation or opinion, (c) has no economic relationship, association, or nexus with Seller or its members or Affiliates, other than with the prior written consent of PGE, services previously or currently being rendered to Seller or its members or

Affiliates, and (d) is not a representative of a consulting engineer, contractor, designer or other individual involved in the development of the Facility, or of a manufacturer or seller of any equipment installed in the Facility.

1.1.66 "Losses" means, with respect to a Party, an amount equal to the present value of the economic loss to it, if any (exclusive of Costs), resulting from termination of its obligations with respect to this Agreement determined in a commercially reasonable manner.

1.1.67 "Market Index Settlement Prices" means the production-weighted sum of the Market Index Price for each hour during the delivery month. In the event of PGE's participation in a different market design (e.g., full ISO participation), the respective five (5) minute pricing interval for the Delivery Point will be used to calculate the Market Index Settlement Prices. Exhibit I sets forth an accurate and indicative example of a Market Index Settlement Price calculation under certain stated assumptions.

1.1.68 "Market Price Index" means the EIM Locational Marginal Price associated with the Pricing Node or Aggregate Pricing Node for the Delivery Point.

1.1.69 "Material Adverse Change" means (i) with respect to PGE, PGE shall have a Credit Rating below BBB- by S&P and below Baa3 by Moody's or both ratings are withdrawn or terminated on a voluntary basis by the rating agencies, (ii) with respect to Seller, Seller or Seller's Guarantor, if applicable, shall have a Credit Rating below BBB- by S&P and below Baa3 by Moody's or both ratings are withdrawn or terminated on a voluntary basis by the rating agencies, if rated by both services. If Seller or Seller's Guarantor is rated by only one service, a Material Adverse Change shall occur if the rating falls below the pertinent level specified above or if such rating is withdrawn or terminated on a voluntary basis by the rating agency.

1.1.70 "Maximum Annual Volume" means the maximum annual production of Specified Energy equal to [___] MWh (the annual total of the Initial Specified Amounts) for each calendar year during the Delivery Period, prorated for any partial calendar years during the Term.

1.1.71 "Merger Event" means, with respect to a Party or an Affiliate of a Party that such Party or Affiliate consolidates or amalgamates with, or merges into or with, or transfers all or substantially all of its assets to another entity, and (i) the resulting, surviving or transferee entity fails, at the time of such consolidation, amalgamation, merger or transfer, to assume each and all of the obligations of such Party or Affiliate under this Agreement or under any Guaranty, Letter of Credit or other Performance Assurance, either by operation of law or pursuant to an agreement reasonably satisfactory to the other Party, or (ii) the benefits of any Guaranty, Letter of Credit, or other Performance Assurance or credit support provided pursuant to this Agreement fail, at any time following such consolidation, amalgamation, merger or transfer, to extend to the performance by such Party or such resulting, surviving or transferee entity of its obligations under this Agreement, or (iii) the Credit Rating (from any of S&P or Moody's) of the resulting, surviving or transferee entity is not equal to or higher than that

of such Party or Affiliate immediately prior to such consolidation, amalgamation, merger, or transfer.

1.1.72 "Mid-Columbia" means an area which includes points at any of the switchyards associated with the following four hydro projects: Rocky Reach, Rock Island, Wanapum and Priest Rapids. These switchyards include: Rocky Reach, Rock Island, Wanapum, McKenzie, Valhalla, Columbia, Midway and Vantage.

1.1.73 "Milestone" and "Milestones" have the meaning assigned to those terms in Section 3.1.9(a)(i).

1.1.74 "Minimum Annual Volume" means an annual production of Specified Energy equal to [___] MWh (85% of the Initial Specified Amounts) for all calendar years during the Delivery Period, prorated for partial calendar years. ***[Note to bidders: For use with baseload facilities.]***

1.1.75 "Month" means a calendar month commencing at hour ending 01:00:00 PPT on the first day of such month through hour ending 24:00:00 PPT on the last day of such month.

1.1.76 "Moody's" means Moody's Investor Services, Inc. or its successor.

1.1.77 "MW" means megawatt.

1.1.78 "MWh" means megawatt hour.

1.1.79 "Nameplate Capacity" means [__] ***[solar: $MW_{DC}$.] [other resources: $MW_{AC}$]***, which is the full (maximum) gross power capability of the Facility's electric power production equipment under optimal conditions designated by the manufacturer and described on Exhibit M. ***[Note to bidders: the optimal conditions based on manufacturer designation and the equipment used by the Facility to be agreed upon and included in Exhibit M]***

1.1.80 "Negative Price Event" shall have the meaning given to that term in Section 3.4.7.

1.1.81 "NERC" means the North American Electric Reliability Corporation.

1.1.82 "Net Available Capacity" means the full (maximum) net Energy the Facility is capable of delivering to the interconnecting Balancing Authority Area continuously for at least sixty (60) minutes; which is equivalent to the Nameplate Capacity Rating of the Facility's generating unit less station service (parasitic power and electrical losses) and inverter limitations, expressed in $MW_{AC}$.

1.1.83 "Non-Defaulting Party" has the meaning set forth in Section 5.2.1.

1.1.84 "Off-Peak" shall mean all hours ending 01:00:00 through 06:00:00 and hours ending 23:00:00 through 24:00:00, PPT, Monday through Saturday and hours ending 01:00:00 through 24:00:00, PPT, on Sundays and NERC designated holidays.

1.1.85 "On-Peak" shall mean all hours ending 07:00:00 through 22:00:00 PPT, Monday through Saturday, excluding NERC designated holidays.

1.1.86 "Oregon Renewable Portfolio Standard" means the renewable portfolio standard contemplated by ORS Chapter 469A, and its implementing regulations, in each case as amended from time to time.

1.1.87 "Party" or "Parties" are defined in the preamble of this Agreement.

1.1.88 "Performance Assurance" means collateral in the form of cash, Letter(s) of Credit, or a Guaranty.

1.1.89 "Permits" shall mean permits, licenses, approvals, consents, orders, registrations, privileges, franchises, memberships, certificates, entitlements variances, waivers, certificates of occupancy and other authorizations issued by any Governmental Authorities, and any siting, zoning and land use approvals required under Law in connection with the development, construction, operation, occupancy, use and/or maintenance of the Site or Facility, including those specified in Exhibit E, and all amendments, modifications, supplements, general conditions and addenda thereto.

1.1.90 "Person" means an individual, partnership, corporation, limited liability company, joint venture, association, trust, unincorporated organization, Governmental Authority, or other form of entity.

1.1.91 "PGE Representatives" has the meaning set forth in Section 3.10.

1.1.92 "PPT" means Pacific Prevailing Time (i.e., prevailing Standard Time or Daylight Savings Time in the Pacific Time Zone).

1.1.93 "Pre-COD Security" has the meaning set forth in Section 9.1.1.

1.1.94 "Pre-Scheduled Energy" has the meaning set forth in Section 3.8.4(a).

1.1.95 "Product" means, each and together, Specified Energy, Un-Specified Energy, and As-Available Energy to be scheduled, delivered and sold by Seller and to be received and purchased by PGE pursuant to this Agreement, together with all associated Environmental Attributes (including Bundled RECs) and Capacity Attributes.

1.1.96 "Prudent Electric Industry Practice" means those practices, methods, standards and acts engaged in or approved by a significant portion of the electric power generation industry in the Western Interconnection that at the relevant time period, in the exercise of reasonable judgment in light of the facts known or that should reasonably have been known at the time a decision was made, would have been expected to accomplish the desired result in a manner consistent with good business practices,

reliability, economy, safety and expedition, and which practices, methods, standards and acts reflect due regard for operation and maintenance standards recommended by the Facility's equipment sellers and manufacturers, operational limits, and all applicable laws and regulations. Prudent Electric Industry Practice is not intended to be limited to the optimum practice, method, standard or act to the exclusion of all others, but rather to those practices, methods and acts generally acceptable or approved by a significant portion of the electric power generation industry in the Western Interconnection, during the relevant period, as described in the immediately preceding sentence.

1.1.97 "PURPA" means the Public Utility Regulatory Policies Act of 1978.

1.1.98 "QF" means "Qualifying Facility," as that term is defined in the FERC regulations (codified at 18 CFR Part 292) in effect on the Effective Date.

1.1.99 "PTCs" means production tax credits under Section 45 of the Internal Revenue Code, as such law may be amended or superseded.

1.1.100 "Qualifying Replacement RECs" means environmental attributes (including renewable energy credits and renewable energy credit reporting rights) that are (i) delivered to PGE bundled with energy produced simultaneously by a generating source that (A) is an Oregon Renewable Portfolio Standard eligible renewable energy resource, (B) produces environmental attributes (including renewable energy credits and renewable energy credit reporting rights) of the same type and quality as Environmental Attributes (including Bundled RECs and REC Reporting Rights), (C) is located in [_____], and (D) achieves commercial operation after the Commercial Operation Date, or (ii) RECs from As-Available Energy that were not conveyed by Seller to PGE under this Agreement, if any, or (iii) a combination thereof.

1.1.101 "Qualifying Replacement REC Price" means the price for Qualifying Replacement RECs as determined by taking the lower of two dealer quotes representing a live offer to sell Qualifying Replacement RECs for the entire quantity of Bundled RECs that are being replaced and subtracting the value of the energy component of such quantity (as specified in the applicable dealer quote) of such Qualifying Replacement RECs.

1.1.102 "REC" means the Environmental Attributes and the REC Reporting Rights associated with Facility Output, however commercially transferred or traded under any or other product names, such as "green tags," "Green-e Certified," or otherwise. RECs are accumulated on a MWh basis and one REC represents the Environmental Attributes made available by the generation of one MWh of Facility Output, as represented by the lesser of the final e-Tag or the actual Facility Output on an hourly basis. All RECs delivered to PGE under this Agreement must comply with the Oregon Renewable Portfolio Standard.

1.1.103 "REC Reporting Rights" are the right of a buyer to report the ownership of accumulated RECs in compliance with federal or state law, if applicable, and to a federal or state agency or any other party at such buyer's discretion, and include

without limitation those REC Reporting Rights accruing under Section 1605(b) of The Energy Policy Act of 1992 and any present federal, state, or local law, regulation or bill, and international or foreign emissions trading program.

1.1.104 "Regulatory Event" has the meaning given to that term in Section 19.6.

1.1.105 "Reliability Entity" may include, without limitation, NERC, WECC, the Balancing Authority, Transmission Provider, regional transmission organization, independent system operator, reliability coordinator or any other entity that has, or that may have in the future, (i) responsibility over the reliability of the bulk power system and (ii) by virtue of such responsibility the legal authority to affect the operations of the Facility or delivery of the Product.

1.1.106 "Remedial Action Scheme" means an automatic protection system designed to detect abnormal or predetermined system conditions, and take corrective actions other than or in addition to the isolation of faulted components to maintain system reliability. Such action may include changes in demand, generation (MW and Mvar), or system configuration to maintain system stability, acceptable voltage, or power flows.

1.1.107 "S&P" means the Standard & Poor's, a division of McGraw-Hill Companies, Inc., or any successor thereto.

1.1.108 "Sales Price" means the price at which Seller, acting in a commercially reasonable manner, resells any Product not accepted by PGE in breach of PGE's obligations under this Agreement, deducting from such proceeds any (i) Costs reasonably incurred by Seller in reselling such Product and (ii) additional transmission charges, if any, reasonably incurred by Seller in delivering such Product to the third party purchasers. "Costs" shall not include any negative price amounts for the Product, penalties, ratcheted demand or similar charges. In no event shall the Sales Price be less than zero dollars ($0.00).

1.1.109 "Schedule," "Scheduled" or "Scheduling" means the actions of Seller, PGE, a Transmission Provider and all other impacted entities, or their representatives, of notifying, requesting, and confirming/implementing the quantity and type of Product, transmission arrangements, and timing of delivery, subject to the prevailing Western EIM, NAESB, WECC and NERC scheduling requirements.

1.1.110 "Scheduled Commercial Operation Date" means [____, 20__].

1.1.111 "Scheduling Agent" has the meaning set forth in Section 3.8.3.

1.1.112 "Scheduling Period" means the hourly scheduling period during which Energy is Scheduled to the Delivery Point in accordance with the tariff and business practices of the EIM.

1.1.113 "Seller" is defined in the Preamble of this Agreement.

1.1.114 "Settlement Amount" means, with respect to this Agreement and the Non-Defaulting Party, the Losses or Gains, and Costs, expressed in USD, which such Party incurs as a result of the termination and liquidation of this Agreement pursuant to Article 5. If the Non-Defaulting Party's Costs and Losses exceed its Gains, then the Settlement Amount shall be an amount owing to the Non-Defaulting Party. If the Non-Defaulting Party's Gains exceed its Costs and Losses, then the Settlement Amount shall be zero dollars ($0). The Settlement Amount shall not include consequential, punitive, exemplary or indirect or business interruption damages.

1.1.115 "Settlement Period" has the meaning set forth in Section 5.2.2.

1.1.116 "Settlement Energy" has the meaning set forth in Section 5.2.2.

1.1.117 "Site" means the real property on which the Facility is or will be located, as more fully described on Exhibit F.

1.1.118 "Specified Amount(s)" means the amount of Firm Energy generated by the Facility that Seller is required to deliver to PGE at the Delivery Point for each monthly On-Peak period and for each monthly Off-Peak period during the Delivery Period. The Specified Amounts for each month during the following calendar year shall be established by Seller pursuant to Section 3.3. ***[Note to bidders: For baseload facilities, the Specified Amount(s) will be based on daily On/Off Peak Hours.]***

1.1.119 "Specified Energy" means Firm Energy simultaneously bundled with the Facility's associated Environmental Attributes, including Bundled RECs, as generated and metered net of all Facility losses and station service at the Facility Meter, scheduled in hourly blocks, and delivered to the Delivery Point, up to the Specified Amount according the Scheduling Procedure in Section 3.8. Each MWh of Specified Energy delivered shall include one (1) Bundled REC.

1.1.120 "Start-Up Testing" means the start-up tests for the Facility as set forth in Exhibit G.

1.1.121 "Taxes" means all taxes, rates, levies, adders, assessments, surcharges, duties and other fees and charges of any nature, including but not limited to ad valorem, consumption, excise, franchise, gross receipts (including any [*State Name*] business and occupation tax and [*State Name*] public utility tax and any successor tax thereto), import, export, license, property, sales, stamp, storage, transfer, turnover, use, or value-added taxes, and any and all items of withholding, deficiency, penalty, addition to tax, interest, or assessment related thereto.

1.1.122 "Term" means the period of time referenced in Section 2.1.

1.1.123 "Test Energy" means electric energy generated by the Facility during periods before the Commercial Operation Date, and all RECs and Capacity Rights associated with such electric energy.

1.1.124 "Termination Payment" has the meaning set forth in Section 5.3.

1.1.125 "Transmission Provider(s)" means any entity (including any FERC-authorized regional transmission organization) transmitting Energy on behalf of Seller to and at the Delivery Point; or on behalf of PGE at and from the Delivery Point.

1.1.126 "Transmission Services" means any and all services (including but not limited to Ancillary Services and control area services) required for the transmission and delivery of Energy to the Delivery Point or at and from the Energy Delivery Point.

1.1.127 "Transmission System(s)" means the transmission system(s) of the Transmission Provider(s) to be used by Seller for the purpose of transmitting Energy to and at, the Delivery Point; or by PGE for the purpose of transmitting Energy at and from, the Delivery Point.

1.1.128 "Transmission Upgrade Cost Cap' has the meaning set forth in Section 3.8.1.

1.1.129 "Un-Specified Energy" means that portion of Firm Energy, measured in MWh, scheduled and delivered to Seller that was not generated by the Facility but is delivered to PGE as a result of Ancillary Services provided by a Balancing Authority Area or Transmission Provider, or other entity, as applicable.

1.1.130 "USD" means United States Dollars.

1.1.131 "WECC" means the Western Electricity Coordinating Council or any successor thereto.

1.1.132 "Western Interconnection" means the network of subsystems of generators, transmission lines, transformers, switching stations, and substations owned or operated by members of the WECC, to the extent located in the continental United States.

1.1.133 "WREGIS" means the Western Renewable Energy Generation Information System.

1.2 Rules of Interpretation.

Unless the context otherwise requires:

1.2.1 Words singular and plural in number shall be deemed to include the other and pronouns having masculine or feminine gender shall be deemed to include the other.

1.2.2 Subject to ARTICLE 15, any reference in this Agreement to any Person includes its successors and assigns and, in the case of any Governmental Authority, any Person succeeding to its functions and capacities.

1.2.3 Any reference in this Agreement to any Section, Exhibit or Appendix means and refers to the Section contained in, or Exhibit or Appendix attached to, this Agreement.

1.2.4 A reference to writing includes typewriting, printing, lithography, photography, email and any other mode of representing or reproducing words, figures or symbols in a lasting and visible form.

1.2.5 Unless otherwise expressly provided in this Agreement, a reference to a specific time for the performance of an obligation is a reference to that time in the place where that obligation is to be performed.

1.2.6 A reference to a Party to this Agreement includes that Party's successors and permitted assigns.

1.2.7 Unless otherwise expressly provided in this Agreement, a reference to a document or agreement, including this Agreement, includes a reference to that document or agreement as modified, amended, supplemented or restated from time to time.

1.2.8 References in this Agreement to "or" shall be deemed to be disjunctive but not necessarily exclusive (i.e., unless the context dictates otherwise, "or" shall be interpreted to mean "and/or" rather than "either/or").

1.2.9 If any payment, act, matter or thing hereunder would occur on a day that is not a Business Day, then such payment, act, matter or thing shall, unless otherwise expressly provided for herein, occur on the next Business Day.

1.3 Technical Meanings.

Words not otherwise defined herein that have well known and generally accepted technical or trade meanings are used in this Agreement in accordance with such recognized meanings.

## ARTICLE 2
## CONTRACT TERM; DELIVERY PERIOD; PRICE; SALE OF FACILITY

2.1 Term; [Conditions Precedent].

2.1.1 Term. The term of this Agreement shall begin on the Effective Date and shall continue through [***existing facility:*** _____[*Date*]] [***facility to be built:*** the [__] anniversary of the Commercial Operation Date] (the "Term"), unless earlier terminated in accordance with its terms; provided, however, that (a) such termination shall not affect or excuse the performance of either Party under any provision of this Agreement that by its terms survives any such termination, and (b) the terms and conditions of this Agreement and any other documents executed and delivered under this Agreement shall continue to govern with respect to obligations arising before termination until such obligations are fully discharged.

2.1.2 PGE's Conditions Precedent. PGE's obligations under this Agreement are subject to the following conditions precedent, each of which may be waived by PGE in its sole discretion:

(a) [Project Specific Conditions: TBD]; and

(b) All authorizations, approvals and consents of all Persons, including PGE's Board of Directors, that are required in connection with the execution, delivery, and performance of this Agreement have been received by PGE; and

(c) All required regulatory approvals have been made and obtained.

If these conditions precedent have not been satisfied or waived by PGE on or before [_____, 20__], either Party shall have the right to terminate this Agreement by giving five (5) Business Days' prior notice of termination to the other Party. Neither Party shall have any liability for such a termination.

2.1.3 Seller's Conditions Precedent. Seller's obligations under this Agreement are subject to the following conditions precedent, each of which may be waived by Seller in its sole discretion: ***[Note to bidders: conditions precedent, if any, to Seller's obligations under the PPA should be set out here]***

If these conditions precedent have not been satisfied or waived by Seller on or before [_____, 20__], either Party shall have the right to terminate this Agreement by giving five (5) Business Days' prior notice of termination to the other Party. Neither Party shall have any liability for such a termination.

2.2 Test Energy. Seller shall use its best efforts to schedule and deliver Facility Test Energy to its Transmission Provider, to a third-party or to an organized market (to the extent PGE has consented to Seller participating in such organized market pursuant to Section 3.14) via its Transmission Provider's system. Seller shall be entitled to any and all compensation received from its Transmission Provider or any third-party or organized market for such Test Energy. Notwithstanding the forgoing, in the event that it is necessary for Seller to schedule and deliver Facility Test Energy to PGE in order to complete start-up testing, Seller shall be entitled to do so pursuant to the Scheduling Procedure set forth in Section 3.8 (to the extent applicable). In such case, the Parties shall coordinate in good faith to schedule deliveries of Test Energy to PGE that minimizes the burden to each of the Parties, and PGE shall receive the Test Energy. The price for such Test Energy received by PGE shall be zero dollars ($0.00) and Seller shall pay any costs or additional expenses that are required for PGE to receive the Test Energy, including but not limited to reimbursement for negative pricing and procurement of any necessary capacity costs or reserves.

2.3 Delivery Period; Price and Adjustments.

2.3.1 Delivery Period. Starting on [***for a completed Facility:*** _____[*Date*]] [***for a Facility under development:*** the Commercial Operation Date], Seller shall Schedule all of the Facility Output to PGE as Energy at the Delivery Point and shall continue such deliveries for the Term (the "Delivery Period").

2.3.2 Price. For each calendar month during the Delivery Period, and except as otherwise provided herein, PGE shall pay Seller the sum of the following:

(a) Subject to subpart (d) below, the Specified Energy delivered during the calendar month, up to the Specified Amount for such month, multiplied by the applicable Fixed Price for On-Peak hours and for Off-Peak hours; and

(b) The As-Available Energy delivered during the calendar month multiplied by the Market Index Settlement Price for the calendar month; and

(c) The Un-Specified Energy delivered during the calendar month multiplied by the Market Index Price for each hour that the Un-Specified Energy was delivered.

(d) For each hour that the Market Index Price is negative, the sum of the Delivered Energy Quantity less Un-Specified Energy, for each applicable hour, multiplied by the Market Index Price.

An indicative example illustrating the determination of payment due under this Section 2.3.2 is set forth in Exhibit I.

2.4 Notice of Sale of Facility.

If Seller or an Affiliate of Seller desire to sell the Facility during the Term, either by a sale of the Facility's assets or by a direct or indirect transfer of the membership interest(s) in Seller, Seller shall first, before it or its Affiliate enters into any substantive discussions with other parties, notify PGE of its desire to sell the Facility. PGE agrees to notify Seller if it is interested in acquiring the Facility within twenty (20) days following receipt of Seller's notice. If PGE so notifies Seller, the Parties shall engage in exclusive good faith negotiations to reach agreement with respect to such a transaction for a period of ninety (90) days thereafter. If during this period the Parties execute a letter of intent, or other document similarly confirming the Parties' intent to enter into a transaction for the purchase and sale of the Facility, then such exclusive negotiation period shall be automatically extended for an additional ninety (90) day period, during which time the Parties may execute a purchase and sale agreement for the Facility. Any purchase and sale agreement executed within the time frame stated in this Section 2.4 shall remain subject to regulatory approval beyond such time frame, as applicable. Seller may pursue any transaction for the sale of the Facility with one or more third parties at any time and from time to time and shall have no obligation to PGE under this Section 2.4 following an occurrence of any of the following: (i) PGE expressly declines interest in acquiring the Facility after receipt of Seller's notice provided pursuant to the first sentence of this Section 2.4, (ii) PGE fails to respond to Seller's notice pursuant to the first sentence of this Section 2.4, within twenty (20) days after receipt thereof; (iii) PGE and Seller fail to execute a letter of intent or other similar document with respect to the sale of the Facility within ninety (90) days after PGE's receipt of notice from Seller provided pursuant to the first sentence of this Section 2.4; or (iv) PGE and Seller fail to execute a purchase and sale agreement for the Facility within one hundred eighty (180) days after PGE's receipt of notice from Seller provided pursuant to the first sentence of this Section 2.4; provided, however, that with respect to clause (iv), if Seller rejects a firm price delivered by PGE in the course of such negotiations, any sale of the Facility to a third party during the subsequent two (2)-year period must be at a price higher than such rejected price or Seller shall

be required to re-engage in negotiations with PGE as otherwise set forth in this Section 2.4 for the sale of the Facility.

2.5 [Option to Purchase/Option to Extend Term]

***[Note to bidders: if a Bidder wishes to propose an end of Term or during Term option for PGE to purchase the Facility, or an option for PGE to extend the Term of the PPA, it should include its proposal here in its mark up of the Agreement.***

## ARTICLE 3
## FACILITY DEVELOPMENT, CONSTRUCTION AND OPERATION

3.1 Development and Construction of Facility. ***[Note to bidders: Section 3.1 will be "intentionally omitted" for a Facility that has already been built.]***

3.1.1 Facility Documents. Seller shall provide PGE with the documents listed below. To the extent they are available on the Effective Date, such documents have been attached to this Agreement as Exhibit E. With respect to any of the listed Facility Documents that become available or are reasonably required to be modified after the Effective Date, Seller shall provide such documents to PGE within ten (10) days after receiving them. Seller may not materially modify such documents or amend Exhibit E after the Effective Date without PGE's prior written consent, which PGE may not unreasonably withhold, condition or delay.

(a) Seller's proposed Level 1 schedule, including significant Facility activities, milestones and deliverables.

(b) A list of permits and approvals required for the construction and operation of the Facility.

(c) Facility layout drawings, including all major equipment and balance of plant equipment.

(d) An electrical single-line diagram for the Facility.

(e) 12x24 net energy profile and, if available, 8760 net energy production estimate.

3.1.2 Intentionally Left Blank.

3.1.3 Permitting. Seller shall obtain all Permits necessary to construct, own and operate the Facility in accordance with this Agreement.

3.1.4 Financing. Seller shall obtain any and all financing necessary to construct and operate the Facility during the Delivery Period and the Term on a schedule consistent with the requirements of this Agreement.

3.1.5 Facility Design. Seller shall be responsible for designing and building the Facility in compliance with all Permits and according to Prudent Electric Industry Practice with respect to project design, engineering and selection and installation of equipment to be used at or installed in the Facility. At PGE's request, Seller shall provide PGE with copies of the site plan for the Facility and descriptions, for the project design of the Facility. Any review by PGE of the design, construction, operation or maintenance of the Facility is solely for PGE's information, and PGE shall have no responsibility to Seller or any third party in connection with such review. Seller is solely responsible for the economic and technical feasibility, operational capability and reliability of the Facility.

3.1.6 Construction and Testing; Interconnection. Seller shall, at its cost, construct and test the Facility and obtain all necessary transmission and interconnection rights, all in compliance with the Permits, the Interconnection Agreement, any other agreements with any Transmission Provider, and Prudent Electric Industry Practice.

3.1.7 Monthly Reports. After the Effective Date, Seller shall provide PGE with monthly written reports regarding Seller's progress in completing the construction, testing and interconnection of the Facility and shall, at PGE's request, meet with PGE's representatives to discuss such progress.

3.1.8 Equipment Supply. Not later than [____] Seller shall provide PGE with written evidence of Seller's commitment from the parties identified on Exhibit E for the supply of all of the equipment required to construct and interconnect the Facility in a timeframe that reasonably would allow Seller to achieve the Commercial Operation Date of the Facility on or before the Scheduled Commercial Operation Date.

3.1.9 Milestones.

(a) Seller shall design, construct, own, operate, repair, and maintain the Facility in accordance and consistent with the Facility Documents and Prudent Electric Industry Practice so as to ensure the continuous ability of the Facility to meet Seller's obligations to PGE under this Agreement. Seller shall exercise its best efforts, consistent with Prudent Electric Industry Practice, to complete development of the Facility in accordance with the dates for each Milestones set forth in this Section 3.1.9 (each, a "Milestone" and collectively "Milestones"). If Seller fails to meet a Milestone in any material respect by the date on which this Section 3.1.9 requires such Milestone to be achieved, Seller shall deliver to PGE the following no more than ten (10) Business Days after receiving notice from PGE: (i) further information concerning the status of Facility development; (ii) a written report containing Seller's analysis of the reasons behind the failure to meet the original Milestone(s), including a description of the remedial actions that Seller agrees to undertake to complete the Facility by the Commercial Operation Date; and (iii) further assurances that the Facility will be completed consistent with the terms of this Agreement.

(i) Site Control. Seller shall demonstrate site control as of the Effective Date of this Agreement by ownership or lease of real property sufficient to enable Seller to finance, construct and operate the Facility, with any such lease having a term equal to or greater than the Term of this Agreement.

(ii) Pre-COD Security. On or before the 30th day following the Effective Date, Seller shall post the Pre-COD Security in the amount described in Section 9.1;

(iii) Interconnection Agreement. On or before the ninetieth ($90^{th}$) day after the Effective Date, Seller shall provide to PGE a fully executed copy of the Interconnection Agreement confirming that the Facility will receive [Network Resource Interconnection Service] [Energy Resource Interconnection Service];

(iv) Permits. On or before the [__] day after the Effective Date, Seller shall provide to PGE copies of all Permits in final, nonappealable form;

(v) Transmission Service Agreements. At least three hundred sixty five (365) days prior to Commercial Operation Date, Seller shall present PGE with copies of the transmission service agreement(s) contemplated by Section 1.1.12(v) and Section 3.8.2 (together with associated service tables).

(vi) [***For biomass facilities:*** Within thirty (30) days after the Effective Date, Seller shall have executed a delivered fixed-price fuel supply contract, that is acceptable to PGE (such acceptance not to be unreasonably withheld), for a term equal to or greater than the Term of this Agreement for the supply and delivery of not less than seventy-five percent (75%) of the maximum annual fuel requirements for the Facility, with an annual escalation rate not to exceed one and nine tenths percent (1.9%) per year.

(vii) [***For biomass facilities:*** No later than sixty (60) days prior to the Commercial Operation Date, Seller shall have executed a delivered fixed-price fuel supply contract, that is acceptable to PGE (such acceptance not to be unreasonably withheld), for a term equal to or greater than the Term of this Agreement for the supply and delivery of not less than one hundred percent (100%) of the maximum annual fuel requirements for the Facility, with an annual escalation rate not to exceed one and nine tenths percent (1.9%) per year.]

(viii) Delivery Period Security. By the Commercial Operation Date, Seller shall provide Delivery Period Security required under Section 9.2;

(ix) Commercial Operation Date. Seller shall cause the Facility to achieve Commercial Operation on or before the Guaranteed Commercial Operation Date;

provided, however, that the date for achieving each Milestone (other than the dates for posting Pre-COD Security and Delivery Security) shall be extended on a day for day basis for any delay due solely to (i) PGE's delay in taking, or failure to take, any action required of it hereunder in breach of this Agreement, or (ii) an event of Force Majeure.

(b) When Seller achieves a Milestone, Seller shall provide to PGE documentation reasonably satisfactory to PGE demonstrating completion of the Milestone. Seller shall provide such documentation to PGE within thirty (30) days of such completion but not later than the date specified above for such Milestone. PGE shall acknowledge receipt of the documentation provided under this Section 3.1.9 and shall provide Seller with written acceptance or denial of each Milestone within fifteen (15) Business Days of receipt of the documentation.

(c) Seller shall notify PGE promptly (and in any event within ten (10) Business Days) after Seller becomes aware of information that leads to a reasonable conclusion that a Milestone will not be met. Seller shall convene a meeting with PGE to discuss the situation not later than fifteen (15) Business Days after becoming aware of this information.

(d) If any Milestone (other than a Critical Milestone identified in Section 3.1.9(e)) is not completed on or before the deadline specified for that Milestone in this Section 3.1.9, Seller shall (i) inform PGE of a revised projected date for the achievement of the Milestone, (ii) inform PGE of any impact on the timing of the Commercial Operation Date and on each other Milestone, and (iii) provide PGE with a written report containing Seller's analysis of the reasons behind the failure to meet the original Milestone deadline and describing the remedial actions that the Seller agrees to undertake to ensure the achievement of the Commercial Operation Date by the Scheduled Commercial Operation Date and in any event no later than the Guaranteed Commercial Operation Date. If (1) Seller fails to submit such a report and remedial action plan within 30 days after a Milestone deadline is missed, or (2) Seller timely submits the required report and remedial action plan but thereafter fails to implement the remedial action plan with diligence, or (3) PGE reasonably concludes based on the report and proposed remedial action plan that the Facility is unlikely to achieve Commercial Operation on or before the Guaranteed Commercial Operation Date, a Seller Event of Default shall be deemed to have occurred.

(e) The Milestones described in Sections 3.1.9(a)(i), 3.1.9(a)(v), and 3.1.9(a)(ix) are "Critical Milestones" that are separately addressed in Section 5.1 (Events of Default) and Section 3.1.12 (failure to achieve the Guaranteed Commercial Operation Date).

3.1.10 Notice of Commercial Operation. Seller shall notify PGE not less than five (5) Business Days in advance of the anticipated date of Commercial Operation and shall confirm to PGE in writing when Commercial Operation has been achieved.

3.1.11 Delay Damages. If Commercial Operation is not achieved on or before the Scheduled Commercial Operation Date, Seller shall pay Delay Damages to PGE from and after the Scheduled Commercial Operation Date up to, but not including, the date that the Facility achieves Commercial Operation.

3.1.12 Contract Termination Damages. If Seller does not achieve Commercial Operation on or before the Guaranteed Commercial Operation Date, PGE shall have the right to terminate this Agreement upon ten (10) Days notice to Seller, and Seller shall pay to PGE, as liquidated damages, Contract Termination Damages equal to $200 per kW of Nameplate Capacity (the "Contract Termination Damages") in addition to all Delay Damages paid or payable pursuant to Section 3.1.11.

3.1.13 Damages Invoicing. By the tenth ($10^{th}$) day following the end of the calendar month in which Delay Damages begin to accrue, as applicable, and continuing on the tenth ($10^{th}$) day of each calendar month during the period in which Delay Damages accrue (and the following months, if applicable), PGE shall deliver to Seller an invoice showing PGE's computation of such damages and any amount due PGE in respect thereof for the preceding calendar month. No later than ten (10) days after receiving such an invoice and subject to Section 7.2 and Section 7.3, Seller shall pay to PGE, by wire transfer of immediately available funds to an account specified in writing by PGE or by any other means agreed to by the Parties in writing from time to time, the amount set forth as due in such invoice.

3.1.14 PGE's Exclusive Remedies. PGE's exclusive remedies for the Facility's failure to achieve Commercial Operation by the Scheduled Commercial Operation Date or by the Guaranteed Commercial Operation Date, as applicable, shall be (i) the payment by Seller of Delay Damages and, if applicable, Contract Termination Damages, as provided in Sections 3.1.11 and Section 3.1.12, (ii) the right of first offer set forth in Section 3.1.15, and/or (iii) the exercise of step in rights under 9.4.

3.1.15 Right of First Offer.

(a) If PGE terminates this Agreement under Section 3.1.12 or this Agreement is otherwise terminated before the Commercial Operation Date, neither Seller nor Seller's Affiliates may sell, market or deliver any quantity of the Product associated with or attributable to the Facility to a party other than PGE for a period of two (2) years following the termination date of this Agreement, unless before selling, marketing or delivering such Product, or entering into an agreement to sell, market or deliver such Product, Seller or Seller's Affiliates provide PGE with a written offer to sell the Product on terms and conditions materially similar to the terms and conditions contained in this Agreement (including price), and PGE fails to accept such offer within forty-five (45) days of PGE's receipt thereof.

(b) Neither Seller nor Seller's Affiliates may sell or transfer the Facility, or any part thereof, or land rights or interests in the Site so long as the limitations contained in this Section 3.1.15 apply, unless the transferee agrees to be bound by the terms set forth in this Section 3.1.15 pursuant to a written agreement approved by PGE.

(c) Seller shall indemnify and hold PGE harmless from all benefits lost and other damages sustained by PGE as a result of any breach by Seller of its covenants contained within this Section 3.1.15.

3.1.16 Tax Credits. Seller shall bear all risks, financial and otherwise throughout the Term, associated with Seller's or the Facility's eligibility to receive PTCs, ITCs or other tax credits, or to qualify for accelerated depreciation for Seller's accounting, reporting or tax purposes. Seller's obligations under this Agreement shall be effective regardless of whether the sale of Facility Output from the Facility, or the Facility itself, is eligible for, or receives, PTCs, ITCs or other tax credits during the Term.

3.2 Facility Operations.

3.2.1 Commitment. Seller hereby commits one hundred percent (100%) of the Facility Output to PGE as provided under this Agreement, except only in the limited cases where Seller is required to deliver Facility Output to the provider of integration services.

3.2.2 Site Control. At all times during the Term, Seller shall control the Site through ownership or lease and shall provide PGE with prompt notice of any change in control of the Site.

3.2.3 Operation and Maintenance. Seller shall operate and maintain the Facility, the Facility Meter and that portion of the Interconnection Facilities and related equipment and systems owned by Seller in accordance with Prudent Electric Industry Practice in a manner that is reasonably likely to: (i) maximize the Facility Output, and (ii) result in an expected useful life for such facilities of not less than thirty (30) years.

3.2.4 Facility Meter Inspection and Correction. PGE shall have the right to periodically inspect, test, repair and replace the Facility Meter, without PGE assuming any obligations under the Interconnection Agreement. If any of the inspections or tests disclose an error exceeding 0.5 percent, either fast or slow, proper correction, based upon the inaccuracy found, shall be made of previous readings for the actual period during which the Facility Meter rendered inaccurate measurements if that period can be ascertained. If the actual period cannot be ascertained, the proper correction shall be made to the measurements taken during the time the metering equipment was in service since last tested, but not exceeding three (3) months, in the amount the Facility Meter shall have been shown to be in error by such test. Any correction in billings or payments resulting from a correction in the meter records shall be made in the next monthly billing or payment rendered. Such correction, when made, shall constitute full adjustment of any claim between Seller and PGE arising out of such inaccuracy of metering equipment.

3.2.5 Inspection and Records. During the Term, Seller shall inspect, maintain and repair the Facility and the components thereof in order to maintain such equipment in accordance with Prudent Electric Industry Practice and shall keep records with respect to inspections, maintenance and repairs thereto consistent with Seller's reasonable business judgment. The records of such activities shall be available for inspection by PGE during Seller's regular business hours upon reasonable notice.

3.2.6 Scheduled Maintenance. Seller shall notify PGE, on or before September 1 preceding the Commercial Operation Date and on or before September 1 of each subsequent calendar year, of the Facility's scheduled maintenance for the next calendar year, and shall use commercially reasonable efforts to plan scheduled maintenance (i) to maximize the productive output of the Facility and (ii) not to occur between July and September or between December and February.

3.3 Specified Amounts. On or before September 1 following the Commercial Operation Date and on or before September 1 of each subsequent year during the Delivery Period, Seller shall provide PGE with an updated version of Exhibit C establishing the Specified Amounts for each month during the following calendar year (except for any months outside the Delivery Period).

3.3.1 For the first three (3) years of the Delivery Period, Seller's designated Specified Amounts for each month shall be consistent with [***for solar facilities: a 50% probability of exceedance of forecasted value for such month (based on PV-Syst or equivalent)] [for wind facilities: generation profile associated with a 50% probability of exceedance forecast created by an independent third party based on 5 years of meteorological tower data]***.

3.3.2 Beginning with Specified Amounts updated on September 1, 20[___] for the ***[for solar facilities: fourth (4th)] [for wind facilities: sixth (6th)]*** year of the Delivery Period, and for each year thereafter, the Specified Amounts for each month shall be consistent with ***[for solar facilities: the Project's demonstrated 3-year rolling average generating output for such month] [for wind facilities: the Project's demonstrated 5-year rolling average generating output for such month].*** In the event that the Parties mutually agree that the generating output in any particular month or months during the rolling [3-year] [5-year] period was caused by materially unusual circumstances, the Parties may agree to exclude such month or months from the rolling [three (3) year] [five (5) year] calculation of generating output. The Parties agree that the intent of using the [three (3) year] [five (5) year] rolling output is to develop generation forecasts that accurately reflect the actual generating characteristics of the Facility.

3.4 Energy Delivery. Seller shall schedule and deliver the Product to PGE at the Delivery Point, commencing on ***[specify date for existing Facility] [for new Facility:*** the Commercial Operation Date***]*** and continuing through the end of the Delivery Period, subject to the terms and conditions herein.

3.4.1 Seller shall provide PGE with (i) a rolling generation forecast, updated hourly, for the next fourteen (14) days, (ii) ***[within PGE's Balancing Authority Area:*** a

rolling generation forecast for five (5) minute and fifteen (15) minute intervals, updated every five (5) and fifteen (15) minutes respectively, for the next 24 hours***]***, and (iii) an updated hourly generation forecast ninety (90) minutes prior to each delivery hour for the balance of the delivery day ("Generation Forecast"). Each Generation Forecast shall be performed by the Forecasting Agent. The Forecasting Agent shall utilize methodology consistent that the requirements set forth in Exhibit L. At PGE's request, Seller will cause the Forecasting Agent to provide PGE with an Application Program Interface from which PGE can access raw forecasting files. The Forecasting Agent and PGE shall have real time access to information and forecasts concerning the Facility's availability status.

3.4.2 Seller shall schedule the Product in accordance with Section 3.8.4 for delivery to PGE at the Delivery Point in the amount of Energy expected to be generated by the Facility consistent with the Generation Forecast. Seller's Energy delivery Schedule may not intentionally exceed the Generation Forecast in any hour. Seller and PGE agree that the intent of this Section 3.4.2 is for Seller to schedule and deliver Energy resembling actual production for each hour.

3.4.3 Seller shall make reasonable efforts to minimize the delivery of Un-Specified Energy to PGE.

3.4.4 Seller shall provide PGE with a real-time ICCP and EIDE communications link to the Facility metered output.

3.4.5 Seller shall deliver to PGE a quantity of Specified Energy for each monthly On-Peak and Off-Peak period during the Delivery Period in an amount equal to Specified Amounts.

3.4.6 Seller shall be responsible for any costs or charges imposed on or associated with the Product or its receipt provided such costs or charges are either (a) imposed on the Seller's side of the Delivery Point, (b) as a result of the schedule changes, or (c) Seller's actions.

3.4.7 If Seller or its agent reasonably anticipates that Market Index Prices will be less than zero, and Seller expects to receive little or no net payment for its output ("Negative Price Event"), Seller shall have the right, but not the obligation, to suspend part or all of its deliveries, via a reduction in Facility Output, for the anticipated duration of the Negative Price Event. In the event the Market Index Price is less than zero during the Negative Price Event, Seller's obligation to deliver Specified Amount shall be reduced by one (1) MWh and Seller's Minimum Annual Volume shall be reduced by one (1) MWh.

3.5 Environmental Attributes Delivery. Unless excused by Force Majeure, Seller shall convey to PGE all Environmental Attributes, including Bundled RECs, associated with all Specified Energy. Seller represents and warrants that Seller will hold good title, free and clear of any liens or encumbrances, to all Environmental Attributes from the Facility, including all Bundled RECs, conveyed to PGE.

3.5.1 Title to RECs transferred by Seller to PGE pursuant to this Agreement shall be settled through WREGIS.

3.5.2 Unless otherwise specified herein or by written notification by PGE, for each month of the Delivery Period after the Commercial Operation Date, Seller shall deliver and convey the Bundled RECs associated with the Specified Energy delivered to PGE within ten (10) Business Days after the end of the month in which the WREGIS certificates for such Bundled RECs are created. Seller shall be responsible for attaching, in accordance with all current WREGIS operating rules, all available and applicable NERC e-tags pertaining to the corresponding Bundled REC before such Bundled REC is transferred to PGE in WREGIS.

3.5.3 PGE and Seller may mutually agree during the Delivery Period for the purchase and conveyance of Environmental Attributes, including Bundled RECs, associated with any As-Available Energy delivered by Seller to PGE.

3.5.4 Seller shall, by written notice to PGE, offer to sell to PGE any RECs generated by the Facility that are not purchased by or conveyed to PGE pursuant to this Agreement. PGE shall have thirty (30) days in which to accept or decline the offer by notice to Seller. If PGE does not respond within the thirty (30) day period, it shall be deemed to have declined the offer. If PGE declines the offer, Seller may then sell such REC's to a third-party under terms and conditions (including price) no more favorable to the third party than those offered to PGE.

3.6 Carbon Emissions. Seller is responsible for and shall pay for all future costs, if any, whether incurred by Seller or PGE, resulting from any carbon emissions generated by or associated with the Delivered Energy Quantity delivered by Seller to the Delivery Point in accordance with this Agreement. Seller may provide PGE with carbon emissions offsets that are reasonably satisfactory to PGE in lieu of a monetary settlement. Within ten (10) Business Days after PGE's request, Seller shall provide PGE with the carbon emissions data for the Product that is delivered during the Delivery Period.

3.7 PGE's Purchase Obligations. PGE shall purchase and receive the Product delivered by Seller to the Delivery Point in an amount not to exceed the Net Available Capacity for each hour during the Delivery Period in accordance with and subject to the terms of this Agreement. PGE shall pay Seller the applicable price for all Specified Energy, Un-Specified Energy and As-Available Energy delivered to the Delivery Point as set forth in Article 6. PGE shall be responsible for any costs or charges imposed on or associated with the Product or its receipt, provided such costs or charges are imposed at or on PGE's side of the Delivery Point and not the result of Seller's actions, except any EIM charges resulting from Seller's scheduling adjustments described in Sections 3.4.7 and 3.9.4(c).

3.8 Transmission and Scheduling of Energy.

3.8.1 Transmission Capability to PGE's Sink Point. Within sixty (60) Business Days after the Effective Date, PGE will submit a request to designate the Facility as a Network Resource, as defined in Section 1.59 of PGE's Open Access

Transmission Tariff (OATT), following the procedures set forth in Section 30 of PGE's OATT and any associated business practices. Seller shall be responsible for performing all actions necessary for PGE to designate the facility as a Network Resource. Such actions may include, but are not limited to, reimbursing PGE for any necessary studies, funding of any necessary transmission upgrades, additions to or upgrades of Facility equipment, sharing of technical or operational data. If the costs of such actions is reasonably projected to exceed [$_____] (the "Transmission Upgrade Cost Cap"), Seller may terminate this Agreement by providing notice to PGE; provided, however, that such termination shall be void if, within thirty (30) days after PGE receives notice of termination, PGE agrees in its sole discretion to bear costs in excess of the Transmission Upgrade Cost Cap. Once the Facility is successfully designated as a Network Resource, PGE will arrange, be responsible for, and make available transmission service from the Delivery Point to the designated sink point. If PGE, as a Transmission Provider, determines that due to insufficient transfer capability, consistent with PGE's OATT requirements, the requested Network Resource designation cannot be achieved, regardless of any proposed upgrades, by the Guaranteed Commercial Operation Date for the Net Available Capacity then PGE may terminate this Agreement by providing notice to Seller.

3.8.2 Transmission Service Agreement. No later than [__] days after Effective Date, Seller shall deliver to PGE copies of transmission service agreements with associated service tables between Seller and its Transmission Provider for transmission service between the Facility's point of interconnection and the Delivery Point for the entire Net Available Capacity during the entire Delivery Period in the form of either: i) a fully executed Precedent Transmission Service Agreement for Long-Term Firm Point-To-Point Service, or ii) a fully executed copy of a Long-Term Firm Point-To-Point Service Transmission Service Agreement, in each case commencing no later than the Commercial Operation Date. Seller may not satisfy the requirements of this Section 3.8.2 by acquiring transmission rights currently held by a third party, or its affiliates, engaged in the development of a Qualifying Facility if such party or its affiliates has contractual obligations to PGE for the delivery of energy under PGE's Tariff Schedule 201 or Schedule 202, unless it can be reasonably determined that the transmission rights are in excess of such third party's contractual obligations to PGE.

Seller shall pay for and maintain Long-Term Firm Point-to-Point Transmission Service (as such term is defined in its Transmission Provider's Open Access Transmission Tariff that is posted on OASIS) for delivery of Energy from the Facility's point of interconnection to the Delivery Point for the entire Net Available Capacity during the entire Delivery Period, commencing on the Commercial Operation Date. Seller shall be responsible for all transmission costs for delivery of the Product to the Delivery Point, including but not limited to all Ancillary Services costs and integration service costs required by the Transmission Provider(s). Seller's transmission agreement shall have a term of no less than five (5) years. In the event Seller's transmission agreement expires prior to the end of the Delivery Period and is not eligible for reservation priority rights, Seller shall acquire replacement transmission agreement(s) consistent with the requirements set forth in this Section 3.8.2. A copy of Seller's long-term transmission plan, as of the Effective Date, is attached to this Agreement as Exhibit J. Within five (5)

days of execution of any new or replacement Transmission Service Agreement(s), Seller shall provide PGE with a copy of Seller's transmission agreement and generation interconnection agreements, and the Parties shall amend Exhibit J to include copies of such agreements.

3.8.3 Seller to Designate Forecasting and Scheduling Agents. At least ten (10) days before it begins to Schedule Test Energy under this Agreement, Seller shall engage at its expense a third-party Scheduling Agent (the "Scheduling Agent") and a third-party forecasting agent (the "Forecasting Agent"), subject in each case to PGE's prior approval. The Scheduling Agent shall perform Seller's pre-scheduling and Scheduling obligations under this Section 3.8.3 based exclusively on forecasts supplied by the Forecasting Agent.

3.8.4 Scheduling Procedure. Seller shall comply with the following "Scheduling Procedure" during the Delivery Period:

(a) "Pre-Scheduled Energy" means Product scheduled under the following conditions for each day during the Delivery Period:

(i) Seller shall communicate to PGE's Pre-schedule Desk, as directed by PGE, the Facility's Generation Forecast to be delivered at the Delivery Point for the Pre-Scheduling Day(s) by 5:00 a.m. PPT of the customary WECC Pre-Scheduling Day for each day during the Delivery Period;

(ii) Seller shall schedule the Energy by submitting a NERC e-Tag ("e-Tags") prior to 1:00 p.m. PPT of the applicable WECC Pre-Scheduling Day for all hours of the applicable delivery day(s); and

(iii) Seller shall schedule the Energy with e-Tags according to prevailing WECC Pre-scheduling provisions and protocols and the terms of this Agreement. Seller shall schedule the Facility as the identified e-Tag source. Seller may not net or otherwise combine schedules from resources other than the Facility, except as necessary for Ancillary Services, subject to the terms of this Agreement.

(b) Seller shall not schedule any Energy to be delivered to PGE pursuant to this Agreement using a Dynamic or Pseudo-Tie e-Tag as such terms are defined and used by NERC.

(c) Seller may make adjustments to the Pre-Scheduled Energy scheduled from the Facility each hour in Real-Time ("Real-time Adjustments"). If Seller elects to make Real-time Adjustments, Seller will:

(i) communicate to PGE's Real-time Desk, as directed by PGE, its intent to adjust the Pre-Scheduled Energy no later than 120 minutes prior to the flow hour; and

(ii) submit and receive approval of e-Tag adjustment no later than sixty (60) minutes prior to the flow hour. Seller will make all NERC e-Tag adjustments. Seller's e-tag shall match the adjustment communicated to PGE pursuant to Section 3.8.4(c)(i). Seller shall be responsible for any costs, charges, or fees associated with deviations to the e-tag after sixty (60) minutes prior to the flow hour.

(d) In the event that the regional market design, Balancing Authority, Area,Reliability Entity or Regulatory Entity (e.g. PGE Transmission, BPA Transmission, WECC, NERC, Peak RC, FERC) causes PGE's scheduling practices to change after the Effective Date, PGE shall have the right but not the obligation to update the Scheduling Procedure by giving [__ (__)] days prior written notice to Seller of such update.

3.8.5 Authorized Scheduling Representatives. Each Party shall designate by notice to the other Party its authorized representatives responsible for Scheduling. The initial authorized representatives responsible for Scheduling are set forth on Exhibit A.

3.8.6 Maximum Delivery Amounts. Seller shall sell and deliver, and PGE shall buy and receive, the Delivered Energy Quantity delivered pursuant to this Agreement, up to the Net Available Capacity. Seller shall not increase (i) the Facility's ability to deliver Facility Output, (ii) Nameplate Capacity, or (iii) Net Available Capacity through any means, including but not limited to replacement or modification of equipment or related infrastructure.

3.8.7 Title to Energy. Title to Energy shall pass to PGE at the Delivery Point.

3.8.8 Reliability Entity Curtailment. PGE shall not be liable to Seller if curtailment of Scheduled or unscheduled Energy is due to the action of a Reliability Entity. Seller shall pay PGE the replacement cost for such Energy. The replacement cost during a Reliability Entity curtailment shall be the greater of zero or the amount calculated as: ((Market Index Price – Fixed Price) multiplied by curtailed Energy based on the Facility's potential generation for periods of the Reliability Entity curtailment. The Forecasting Agent shall calculate the potential generation during periods of the Reliability Entity curtailment.

3.8.9 Approval for Seller to Join Organized Markets. During the Term of this Agreement, Seller shall not register as a participating resource in any energy imbalance market, independent system operator market or other organized market without prior written consent from PGE, which consent may be granted in PGE's sole discretion.

3.9 Measurement and Transfer of RECs.

Bundled RECs shall be deemed sold and delivered to PGE under this Agreement as they are produced and measured by the Facility Meter. Title to such Bundled RECs shall pass to PGE when generated. PGE shall own or be entitled to claim all Bundled RECs during the Term

(including any value in the ownership, use or allocation of Bundled RECs created by legislation or regulation after the Effective Date). The Facility Meter shall serve as the record source for purposes of calculating, certifying, and auditing Bundled RECs. Seller shall cause the Facility to implement all necessary generation information communications in WREGIS, and report generation information to WREGIS pursuant to a WREGIS-approved meter that is dedicated to the Facility and only the Facility. Seller shall cause delivery and transfer of the Bundled RECs to PGE's WREGIS account to be perfected in accordance with WREGIS rules. Seller shall hold the Bundled RECs in trust for PGE until such delivery and transfer is perfected. Each Party shall take such steps and further actions as may be required by WREGIS or applicable Law in order to effect and confirm the sale and delivery of the Bundled RECs to PGE for all purposes.

3.10 Access. Upon reasonable prior notice and subject to the prudent safety requirements of Seller, and Law relating to workplace health and safety, Seller shall provide PGE and its authorized agents, employees and inspectors ("PGE Representatives") with reasonable access to the Facility: (a) for the purpose of reading or testing metering equipment, (b) as necessary to witness any acceptance tests, (c) to provide tours of the Facility to customers and other guests of PGE (not more than twelve (12) times per year), (d) for purposes of implementing Section 17.2 (Audit Rights), and (e) for other reasonable purposes at the reasonable request of PGE. PGE shall release Seller against and from any and all Liabilities resulting from actions or omissions by any of the PGE Representatives in connection with their access to the Facility, except to the extent that such damages are caused by the intentional or negligent act or omission of Seller.

3.11 Facility Remedial Action Scheme. To the extent the Facility is not otherwise subject to Seller's Transmission Provider's Remedial Action Scheme, PGE shall have the right to utilize the Facility for PGE's Transmission Provider's Remedial Action Scheme. Before the Commercial Operation Date, Seller shall at its expense make necessary arrangements, including installing any required equipment and entering into any applicable agreements, to enable the Facility to participate in a Remedial Action Scheme for PGE's benefit.

## ARTICLE 4
## FORCE MAJEURE

4.1 Definition.

"Force Majeure" means any event or circumstance, or combination of events or circumstances, that meets all of the following criteria:

(a) arises after the Effective Date,

(b) was not caused by and is unforeseeable and beyond the reasonable control of the Party claiming the Force Majeure Event,

(c) is unavoidable or could not be prevented or overcome by the reasonable efforts and due diligence of the Party claiming the Force Majeure Event, and

(d) either (i) as with respect to PGE as the impacted Party, has an impact which will actually, demonstrably and adversely affect PGE's ability to perform its

obligations (other than payment obligations) in accordance with the terms of the Agreement or (ii) as with respect to Seller as the impacted Party, has an impact which will actually, demonstrably and adversely affect Seller's ability to perform its obligations in accordance with the terms of the Agreement.

4.2 Provided they meet all of the criteria described above, Force Majeure Events may include the following: acts of God, natural disasters, wildfires, earthquakes, tornadoes, lightning, floods, civil disturbances, riots, war and military invasion, physical damage to the Facility caused by third parties who are not subcontractors or representatives, employees or agents of the impacted Party; acts of the public enemy; blockade; acts of terrorism; insurrection, riot or revolution; sabotage or vandalism; embargoes, and actions of a Governmental Authority (other than in respect of or in relation to or resulting from Seller's non-compliance with Laws). Notwithstanding anything in the foregoing to the contrary, in no event shall any of the following constitute a Force Majeure Event: (i) strikes, and other labor disputes (including collective bargaining disputes and lockouts) of the labor force under the control of the Party claiming the Force Majeure Event or its Affiliates or with respect to the work completed by a subcontractor of Seller on the Site unless the strike is part of a more widespread or general strike extending beyond the Party, Affiliate or subcontractor; (ii) cost or shortages of labor or manpower; (iii) unavailability, late delivery, failure, breakage or malfunction of equipment or materials unless there is an independent, identifiable Force Majeure Event causing such condition; (iv) events that affect the cost of equipment or materials; (v) economic hardship (including lack of money) of any entity or its Affiliates or their respective subcontractors or suppliers; (vi) delays in transportation (including delays in clearing customs) other than delays in transportation resulting from accidents or closure of roads or other transportation route by Governmental Authorities; (vii) any weather conditions which are not defined above as Force Majeure Events; (viii) actions of a Governmental Authority in respect of or in relation to or resulting from Seller's compliance or non-compliance with Laws; (ix) any failure by Seller to obtain and maintain any Permit it is required to obtain or maintain hereunder; (x) any other act, omission, delay, default or failure (financial or otherwise) of a subcontractor of Seller or other personnel of Seller; (xi) loss of PGE's markets; (xii) PGE's inability economically to use or resell the Product purchased under this Agreement; (xiii) the loss or failure of Seller's fuel supply or equipment; (xiv) either Party's inability to pay when due any amounts owed under this Agreement; or (xv) Seller's ability to sell the Product at a price greater than the Fixed Price. Seller may not raise a claim of Force Majeure with respect to the unavailability of Energy or Bundled RECs from the Facility based on any of the following: (i) routine or scheduled maintenance of the Facility; (ii) any unscheduled outage undertaken to address normal wear and tear of the Facility during the Term; (iii) any outage caused by Seller's failure to design, construct, operate or maintain the Facility consistent with Prudent Electric Industry Practice; (iv) changes in climactic conditions; (v) environmental obstructions caused by events or circumstances that may impact the Facility's generation output but without causing a Facility outage (e.g., forest fire or volcanic eruption located outside of the Facility site); (vi) financial inability to perform; (vii) changes in cost or availability of materials, equipment, or services; or (ix) strikes or labor disturbances involving the employees of Seller or any of its subcontractors unless such strike or labor disturbance has a national impact making it impossible for Seller to perform its obligations with respect to the Facility. .Occurrence and Notice.

To the extent either Party is prevented by Force Majeure from carrying out, in whole or part, its obligations under this Agreement and such Party (the "Claiming Party") gives notice and details of the Force Majeure to the other Party as soon as practicable, then, unless the terms of this Agreement specify otherwise, the Claiming Party shall be excused from the performance of its obligations related thereto. The Claiming Party shall remedy the Force Majeure with all reasonable dispatch. The non-Claiming Party shall not be required to perform

its obligations to the Claiming Party that correspond to the obligations of the Claiming Party that are excused by Force Majeure.

4.3 Obligations.

No Party shall be relieved by operation of this Article 4 of any liability to pay for Products delivered hereunder or to make payments then due or which the Party is obligated to make with respect to performance which occurred prior to the Force Majeure.

4.4 Right to Terminate.

If a Force Majeure event prevents a Party from performing its material obligations under this Agreement for a period exceeding 180 consecutive days before the Commercial Operation Date or, after the Commercial Operation Date, for a period exceeding 240 consecutive days (despite the affected Party's effort to take all reasonable steps to remedy the effects of the Force Majeure with all reasonable dispatch), then the Party not affected by the Force Majeure event, with respect to its obligations under this Agreement, may terminate this Agreement by giving 10 days' prior notice to the other Party. Upon such termination, neither Party will have any liability to the other with respect to periods following the effective date of such termination, except for the right of first offer set forth in Section 3.1.15 and as otherwise expressly provided in this Agreement; provided, however, that this Agreement will remain in effect to the extent necessary to facilitate the settlement of all liabilities and obligations arising under this Agreement before the effective date of such termination.

## ARTICLE 5
## EVENTS OF DEFAULT; REMEDIES

5.1 Events of Default.

An "Event of Default" shall mean, with respect to a Party (a "Defaulting Party"), the occurrence of any of the following:

5.1.1 in the case of the Seller, the occurrence of a Material Adverse Change with respect to Seller or its Guarantor; provided, such Material Adverse Change shall not be considered an Event of Default if Seller establishes, delivers to PGE and maintains for so long as the Material Adverse Change is continuing, Performance Assurance in an amount equivalent to the Termination Payment as determined under Section 5.3;

5.1.2 the failure to make, when due, any payment required pursuant to this Agreement if such failure is not remedied within ten (10) Business Days after written notice;

5.1.3 any representation or warranty made by such Party in this Agreement is false or misleading in any material respect when made or when deemed made or repeated if such inaccuracy is not cured within thirty (30) days after the non-defaulting Party gives the defaulting Party a notice of default;

5.1.4 if a Party fails to deliver or receive Product as required by this Agreement, and such failure occurs for (i) more than five (5) consecutive Days, or (ii) ten (10) Days out of any Contract Year (it being the intent of the Parties that other failures to deliver or receive Product in any Contract Year will be governed by Article 6);

5.1.5 such Party becomes Bankrupt;

5.1.6 the occurrence of a Merger Event with respect to such Party or its Guarantor that is not cured within ten (10) Business Days of notice by the other Party;

5.1.7 in the case of Seller, Seller's failure to establish, maintain, extend or increase Performance Assurance when required pursuant to this Agreement;

5.1.8 ***[Note to bidders: Applicable to baseload facilities.]*** commencing on the Commercial Operation Date, Seller's failure to deliver the Minimum Annual Volume to Buyer during two (2) out of three (3) calendar years during the Delivery Period;

5.1.9 ***[Note to bidders: Applicable to intermittent facilities.]*** beginning with the second full calendar year following the calendar year in which the Commercial Operation Date has occurred, Seller's failure to maintain a minimum Mechanical Availability Percentage for the Facility of [ninety-seven percent (97%)] for any two (2) out of three (3) calendar years on a rolling basis. The Mechanical Available Percentage of the Facility shall be determined by Seller by dividing the total Operational Hours for such calendar year ***[non-solar resources:*** by the total number of hours in the calendar year***] [solar resources:*** by the total number of daylight hours in the calendar year.***]*** On or before January 31st of each year, Seller shall provide PGE written documentation, which shall be subject to audit by PGE, to verify or otherwise substantiate Seller's calculation of the Mechanical Available Percentage of the Facility for the prior calendar year. The operational hours for the Facility shall be the hours that the Facility is potentially capable of producing power at Nameplate Capacity regardless of actual weather conditions or season, without any mechanical operating constraint or restriction, and potentially capable of delivering such power to the point of interconnection with the Transmission Provider. The methodology for calculating Operational Hours and the resulting Mechanical Availability Percentage is set forth in Exhibit N ***[Note to bidders: the Parties would agree to a more detailed methodology consistent with this Section 6.1.9 and attached it as Exhibit N]***;

5.1.10 in the case of Seller, the occurrence of a Letter of Credit Default;

5.1.11 with respect to Seller's Guarantor, if any, the occurrence of a Guaranty Default;

5.1.12 in the case of Seller, the occurrence of an Event of Default under Section 3.1.9(d);

5.1.13 the failure to perform any material covenant or obligation set forth in this Agreement for which an exclusive remedy is not provided in this Agreement and which is not addressed in any other Event of Default, if the failure is not cured within

thirty (30) days after the Non-Defaulting Party gives the Defaulting Party notice of the default; provided that if such default is not reasonably capable of being cured within the thirty (30) day cure period but is reasonably capable of being cured within a sixty (60) day cure period, the Defaulting Party will have such additional time (not exceeding an additional thirty (30) days) as is reasonably necessary to cure, if, prior to the end of the thirty (30) day cure period the Defaulting Party provides the Non-Defaulting Party a remediation plan, the Non-Defaulting party approves such remediation plan, and the Defaulting Party promptly commences and diligently pursues the remediation plan.

5.2 Declaration of an Early Termination Date and Calculation of Settlement Amounts.

5.2.1 Early Termination Date. If an Event of Default with respect to a Defaulting Party shall have occurred at any time during the Term and be continuing, the other Party (the "Non-Defaulting Party") shall have the right to (i) designate a day, no earlier than the day such notice is effective and no later than twenty (20) days after such notice is effective, as an early termination date ("Early Termination Date") on which to liquidate, terminate, and accelerate all amounts owing between the Parties, (ii) withhold any payments due to the Defaulting Party under this Agreement, and (iii) suspend performance. If an Early Termination Date has been designated, the Non-Defaulting Party shall calculate, in a commercially reasonable manner, its Gains or Losses and Costs resulting from the termination of this Agreement as of the Early Termination Date. The Non-Defaulting Party shall calculate the Termination Payment payable hereunder in accordance with Section 5.2.2 below.

5.2.2 Calculation of Settlement Amounts. The Gains or Losses resulting from the termination of this Agreement shall be determined by calculating the amount that would be incurred or realized to replace or to provide the economic equivalent of the remaining payments or deliveries in respect of this Agreement. The Gains or Losses shall be calculated for a period equal to the remaining Term ("Settlement Period"). The quantity of Energy in each month of the Settlement Period shall be equal to the Initial Specified Amount for such month ("Settlement Energy"). The Non-Defaulting Party (or its agent) may determine its Gains and Losses by reference to information either available to it internally or supplied by one or more third parties including, without limitation, quotations (either firm or indicative) of relevant rates, prices, yields, yield curves, volatilities, spreads or other relevant market data in the relevant markets. Third parties supplying such information may include, without limitation, dealers in the relevant markets, end-users of the relevant product, information vendors and other sources of market information. However, it is expressly agreed that (a) a Party shall not be required to enter into a replacement agreement in order to determine the Termination Payment and (b) a Party's Gains, Losses or Costs will in no event include any penalties, ratcheted demand or similar charges.

5.3 Termination Payment.

The "Termination Payment" shall equal the sum of all amounts owed by the Defaulting Party to the Non-Defaulting Party under this Agreement, including a Settlement

Amount (if any), less any amounts owed by the Non-Defaulting Party to the Defaulting Party determined as of the Early Termination Date.

5.4 Notice of Payment of Termination Payment.

As soon as practicable after calculating the Termination Payment, the Non-Defaulting Party shall give notice to the Defaulting Party of the amount of the Termination Payment and whether the Termination Payment is due to or due from the Non-Defaulting Party. The notice shall include a written statement explaining in reasonable detail the calculation of such amount. If the Termination Payment is due from the Defaulting Party, the Termination Payment shall be made by the Defaulting Party within two (2) Business Days after such notice is effective. Notwithstanding any provision to the contrary contained in this Agreement, the Non-Defaulting Party shall not be required to pay to the Defaulting Party any amount under this Article 5 until the earlier of (i) the date the Non-Defaulting Party receives confirmation satisfactory to it in its reasonable discretion (which may include an opinion of its counsel) that all other obligations of any kind whatsoever of the Defaulting Party to make any payments to the Non-Defaulting Party under this Agreement or otherwise which are due and payable as of the Early Termination Date have been fully and finally performed, or (ii) 180 days after the Early Termination Date.

5.5 Disputes with Respect to Termination Payment.

If the Defaulting Party disputes the Non-Defaulting Party's calculation of the Termination Payment in whole or in part, the Defaulting Party shall, within ten (10) Business Days of receipt of Non-Defaulting Party's calculation of the Termination Payment provide to the Non-Defaulting Party a detailed written explanation of the basis for such dispute; provided, however, that if the Termination Payment is due from the Defaulting Party, the Defaulting Party shall pay the non-disputed amount of the Termination Payment as provided in Section 5.4 and transfer, within two (2) Business Days, Performance Assurance to the Non-Defaulting Party in an amount equal to the disputed amount of the Termination Payment.

5.6 Closeout Setoffs.

After calculation of a Termination Payment in accordance with Section 5.3, if the Defaulting Party would be owed the Termination Payment, the Non-Defaulting Party shall be entitled, at its option and in its discretion, to set off against such Termination Payment any amounts due and owing by the Defaulting Party to the Non-Defaulting Party under any other agreements, instruments or undertakings between the Defaulting Party and the Non-Defaulting Party. The remedy provided for in this Section 5.6 shall be without prejudice and in addition to any right of setoff, combination of accounts, lien or other right to which the Non-Defaulting Party is at any time otherwise entitled (whether by operation of law, contract or otherwise).

5.7 Suspension of Performance.

Notwithstanding any other provision of this Agreement, if an Event of Default shall have occurred and be continuing, the Non-Defaulting Party, upon written notice to the Defaulting Party, shall have the right (i) to suspend performance under this Agreement; provided, however, in no event shall any such suspension continue for longer than ten (10)

Business Days with respect to any single Scheduled Product unless an early Termination Date shall have been declared and notice thereof pursuant to Section 5.2 given, and (ii) to the extent an Event of Default shall have occurred and be continuing to exercise any remedy available at law or in equity.

5.8 Post-Termination PURPA Status. If this Agreement is terminated because of a default by Seller, and Seller has subsequently remedied the default after such termination, neither Seller nor any Affiliate of Seller, nor any successor to Seller with respect to the ownership of the Facility or Site, on whose behalf Seller acts herein as agent, may thereafter require or seek to require PGE to make any purchases from the Facility or any electric generation facility constructed on the Site under PURPA, or any other Law, under terms and conditions different from those set forth in this Agreement (including rates higher than those set forth in this Agreement) for any periods that would have been within the Term had this Agreement remained in effect. Seller, on behalf of itself and on behalf of any other entity on whose behalf it may act, hereby waives its rights to require PGE to do so. On or before the Effective Date, the Parties shall execute and record, in the appropriate real property records of the counties in which the Facility or Site is situated, and any federal agency as applicable, a memorandum in form acceptable to PGE to provide constructive notice to third parties of Seller's agreements under this Section 5.8. In no event will PGE be require to make any purchases from the Facility or any electric generation facility constructed on the Site in the event the default that caused the termination is still in effect.

## ARTICLE 6
## REMEDIES FOR FAILURE TO DELIVER/RECEIVE

6.1 Seller Failure to Deliver Specified Energy. If Seller fails to deliver Specified Energy and the associated Environmental Attributes, including Bundled RECs, in an amount equal to the Specified Amount for any monthly On-Peak and Off-peak period, and such failure is not excused by Force Majeure, or by PGE's breach of this Agreement, Seller shall owe PGE an amount as calculated below:

6.1.1 Seller shall owe PGE an amount for such deficiency equal to the positive difference (if any) of the applicable Market Index Settlement Price minus the Fixed Price multiplied by the positive difference (if any) of the Specified Amount for the applicable monthly On-Peak and Off-peak period minus the Specified Energy delivered during that monthly On-Peak and Off-peak period; and

6.1.2 Seller shall owe PGE an amount for such deficiency should the replacement energy procured by PGE as a result of Seller's failure to deliver the Specified Amount result in incremental Carbon Emissions costs to PGE, consistent with Section 3.6,

6.1.3 Seller shall owe PGE an amount for such deficiency should the replacement energy procured by PGE as a result of Seller's failure to deliver the Specified Amount result in incremental ancillary services and transmission costs; and

6.1.4 Seller shall be obligated to settle any shortfall in the delivery of Environmental Attributes (including Bundled RECs) as follows:

(a) Seller shall, within 120 days after the end of the shortfall month, deliver an equivalent amount of Qualifying Replacement RECs that are generated in the same calendar year; or

(b) If Seller elects not to deliver an equivalent amount of Qualifying Replacement RECs under Section 6.1.4(a) and PGE elects in its sole discretion to purchase Qualifying Replacement RECs, Seller shall owe PGE the price that PGE actually pays for Qualifying Replacement RECs; or

(c) If Seller elects not to deliver an equivalent amount of Qualifying Replacement RECs under Section 6.1.4(a) and PGE does not elect, in its sole discretion, to purchase replacement bundled RECs under subpart (b), Seller shall owe PGE the Qualifying Replacement REC Price identified by PGE multiplied by the number of Bundled RECs Seller failed to deliver. PGE shall use commercially reasonable efforts to mitigate the amount owed by Seller under this Section 6.1.4(c).

6.1.5 Any amount owed by the Seller to PGE under this Section 6.1shall be netted against PGE's payment obligation for the month pursuant to Section 6.5 below.

6.1.6 An example illustrating the calculation of amounts due to PGE under this Section 6.1 under certain stated assumptions is set forth in Exhibit I.

6.2 PGE's Failure to Accept. If PGE fails to accept any part of the Product that is scheduled in accordance with Section 3.8, and Seller is ready willing and able to deliver to the Delivery Point, and such failure is not excused by a reliability or transmission constraint, Force Majeure or by Seller's failure to perform, then PGE shall owe Seller an amount for such deficiency equal to the positive difference between the applicable purchase price as set forth in Section 7.1 for the amount of Product PGE fails to accept minus the Sales Price associated with the amount of Product PGE fails to accept. Any such amount owed by PGE to Seller shall be added to the calculation of PGE's payment obligation for the month pursuant to Section 7.1. For each MWh of Product not accepted by PGE pursuant to this Section 6.2, Seller's obligation to deliver the Specified Amount shall be reduced by one (1) MWh, and Seller's Minimum Annual Volume shall be reduced by one (1) MWh. An example illustrating the calculation of amounts due to Seller under this Section 6.2 under certain stated assumptions is set forth in Exhibit I.

6.3 Duty to Mitigate.

Each Party agrees that it has a duty to mitigate damages and covenants that it will use commercially reasonable efforts to minimize any damages it may incur as a result of the other Party's performance or non-performance of this Agreement.

6.4 Acknowledgement of the Parties.

The Parties stipulate that the payment obligations set forth in this Article 6 are reasonable in light of the anticipated harm and the difficulty of estimation or calculation of actual damages and waive the right to contest such payments as an unreasonable penalty. If either Party fails to pay undisputed amounts in accordance with this Article 6 when due, the other Party shall have the right to: (i) suspend performance until such amounts plus interest at the Interest Rate have been paid, and/or (ii) exercise any remedy available at Law or in equity to enforce payment of such amount plus interest at the Interest Rate. With respect to the amount of such damages only, the remedy set forth in this Article 6 shall be the sole and exclusive remedy of the Parties for the failure of Seller to sell and deliver, and PGE to purchase and receive the Product and all other damages and remedies are hereby waived. Disagreements with respect to the calculation of damages pursuant to this Article 6 may be submitted by either Party for resolution in accordance with ARTICLE 18 and with applicable Law.

6.5 Survival.

The provisions of this Article 6 shall survive the expiration or termination of this Agreement for any reason.

## ARTICLE 7
## PAYMENT AND NETTING

7.1 Billing Period.

Unless otherwise specifically agreed upon by the Parties, the Month shall be the standard period for all payments under this Agreement (other than for Seller or PGE failure under Sections 6.1 and 6.2 respectively and for termination under Section 5.4). On or before the tenth (10th) day of each Month, each Party shall render to the other Party an invoice for the payment obligations, if any, incurred hereunder during the preceding Month.

7.2 Timeliness of Payment.

Unless otherwise agreed by the Parties, all invoices under this Agreement shall be due and payable in accordance with each Party's invoice instructions on or before the later of the twentieth (20th) day of each Month, or the tenth (10th) day after receipt of the invoice or, if such day is not a Business Day, then on the next Business Day. Each Party will make payments by electronic funds transfer, or by other mutually agreeable method(s), to the account designated by the other Party. Any amounts not paid by the due date will be deemed delinquent and will accrue interest at the Interest Rate, such interest to be calculated from and including the due date to but excluding the date the delinquent amount is paid in full.

7.3 Disputes and Adjustments of Invoices.

A Party may, in good faith, dispute the correctness of any invoice or any adjustment to an invoice, rendered under this Agreement or adjust any invoice for any arithmetic or computational error within twenty-four (24) months of the date the invoice, or adjustment to an invoice, was rendered. In the event an invoice or portion thereof, or any other claim or

adjustment arising hereunder, is disputed, payment of the undisputed portion of the invoice shall be required to be made when due, with notice of the objection given to the other Party. Any invoice dispute or invoice adjustment shall be in writing and shall state the basis for the dispute or adjustment. Payment of the disputed amount shall not be required until the dispute is resolved. Upon resolution of the dispute, any required payment shall be made within ten (10) Business Days of such resolution along with interest accrued at the Interest Rate from and including the due date to but excluding the date paid. Inadvertent overpayments shall be returned upon request or deducted by the Party receiving such overpayment from subsequent payments, with interest accrued at the Interest Rate from and including the date of such overpayment to but excluding the date repaid or deducted by the Party receiving such overpayment. Any dispute with respect to an invoice is waived unless the other Party is notified in accordance with this Section 7.3 within twenty-four (24) months after the invoice is rendered or any specific adjustment to the invoice is made. If an invoice is not rendered within twelve (12) months after the close of the Month during which performance of this Agreement occurred, the right to payment for such performance is waived.

7.4 Netting of Payments.

The Parties hereby agree that they shall discharge mutual debts and payment obligations due and owing to each other on the same date through netting, in which case all amounts owed by one Party to the other Party during the monthly billing period under this Agreement, including any related damages calculated pursuant to ARTICLE 5 (unless one of the Parties elects to accelerate payment of such amounts as permitted by Section 5.2.1), interest, and payments or credits, shall be netted so that only the excess amount remaining due shall be paid by the Party who owes it.

7.5 Payment Obligation Absent Netting.

If no mutual debts or payment obligations exist and only one Party owes a debt or obligation to the other during the monthly billing period, including, but not limited to, any related damage amounts calculated pursuant to Article 5, interest, and payments or credits, that Party shall pay such sum in full when due.

## ARTICLE 8
## LIMITATIONS

8.1 Essential Purposes. THE PARTIES CONFIRM THAT THE EXPRESS REMEDIES AND MEASURES OF DAMAGES PROVIDED IN THIS AGREEMENT SATISFY THE ESSENTIAL PURPOSES OF THIS AGREEMENT.

8.2 Exclusive Remedies. FOR BREACH OF ANY PROVISION FOR WHICH AN EXPRESS REMEDY OR MEASURE OF DAMAGES IS PROVIDED, SUCH EXPRESS REMEDY OR MEASURE OF DAMAGES SHALL BE THE SOLE AND EXCLUSIVE REMEDY, THE OBLIGOR'S LIABILITY SHALL BE LIMITED AS SET FORTH IN SUCH PROVISION AND ALL OTHER REMEDIES OR DAMAGES AT LAW OR IN EQUITY ARE WAIVED.

8.3 Direct Damages. IF NO REMEDY OR MEASURE OF DAMAGES IS EXPRESSLY PROVIDED HEREIN, THE OBLIGOR'S LIABILITY SHALL BE LIMITED TO DIRECT ACTUAL DAMAGES ONLY, SUCH DIRECT ACTUAL DAMAGES SHALL BE THE SOLE AND EXCLUSIVE REMEDY AND ALL OTHER REMEDIES OR DAMAGES AT LAW OR IN EQUITY ARE WAIVED.

8.4 No Consequential Damages. EXCEPT AS EXPRESSLY PROVIDED IN THIS AGREEMENT, NEITHER PARTY SHALL BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, PUNITIVE, EXEMPLARY OR INDIRECT DAMAGES, LOST PROFITS OR OTHER BUSINESS INTERRUPTION DAMAGES, BY STATUTE, IN TORT OR CONTRACT, UNDER ANY INDEMNITY PROVISION OR OTHERWISE.

8.5 Causes Disregarded. IT IS THE INTENT OF THE PARTIES THAT THE LIMITATIONS IMPOSED IN THIS AGREEMENT ON REMEDIES AND THE MEASURE OF DAMAGES BE WITHOUT REGARD TO THE CAUSE OR CAUSES RELATED THERETO, INCLUDING THE NEGLIGENCE OF ANY PARTY, WHETHER SUCH NEGLIGENCE BE SOLE, JOINT OR CONCURRENT, OR ACTIVE OR PASSIVE.

8.6 Liquidated Damages. TO THE EXTENT ANY DAMAGES REQUIRED TO BE PAID UNDER THIS AGREEMENT ARE LIQUIDATED, THE PARTIES ACKNOWLEDGE THAT THE DAMAGES ARE DIFFICULT OR IMPOSSIBLE TO DETERMINE, OR OTHERWISE OBTAINING AN ADEQUATE REMEDY IS INCONVENIENT, AND THE DAMAGES CALCULATED UNDER THIS AGREEMENT CONSTITUTE A REASONABLE APPROXIMATION OF THE HARM OR LOSS.

## ARTICLE 9
## CREDIT AND COLLATERAL REQUIREMENTS

9.1 Pre-COD Security.

9.1.1 Amount of Pre-COD Security. On or before the date specified in Section 3.1.9(a)(i), Seller shall post and maintain Performance Assurance in favor of PGE, equal in each case to $200 per kW of Nameplate Capacity (the "Pre-COD Security"). Seller shall ensure that any Person providing a guaranty for Seller shall provide within five (5) Business Days from receipt of a written request from PGE all reasonable financial records necessary for PGE to confirm Seller and/or the guarantor satisfies the Credit Requirements.

9.1.2 Use of Pre-COD Security to Pay Delay Damages. If the Commercial Operation Date occurs after the Expected Commercial Operation Date and Seller has failed to pay any Delay Damages when due under Section 3.1.13, PGE shall be entitled to and shall draw upon the Pre-COD Security an amount equal to the Delay Damages until such time as the Pre-COD Security is exhausted. PGE shall also be entitled to draw upon the Pre-COD Security for Contract Termination Damages.

9.1.3 Termination of Pre-COD Security. Seller shall no longer be required to maintain the Pre-COD Security (or the remaining balance thereof) after the Commercial Operation Date, if at such time no damages are owed to PGE under this

Agreement. PGE shall release the Pre-COD Security to Seller upon PGE's receipt of the Delivery Period Security under Section 9.2. However, as of the Commercial Operation Date, Seller may elect to apply the Pre-COD Security toward the Delivery Period Security required by Section 9.2, including by the automatic continuation (as opposed to the replacement) thereof.

9.2 Delivery Period Security.

9.2.1 Duty to Post Delivery Period Security. Beginning on the Commercial Operation Date, at any time during the Term when Seller does not satisfy the Credit Requirements, Seller shall post and maintain Performance Assurance in favor of PGE as provided in this Section 9.2 (the "Delivery Period Security"). Seller and any party providing a guaranty for Seller shall provide within five (5) Business Days from receipt of a written request from PGE all reasonable financial records necessary for PGE to confirm Seller and/or the guarantor satisfies the Credit Requirements.

9.2.2 Amount of Delivery Period Security. The amount of the Delivery Period Security required by Section 9.2.1 shall be sufficient to provide replacement power and Qualifying Replacement RECs under this Agreement for the next 60 calendar months. This amount shall be deemed equal to the positive difference between (a) the forward power prices at Mid-Columbia as determined by PGE in good faith using information from a commercially reasonable independent source (e.g., indicative of the most relevant ICE forward price curve for the Mid-Columbia) for the next 60 calendar months (or, if the remaining Term is less than 60 calendar months, then for the remainder of the Term), multiplied by [__] percent ([__]%), plus the Qualifying Replacement REC Price, plus the costs of transmitting such replacement energy from Mid-Columbia to the Delivery Point, minus (b) the Fixed Price, multiplied by the MWhs that would be delivered for such period under this Agreement (based on the Specified Amount set forth on Exhibit C for that period); provided, however, that the Delivery Period Security shall in no event be less than an amount equal to the Bundled RECs that would be delivered for the next 18 months (based on the Specified Amount set forth on Exhibit C for that period) multiplied by the Qualifying Replacement REC Price.

9.2.3 Adjustments to Delivery Period Security. On or before January 31st of each year during the Term, Seller shall (a) adjust the Delivery Period Security by increasing or decreasing the Delivery Period Security to correspond to the amount reasonably determined by PGE under Section 9.2.2, and (b) deliver such adjusted Delivery Period Security to PGE. PGE shall notify Seller of the determination of such amount on or before the preceding December 1 of each calendar year.

9.3 Grant of Security Interest/Remedies.

To secure its obligations under this Agreement and to the extent Seller delivers Performance Assurance, Seller hereby grants to PGE a present and continuing security interest in, and lien on (and right of setoff against), and assignment of, all cash collateral and cash equivalent collateral and any and all proceeds resulting therefrom or the liquidation thereof, whether now or hereafter held by, on behalf of, or for the benefit of, PGE, and Seller agrees to

take such action as PGE reasonably requires in order to perfect PGE's first-priority security interest in, and lien on (and right of setoff against), such collateral and any and all proceeds resulting therefrom or from the liquidation thereof.

Upon or at any time after the occurrence and during the continuation of an Event of Default or an Early Termination Date affecting the Seller, PGE may do any one or more of the following: (i) exercise any of the rights and remedies of a secured party with respect to all Performance Assurance, including any such rights and remedies under Law then in effect; (ii) exercise its rights of setoff against any and all property of the Seller in the possession of PGE or its agent; (iii) draw on any outstanding Letter of Credit issued for its benefit; and (iv) liquidate all Performance Assurance then held by or for the benefit of PGE free from any claim or right of any nature whatsoever of Seller, including any equity or right of purchase or redemption by Seller. PGE shall apply the proceeds of the collateral realized upon the exercise of any such rights or remedies to reduce the Seller's obligations under this Agreement (the Seller remaining liable for any amounts owing to PGE after such application), subject to PGE's obligation to return any surplus proceeds remaining after such obligations are satisfied in full.

9.4 Step-In Rights.

9.4.1 Notice. At any time after the Facility has achieved Commercial Operation, and if at such time PGE has the right to terminate this Agreement due to an Event of Default, then prior to and in lieu of exercising the termination right related to such Event of Default, PGE shall have the right, but not the obligation, to assume control of and operate the Facility as agent for Seller under the terms and conditions set forth herein ("Step-In Rights"). If PGE contemplates exercising its Step-In Rights under this Section 9.4, PGE shall give Seller at least ten (10) Days' advance notice thereof.

9.4.2 Books and Records. After notice is given and during the relevant notice period, Seller shall collect and have available at a convenient central location at the Facility and shall make available to PGE, at PGE's request, all documents, contracts, books, manuals, reports, records, plans, tools, equipment, inventories and supplies necessary or convenient to construct, operate and maintain the Facility in accordance with Prudent Electric Industry Practice.

9.4.3 Application of Proceeds. During any period that PGE is in control of and operating the Facility pursuant to exercise of its Step-In Rights, PGE shall perform and comply with all of the obligations of Seller under this Agreement and shall apply the Fixed Price that Seller would otherwise be entitled to receive hereunder in respect of the sale of Product and any other revenues of the Facility received by PGE from any source attributable to the Facility operation as follows:

(a) first, to reimburse PGE for any and all out-of-pocket expenses reasonably incurred by PGE in taking possession of and operating the Facility, including PGE's personnel time and expenses, such operation to be subject to the operating budget and any operating agreement if such agreements are applicable;

(b) second, to pay any unpaid amounts owed to PGE under this Agreement;

(c) third, to satisfy any payments due and owing to any Lenders, arising after PGE's exercise of its Step-In Rights, and

(d) fourth, to Seller.

9.4.1 Title and Possession. During any period that PGE is in control of and operating the Facility pursuant to the exercise of its Step-In Rights, Seller shall retain legal title to and ownership of the Facility and PGE shall assume possession, operation and control solely as agent for Seller, provided that PGE shall operate the Facility in conformance with Prudent Electric Industry Practice (including operation and maintenance of the Facility in accordance with manufacturer's recommendations), the provisions and covenants set forth herein and in the interconnection agreement between Seller and the Transmission Provider, all leases, subleases, rights-of-way, easements and rights of ingress and egress used in connection with the Facility and Law (including all material permits, consents, licenses, approvals or authorizations from any Governmental Authority pertaining to the Facility). PGE's exercise of its Step-In Rights shall not be deemed an assumption by PGE of any liability of, or attributable to, Seller; provided, however, during the time PGE is operating the Facility, PGE shall indemnify and hold Seller harmless for any third party claims against Seller arising out of PGE's negligence or willful misconduct.

9.4.2 Seller's Resumption of Operations. If PGE is in control of the Facility pursuant to the exercise of its Step-In Rights, Seller may resume operation and PGE shall relinquish its right to control and operate the Facility under this Section 9.4 at such time as Seller has demonstrated to PGE's reasonable satisfaction that it possesses the resources to perform its duties under this Agreement.

9.4.3 PGE's Return of Control. If at any time after exercising its Step-In Rights and taking control of and operating the Facility, PGE elects to return control and operation to Seller, PGE shall give Seller thirty (30) Business Days' advance notice of the date that PGE intends to return such control to Seller. Upon receipt of such notice, Seller shall take all actions necessary or appropriate to resume control and operation of the Facility on such date in accordance with the terms of this Agreement.

9.4.4 Purpose. PGE and Seller agree that (i) the Step-In Rights are intended solely to provide further assurance that the terms of this Agreement will be achieved, and accordingly that the purpose of the Step-In Rights is the same as the purpose of this Agreement; (ii) there is no separate or additional consideration for the Step-In Rights; and (iii) Seller's obligations in respect of the Step-In Rights are inextricably interrelated to PGE's obligations under the terms of this Agreement.

9.6 Holding Performance Assurance.

PGE will be entitled to hold Performance Assurance in the form of cash provided that the following conditions are satisfied: (i) PGE is not a Defaulting Party and a Material

Adverse Change has not occurred and is continuing with respect to PGE and (ii) Performance Assurance is held only in a jurisdiction within the United States.

9.7 Interest Rate on Cash Collateral.

Performance Assurance in the form of cash shall bear interest at the Interest Rate on Cash Collateral and shall be paid to the Seller on the third Business Day of each Month. "Interest Rate on Cash Collateral" means the lesser of (i) the maximum amount allowed by applicable Law and (ii) the Federal Funds Rate for the holding period. The "Federal Funds Rate" means the effective Federal Funds Rate as published daily by the Federal Reserves Bank H.15 Statistical Release website for each day of the holding period. Such interest shall be calculated on the basis of the actual number of days elapsed over a year of 360 days.

9.8 Performance Assurance is Not a Limit on Seller's Liability.

The Performance Assurance contemplated by this ARTICLE 9: (a) constitutes security for, but is not a limitation of, Seller's obligations under this Agreement, and (b) shall not be PGE's exclusive remedy for Seller's failure to perform in accordance with this Agreement. To the extent that PGE draws on any Pre-COD Security or Delivery Period Security, Seller shall replenish or reinstate the Pre-COD Security or Delivery Period Security to the full amount then required under this ARTICLE 9.

9.9 Waiver.

This Agreement sets forth the entire agreement of the Parties regarding credit, collateral, financial assurances and adequate assurances. Except as expressly set forth in this Agreement, including this ARTICLE 9, neither Party:

(a) has or will have any obligation to post margin, provide letters of credit, pay deposits, make any other prepayments or provide any other financial assurances, in any form whatsoever, or

(b) will have reasonable grounds for insecurity with respect to the creditworthiness of a Party that is complying with the relevant provisions of Article 9 of this Agreement; and all implied rights relating to financial assurances arising from Section 2-609 of the Uniform Commercial Code or case law applying similar doctrines, are hereby waived.

## ARTICLE 10
## GOVERNMENTAL CHARGES

10.1 Cooperation.

Each Party shall use reasonable efforts to implement the provisions of and to administer this Agreement in accordance with the intent of the Parties to minimize all taxes, so long as neither Party is materially adversely affected by such efforts.

10.2 Non-Sale Related Governmental Charges and Taxes.

Seller shall pay or cause to be paid all charges or taxes imposed by any government authority ("Governmental Charges") on or with respect to the Product arising prior to the Delivery Point. PGE shall pay or cause to be paid all Governmental Charges on or with respect to the Product at and from the Delivery Point (other than those related to the sale of the Product, which are the responsibility of Seller). In the event Seller is required by Law or regulation to remit or pay Governmental Charges which are PGE's responsibility hereunder, PGE shall promptly reimburse Seller for such Governmental Charges. If PGE is required by Law or regulation to remit or pay Governmental Charges which are Seller's responsibility hereunder, PGE may invoice Seller for the amount of any such Governmental Charges or, in its sole discretion, deduct the amount of any such Governmental Charges from the sums due to Seller under ARTICLE 7 of this Agreement. Nothing in this Agreement shall obligate or cause a Party to pay or be liable to pay any Governmental Charges for which it is exempt under the Law.

10.3 Sale-related Governmental Charges and Taxes.

In addition to all other payments required under this Agreement, Seller shall be solely responsible for all existing and any new sales, use, excise, ad valorem, and any other similar taxes imposed or levied by any federal, state or local governmental agency on the Product sold and delivered hereunder (including any taxes imposed or levied with respect to the transmission of such energy) up to the delivery of such Product to the Delivery Point.

10.4 Indemnification.

Each Party shall indemnify, release, defend and hold harmless the other Party from and against any and all liability for taxes imposed or assessed by any taxing authority with respect to the Product sold, delivered and received hereunder that are the responsibility of such Party pursuant to this ARTICLE 10.

## ARTICLE 11
## RATES AND TERMS BINDING; FERC STANDARD OF REVIEW

11.1 Mobile-Sierra Doctrine.

11.1.1 Standard of Review. Absent the agreement of all Parties to the proposed change, the standard of review for changes to any rate, charge, classification, term or condition of this Agreement, proposed by a Party (to the extent that any waiver in subsection 11.2 below is unenforceable or ineffective as to such Party), or FERC acting *sua sponte*, shall solely be the "public interest" application of the "just and reasonable" standard of review set forth in United Gas Pipe Line Co. v. Mobile Gas Service Corp., 350 U.S. 332 (1956) and Federal Power Commission v. Sierra Pacific Power Co., 350 U.S. 348 (1956) and clarified by Morgan Stanley Capital Group, Inc. v. Public Util. Dist. No. 1 of Snohomish, 554 U.S. 527 (2008), and NRG Power Marketing LLC v. Maine Public Utility Commission, 558 U.S. 527 (2010).

11.1.2 Waiver of FERC Rights. In addition, and notwithstanding Section 11.1.1, to the fullest extent permitted by applicable Law, each Party, for itself and its successors and assigns, hereby expressly and irrevocably waives any rights it can or may have, now or in the future, whether under §§ 205 and/or 206 of the Federal Power Act or otherwise, to seek to obtain from FERC by any means, directly or indirectly (through complaint, investigation or otherwise), and each hereby covenants and agrees not at any time to seek to so obtain, an order from FERC changing any Section of this Agreement specifying the rate, charge, classification, or other term or condition agreed to by the Parties, it being the express intent of the Parties that, to the fullest extent permitted by applicable Law, neither Party shall unilaterally seek to obtain from FERC any relief changing the rate, charge, classification, or other term or condition of this Agreement, notwithstanding any subsequent changes in applicable Law or market conditions that may occur. If it were to be determined that applicable Law precludes the Parties from waiving their rights to seek changes from FERC to their market-based power sales contracts (including entering into covenants not to do so) then this subsection Section 11.1.1shall not apply, provided that, consistent with Section 11.1.1, neither Party shall seek any such changes except solely under the "public interest" application of the "just and reasonable" standard of review and otherwise as set forth in Section 11.1.1.

## ARTICLE 12
## REPRESENTATIONS AND WARRANTIES; INDEMNITY

12.1 Representations and Warranties.

On the Effective Date and throughout the Term, each Party represents and warrants to the other Party that:

12.1.1 it is duly organized, validly existing and in good standing under the Laws of the jurisdiction of its formation;

12.1.2 it has all regulatory authorizations necessary for it to legally perform its obligations under this Agreement;

12.1.3 the execution, delivery and performance of this Agreement are within its powers, have been duly authorized by all necessary action and do not violate any of the terms and conditions in its governing documents, any contracts to which it is a party or any law, rule, regulation, order or the like applicable to it;

12.1.4 this Agreement, and each other document executed and delivered in accordance with this Agreement constitutes its legally valid and binding obligation enforceable against it in accordance with its terms; subject only to any Equitable Defenses;

12.1.5 it is not Bankrupt and there are no proceedings pending or being contemplated by it or, to its knowledge, threatened against it which would result in it being or becoming Bankrupt;

12.1.6 there is not pending or, to its knowledge, threatened against it or any of its Affiliates any legal proceedings that could materially adversely affect its ability to perform its obligations under this Agreement;

12.1.7 no Event of Default with respect to it has occurred and is continuing and no such event or circumstance would occur as a result of its entering into or performing its obligations under this Agreement;

12.1.8 it is acting for its own account, has made its own independent decision to enter into this Agreement and as to whether this Agreement is appropriate or proper for it based upon its own judgment, is not relying upon the advice or recommendations of the other Party in so doing, and is capable of assessing the merits of and understanding, and understands and accepts, the terms, conditions and risks of this Agreement;

12.1.9 it has entered into this Agreement in connection with the conduct of its business and it has the capacity or ability to make or take delivery of all Products referred to in this Agreement;

12.1.10 the material economic terms of this Agreement were subject to individual negotiation by the Parties;

12.1.11 it, and any guarantor of its obligations under this Agreement, is an "eligible contract participant" within the meaning of the Commodity Exchange Act.

12.2 Indemnity.

To the fullest extent permitted by Law, each Party (the "Indemnitor") hereby indemnifies and agrees to defend and hold harmless the other Party (the "Indemnitee") from and against any Indemnity Claims caused by, resulting from, relating to or arising out of any act or incident involving or related to the Product and occurring at any time when such Product is under the Indemnitor's possession and control; provided, however, that the Indemnitor shall not have any obligation to indemnify the Indemnitee from or against any Indemnity Claims caused by, resulting from, relating to or arising out of the negligence or intentional misconduct of the Indemnitee.

12.3 Additional Representations and Warranties of Seller.

On the Effective Date and throughout the Term, Seller hereby further represents and warrants to PGE that:

12.3.1 Seller has the right to sell the Product to PGE free and clear of liens of encumbrances;

12.3.2 Seller has title to the Product sold under this Agreement free and clear of liens and encumbrances;

12.3.3 Seller is authorized to sell power at market-based rates pursuant to FERC Dockets Number ER [_____];

12.3.4 The Facility is either an EWG or a QF;

12.3.5 Seller has obtained, or will obtain as and when required by this Agreement, all Permits and all other rights and agreements required to construct, own, operate and maintain the Facility, and they will be in full force and effect for the Term;

12.3.6 All leases of real property and other real property rights and agreements required for the operation of the Facility or the performance of any obligations of Seller under this Agreement have been obtained and are owned by Seller, free and clear of liens and encumbrances;

12.3.7 Except as disclosed on Exhibit E, neither Seller nor any Affiliate of Seller has entered into any document, arrangement, understanding, promise or agreement or the like with any Person concerning, with respect to the Facility, (i) remediation or mitigation of environmental impacts, (ii) endangered species, (iii) migratory birds (including eagles), (iv) wildlife and species of conservation concern (state and federal), (v) environmentally, culturally or historically sensitive property or resources, (vi) a military facility, or (vii) national security. In addition, neither Seller nor any Affiliate of Seller has entered into any agreement where public disclosure of the agreement or the subject matter of the agreement could reasonably be expected to negatively affect the Facility's reputation.

12.3.8 Except as disclosed in Exhibit K, there is no litigation, legal action or administrative action pending with respect to the Facility nor, to Seller's knowledge, is any such litigation, legal action or administrative action threatened.

12.3.9 Seller has at all times been fully compliant with the requirements of the Federal Trade Commission's "Green Guides," 77 F.R. 62122, 16 C.F.R. Part 260, as amended or restated in any communication concerning Facility Output, the Facility or the Bundled RECs.

12.4 No Other Representations or Warranties. Each Party acknowledges that it has entered into this Agreement in reliance upon only the representations and warranties set forth in this Agreement, and that no other representations or warranties have been made by the other Party with respect to the subject matter of this Agreement.

## ARTICLE 13
## INSURANCE

13.1 Insurance. During the Term, Seller shall secure and continuously carry the following insurance coverage:

13.1.1 Commercial general liability insurance with a minimum combined single limit of $1,000,000 per occurrence and in the annual aggregate, with coverage for bodily injury, personal injury and broad form property damage, contractual liability, products and completed operations.

13.1.2 Workers' compensation insurance to cover statutory limits of the worker's compensation laws and employers liability insurance with a minimum limit of $1,000,000.

13.1.3 Business automobile liability insurance (including coverage for owned, non-owned, and hired automobiles) used in connection with the Facility in an amount not less than $1,000,000 per accident for combined bodily injury, property damage or death. To the extent that the Seller does not own automobiles, coverage for non-owned and hired automobiles may be combined with commercial general liability.

13.1.4 Umbrella/excess insurance covering claims in excess of the underlying insurance described in Sections 13.1.1, 13.1.2 (employers liability only) and 13.1.3 with a $5,000,000 minimum per occurrence and annual aggregate.

13.1.5 All-risk property insurance including boiler & machinery coverage insuring Seller's property at replacement cost value.

13.2 Seller to Provide Certificate of Insurance. All policies required, with the exception of workers' compensation employers liability and business automobile liability, shall include (i) endorsement(s) naming PGE as an additional insured but only to the extent of Indemnitee's indemnifications as stated in Section 13.1, and (ii) a cross-liability and severability of interest clause. Said policies shall also contain provisions that such insurance is primary insurance without right of contribution of any other insurance carried by or on behalf of PGE with respect to its interests as additional insured. A certificate of insurance showing that the above-required insurance is in full force and effect (on Accord or similar form) shall be furnished to PGE. All policies shall be placed with companies with a minimum A.M. Best rating of A- IX. Seller shall deliver copies of all certificates of insurance to PGE within thirty (30) days of the Effective Date.

13.3 Seller to Notify PGE of Loss of Coverage. Seller or Seller's insurers shall endeavor to provide PGE thirty (30) days notice (or ten (10) days in the case of cancellation due to non-payment of premiums) in the event of any material change to, cancellation or non-renewal of the required insurance.

## ARTICLE 14
## TITLE AND RISK OF LOSS

Title and risk of loss related to the Product shall transfer from Seller to PGE at the Delivery Point, except that title to Bundled RECs up to the Specified Amounts shall transfer to PGE when generated and shall be measured at the Facility Meter. Seller represents and warrants that it will deliver all Product to PGE free and clear of all liens, security interests, claims and encumbrances or any interest therein or thereto by any Person arising prior to the Delivery Point.

## ARTICLE 15
## ASSIGNMENT; BINDING EFFECT

15.1 Assignment.

Neither Party may assign this Agreement or its rights hereunder to any entity whose Credit Rating is not equal to or higher than that of such Party and is at least above BBB- by S&P and Baa3 by Moody's. No assignment may be made without the prior written consent of the other Party, which consent shall not be unreasonably withheld or delayed; provided, however, either Party may, without the consent of the other Party (and without relieving itself from liability hereunder), (i) transfer, sell, pledge, encumber or assign this Agreement or the accounts, revenues or proceeds hereof in connection with any financing or other financial arrangements, (ii) transfer or assign this Agreement to an Affiliate of such Party which Affiliate's Credit Rating is equal to or higher than that of such Party, or (iii) transfer or assign this Agreement to any person or entity succeeding to all or substantially all of its assets whose Credit Rating is equal to or higher than that of such Party; provided, however, that in each such case, any such assignee shall agree in writing to be bound by the terms and conditions hereof and so long as the transferring Party delivers such tax and enforceability assurance as the non-transferring Party may reasonably request.

15.2 Change in Control.

No direct or indirect change in the control of Seller may occur without PGE's prior written consent, not to be unreasonably withheld, conditioned or delayed.

15.3 Binding Effect.

This Agreement shall inure to the benefit of and be binding upon the Parties and their respective successors and permitted assigns. No assignment or transfer permitted hereunder shall relieve the assigning or transferring Party of any of its obligations under this Agreement.

## ARTICLE 16
## GOVERNING LAW

THIS AGREEMENT AND THE RIGHTS AND DUTIES OF THE PARTIES HEREUNDER SHALL BE GOVERNED BY AND CONSTRUED, ENFORCED AND PERFORMED IN ACCORDANCE WITH THE LAWS OF THE STATE OF OREGON, WITHOUT REGARD TO ITS PRINCIPLES OF CONFLICTS OF LAW.

## ARTICLE 17
## RECORDS AND AUDIT

17.1 Records.

Each Party shall keep proper books of records and account, in which full and correct entries shall be made of all dealings in relation to this Agreement in accordance with generally accepted accounting principles, consistently applied.

17.2 Audit Rights.

Each Party has the right, at its sole expense and during normal working hours, to examine the records of the other Party to the extent reasonably necessary to verify the accuracy of any statement, charge or computation made pursuant to this Agreement. If requested, a Party shall provide to the other Party statements evidencing the quantity of Product delivered at the Delivery Point. If any such examination reveals any inaccuracy in any statement, the necessary adjustments in such statement and the payments thereof will be made promptly and shall bear interest calculated at the Interest Rate from the date the overpayment or underpayment was made until paid; provided, however, that no adjustment for any statement or payment will be made unless objection to the accuracy thereof was made prior to the lapse of twenty-four (24) months from the rendition thereof, and thereafter any objection shall be deemed waived.

## ARTICLE 18
## DISPUTE RESOLUTION

18.1 Referral to Senior Management

In the event of any controversy, claim or dispute between the Parties arising out of or related to this Agreement ("Dispute"), either Party may notify the other of the existence of the Dispute. Upon receipt of a notice of Dispute, the Parties' representatives will first attempt to resolve the Dispute informally through negotiation and consultation. If they are unable to do so within ten (10) Business Days after the date on the notice of Dispute was given, then within a further three (3) Business Day period following an additional written request by either Party, (i) each Party shall appoint as its representative a senior officer, and (ii) such senior officers shall meet, negotiate and attempt in good faith to resolve the Dispute quickly, informally and inexpensively.

18.2 Mediation.

Any Dispute that is not resolved pursuant to Section 18.1 within thirty (30) days after the Dispute notice was given may be submitted for mediation by either Party before a single mediator in accordance with the provisions contained herein and in accordance with the Commercial Mediation Procedures of the AAA in effect at the time of the mediation ("AAA Procedures"); provided, however, that in the event of any conflict between the procedures herein and the AAA Procedures the procedures herein shall control. The mediator will be named by mutual agreement of the Parties or by obtaining a list of five (5) qualified Persons from each of the Parties and alternately striking names. All mediation shall be administered by the AAA. All mediation shall take place in the City of Portland, Oregon, unless otherwise agreed to by the Parties. Each Party shall be required to exchange documents to be used in the mediation not less than five (5) Business Days prior to the mediation. The Parties shall use all commercially reasonable efforts to conclude the mediation as soon as practicable. All aspects of the mediation shall be treated as confidential. Neither the Parties nor any mediator may disclose the content or results of the mediation, except as necessary to comply with legal, audit or regulatory requirements. Before making any such disclosure, a Party shall give written notice to the other Party and shall afford such Party a reasonable opportunity to protect its interests. Each Party shall be responsible for its own expenses and one-half of any mediation expenses incurred to

resolve the dispute. The mediator will provide the Parties with a fee and expense schedule in advance of mediation. Mediation will terminate by: (a) written agreement signed by both Parties, (b) determination by the mediator that the Parties are at an unresolvable impasse, (c) two unexcused absences by either Party from the mediation sessions, or (d) failure to resolve the Dispute on or before the sixtieth ($60^{th}$) day after the date on which the notice of Dispute was given (unless the Parties otherwise agree in writing to extend such date). The mediator will never participate in any claim or controversy covered by this Article as a witness, collateral contract, or attorney and may not be called as a witness to testify in any proceeding involving the subject matter of mediation. O.R.S. §§ 36.100 to 36.238 will apply to the entire process of mediation.

18.3 Legal Action.

If the Parties are still unable to resolve their differences through mediation pursuant to Section 18.2 within sixty (60) days after the date on which notice of the Dispute was originally given, then each of the Parties hereby irrevocably consents and agrees that any legal action or proceedings with respect to this Agreement may be brought in any of the courts of the State of Oregon located in the City of Portland or the courts of the United States of America for the District of Oregon having subject matter jurisdiction. By execution and delivery of this Agreement and such other documents executed in connection herewith, each Party hereby (a) accepts the exclusive jurisdiction of the aforesaid courts, (b) irrevocably agrees to be bound by any final judgment (after any and all appeals) of any such court with respect to such documents, (c) irrevocably waives, to the fullest extent permitted by Law, any objection it may now or hereafter have to the laying of venue of any action or proceeding with respect to such documents brought in any such court, and further irrevocably waives, to the fullest extent permitted by Law, any claim that any such action or proceeding brought in any such court has been brought in any inconvenient forum, (d) agrees that services of process in any such action or proceeding may be effected by mailing a copy thereof by registered or certified mail (or any substantially similar form of mail), postage prepaid, to such Party at its address set forth in Exhibit A, or at such other address of which the Parties have been notified. The dispute resolution process contemplated by this Agreement shall not prevent a Party from seeking temporary or preliminary equitable relief to prevent irreparable damage to that Party or to preserve the status quo pending resolution of a Dispute, and this Section 18.3 shall apply with respect to any application for such relief.

18.4 Waiver of Jury Trial. EACH PARTY IRREVOCABLY WAIVES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, ANY AND ALL RIGHTS TO TRIAL BY JURY IN ANY LEGAL PROCEEDING ARISING OUT OF OR RELATING TO THIS AGREEMENT OR THE TRANSACTIONS CONTEMPLATED HEREBY.

18.5 Attorneys' Fees. If either Party institutes any legal suit, action or proceeding against the other party arising out of or relating to this Agreement, including, but not limited to, contract, equity, tort, fraud and statutory claims, the prevailing party in the suit, action or proceeding will be entitled to receive, in addition to all other remedies to which the prevailing party may be entitled, the costs and expenses incurred by the prevailing party in conducting the suit, action or proceeding, whether incurred before suit, during suit, or at the appellate level, including reasonable attorneys' fees and expenses, court costs and other legal expenses such as

expert witness fees, and all fees, taxes, costs and expenses incident to appellate, bankruptcy and post-judgment proceedings.

18.6 Survival. The provisions set forth in this ARTICLE 18 shall survive the termination or expiration of this Agreement.

## ARTICLE 19
## GENERAL PROVISIONS

19.1 Entire Agreement.

This Agreement (including the attached exhibits and schedules), any designated collateral, credit support or margin agreement or similar arrangement between the Parties and all transactions under this Agreement constitute the entire agreement between the Parties relating to the subject matter. There are no prior or contemporaneous agreements or representations affecting the same subject matter other than those herein expressed. Any and all Exhibits referred to in this Agreement are, by such reference, incorporated herein and made a part hereof for all purposes.

19.2 Joint Efforts.

This Agreement shall be considered for all purposes as prepared through the joint efforts of both Parties and shall not be construed against one Party or the other as a result of the preparation, substitution, submission or other event of negotiation, drafting or execution hereof.

19.3 Amendments in Writing.

No amendment or modification to this Agreement shall be enforceable unless reduced to writing and executed by both Parties.

19.4 No Third Party Beneficiaries.

This Agreement shall not impart any rights enforceable by any third party (other than a permitted successor or assignee bound to this Agreement), it being the intent of the Parties that this Agreement shall not be construed as a third party beneficiary contract.

19.5 Non-Waiver.

No waiver by any Party of any one or more defaults by the other Party in the performance of any of the provisions of this Agreement shall be construed as a waiver of any other default or defaults whether of a like kind or different nature. No failure or delay by either Party in exercising any right, power, privilege, or remedy hereunder shall operate as a waiver thereof.

19.6 Severability.

Any provision of this Agreement declared or rendered invalid, unlawful, or unenforceable by any applicable court of law or regulatory agency or deemed unlawful because

of a statutory change (individually or collectively, such events referred to as "Regulatory Event") will not otherwise affect the remaining lawful obligations that arise under this Agreement; and provided, further, that if a Regulatory Event occurs, the Parties shall use their best efforts to reform this Agreement in order to give effect to the original intention of the Parties.

19.7 Survival.

All indemnity and audit rights shall survive the termination of this Agreement. All obligations provided in this Agreement shall remain in effect, after the expiration or termination for any reason of this Agreement, for the purpose of complying herewith.

19.8 Bankruptcy Matters.

The Parties acknowledge and intend that this Agreement, the transactions contemplated in this Agreement, and any instruments that may be provided by either Party under this Agreement (including any Guaranty) will each, and together, constitute one and the same "forward contract," "forward agreement" and "master netting agreement" within the meaning of the Bankruptcy Code, and that PGE and Seller are "forward contract merchants" within the meaning of the Bankruptcy Code. Each Party agrees that it will not make any assertion or claim, or otherwise take any position to the effect that this Agreement, the transactions contemplated under this Agreement, and any instrument(s) that may be provided by either Party under this Agreement (including the Guaranty) do not each, and together, constitute one and the same "forward contract," "forward agreement" and "master netting agreement" within the meaning of the Bankruptcy Code, or that PGE and Seller are not "forward contract merchants" within the meaning of the Bankruptcy Code.

19.9 Relationships of Parties.

The Parties shall not be deemed in a relationship of partners or joint venturers by virtue of this Agreement, nor shall either Party be deemed an agent, representative, trustee or fiduciary of the other. Neither Party shall have any authority to bind the other to any agreement. This Agreement is intended to secure and provide for the services of each Party as an independent contractor.

19.10 Headings.

The headings used for the Sections and Articles herein are for convenience and reference purposes only and shall not affect the meaning or interpretation of this Agreement.

19.11 Consolidation of Variable Interest Entities.

If PGE or one of its Affiliates determines that, under Accounting Standards Codification 810 ("ASC 810") Consolidation of Variable Interest Entities ("VIE's"), formerly referred to as the Financial Accounting Standards Board's revised Interpretation No. 46 ("FIN 46"), it may hold a controlling financial interest in Seller, but it lacks the information necessary to make a definitive conclusion, Seller hereby agrees to provide, upon PGE's written request, sufficient financial and ownership information so that PGE or its Affiliate may assess whether a controlling financial interest in a VIE does exist under FIN 46. If PGE or

its Affiliate determines that, under FIN 46, it holds a variable interest in Seller, Seller hereby agrees to provide, upon PGE's written request, sufficient financial and other information to PGE or its Affiliates so that PGE may properly consolidate the entity in which it holds the controlling financial interest and present the required disclosures. PGE shall reimburse Seller for Seller's reasonable costs and expenses, if any, incurred in connection with PGE's requests for information under this Section 19.11.

## ARTICLE 20
## CONFIDENTIALITY

Neither Party shall disclose the terms or conditions of this Agreement to a third party except (i) as may become generally available to the public, (ii) as may be required or appropriate in response to any summons, subpoena, or otherwise in connection with any litigation or to comply with any applicable law, order, regulation, ruling, or accounting disclosure rule or standard, (iii) as may be obtained from a non-confidential source that disclosed such information in a manner that did not violate its obligations to the non-disclosing Party in making such disclosure, (iv) to an index publisher or rating agency who has executed a confidentiality agreement with such Party, (v) in order to comply with any applicable law, regulation, order, or directive, including an order or directive of the Oregon Public Utility Commission, or (vi) in connection with any court or regulatory proceeding, including a proceeding of the Oregon Public Utility Commission; provided, however, that in the case of a disclosure under paragraphs (ii), (v) or (vi), each Party shall, to the extent practicable, use reasonable efforts to prevent or limit the disclosure. The parties shall be entitled to all remedies available at law or in equity to enforce, or seek relief in connection with this confidentiality obligation. Before Seller issues any news release or publicly distributed promotional material regarding the Facility that mentions the Facility or PGE, Seller shall first provide a copy thereof to PGE for its review and approval, which approval shall not be unreasonably withheld, conditioned or delayed.

## ARTICLE 21
## NOTICES AND COUNTERPARTS

21.1 Notices.

21.1.1 All notices, requests, statements or payments shall be made to the addresses and persons specified in Exhibit A. All notices, requests, statements or payments shall be made in writing except where this Agreement expressly provides that notice may be made orally. Notices required to be in writing shall be delivered by hand delivery, overnight delivery, facsimile, e-mail (so long as a copy of such e-mail notice is provided immediately thereafter by hand delivery, overnight delivery, or facsimile), or other documentary form. Notice by facsimile shall (where confirmation of successful transmission is received) be deemed to have been received on the day on which it was transmitted (unless transmitted after 5:00 p.m. at the place of receipt or on a day that is not a Business Day, in which case it shall be deemed received on the next Business Day); provided that Scheduling and Dispatch notifications and notifications of changes in availability of the Facility sent by facsimile shall be treated as received when confirmation of successful transmission is received. Notice by hand delivery or overnight delivery shall be deemed to have been received when delivered. Notice by e-

mail shall be deemed to have been received when delivered, so long as a copy of such e-mail notice is provided immediately thereafter by hand delivery, overnight delivery, courier or facsimile. Notice by telephone shall be deemed to have been received at the time the call is received.

21.1.2 A Party may change its address by providing notice of the same in accordance with the provisions of Section 21.1.1.

21.2 Counterparts.

This Agreement may be executed in counterparts, each of which is an original and all of which constitute one and the same instrument.

IN WITNESS WHEREOF, the Parties have caused this Wholesale Renewable Energy Purchase and Sale Agreement to be duly executed as of the Effective Date. This Agreement shall not become effective as to either Party unless and until executed by both Parties.

| **PORTLAND GENERAL ELECTRIC COMPANY** | | **[*Seller*]** | |
|---|---|---|---|
| Signature: | _____ | Signature: | _____ |
| Name: | _____ | Name: | _____ |
| Title: | _____ | Title: | _____ |

# EXHIBIT A

## Notices

**Portland General Electric Company ("PGE")**

**All Notices:**

Street: 121 SW Salmon Street

City: Portland, Oregon 97204

Attn: Power Contracts; 3WTCBR06
Phone: (503) 464-___
Facsimile: (503) 464-2605
Duns: 00-790-9054
Federal Tax ID Number: 93-0256820

**Invoices:**
Attn: Accounts Payable
Phone: (503) 464-7126
Facsimile: 464-7006

**Scheduling:**
Attn: Manager Power Coordination
Phone: (503) 464-7241
Facsimile: (503) 464-2605

**Wire Transfer:**
BNK: United States National Bank of Oregon-Portland
ABA: 123000220
ACCT: #153600063512
NAME: Portland General Electric Company

**Credit and Collections:**
Attn: Credit Manager
Phone: (503) 464-_____
Facsimile: (503) 464-2605

With additional Notices of an Event of Default to:
Attn: General Counsel
Phone: (503) 464-7822
Facsimile: (503) 464-2200

**Seller ("Seller" or "Name")**

**All Notices:**

Street: _____

City: _____ Zip: _____

Attn: Contract Administration
Phone: _____
Facsimile: _____
Duns: _____
Federal Tax ID Number: _____

**Invoices**:
Attn: _____
Phone: _____
Facsimile: _____

**Scheduling**:
Attn: _____
Phone: _____
Facsimile: _____

**Wire Transfer:**
BNK: _____
ABA: _____
ACCT: _____

**Credit and Collections**:
Attn: _____
Phone: _____
Facsimile: _____

With additional Notices of an Event of Default to:
Attn: _____
Phone: _____
Facsimile: _____

# EXHIBIT B

## Fixed Price

| Contract Year | On-Peak Price ($/MWh) | Off-Peak Price ($/MWh) |
|---|---|---|
| 2021 | $60.00 | $40.00 |
| 2022 | $61.00 | $41.00 |
| 2023 | $62.00 | $42.00 |
| 2024 | $63.00 | $43.00 |
| 2025 | $64.00 | $44.00 |
| 2026 | $65.00 | $45.00 |
| 2027 | $66.00 | $46.00 |
| 2028 | $67.00 | $47.00 |
| 2029 | $68.00 | $48.00 |
| 2030 | $69.00 | $49.00 |
| 2031 | $70.00 | $50.00 |
| 2032 | $71.00 | $51.00 |
| 2033 | $72.00 | $52.00 |
| 2034 | $73.00 | $53.00 |
| 2035 | $74.00 | $54.00 |
| 2036 | $75.00 | $55.00 |
| 2037 | $76.00 | $56.00 |
| 2038 | $77.00 | $57.00 |
| 2039 | $78.00 | $58.00 |
| 2040 | $79.00 | $59.00 |

# EXHIBIT C

## Specified Amount

| Month | On-Peak Specified Amount (MWh) | Off-Peak Specified Amount (MWh) |
|---|---|---|
| January | 30,000 | 35,000 |
| February | 45,000 | 35,000 |
| March | 55,000 | 30,000 |
| April | 30,000 | 60,000 |
| May | 35,000 | 65,000 |
| June | 45,000 | 45,000 |
| July | 30,000 | 20,000 |
| August | 25,000 | 25,000 |
| September | 40,000 | 35,000 |
| October | 35,000 | 40,000 |
| November | 30,000 | 45,000 |
| December | 20,000 | 20,000 |

# EXHIBIT D

## Facility Description

# EXHIBIT E

## Facility Documents

# EXHIBIT F

## Site

# EXHIBIT G

## Start-Up Testing

# EXHIBIT H

## Intentionally Left Blank

# EXHIBIT I

## Examples

***Exhibit provided for example purposes only and may not be representative of information included in final contract***

## Market Index Settlement Price Example

| (A) | (B) | (C) | (D) = (C)*(B)/Production Total |
|---|---|---|---|
| **Hour** | **Production (MWh)** | **Market Index Price ($/MWh)** | **Production-Weighted Market Index Price ($/MWh)** |
| HE01 | | | |
| HE02 | | | |
| HE03 | | | |
| HE04 | | | |
| HE05 | | | |
| HE06 | | | |
| HE07 | | | |
| HE08 | | | |
| HE09 | | | |
| HE10 | | | |
| HE11 | | | |
| HE12 | | | |
| HE13 | | | |
| HE14 | | | |
| HE15 | | | |
| HE16 | | | |
| HE17 | | | |
| HE18 | | | |
| HE19 | | | |
| HE20 | | | |
| HE21 | | | |
| HE22 | | | |
| HE23 | | | |
| HE24 | | | |
| Production Total | | | |
| Market Index Settlement Price | | | |

## Example Illustrating Determination of Payments Due under Section 2.3.2

Specified Energy

| (A) | (B) | (C) | (D) | (E) | (F)=(B)*(C)+(D)*(E) |
|---|---|---|---|---|---|
| **Month** | **On-Peak Specified Energy (MWh)** | **Off-Peak Specified Energy (MWh)** | **On-Peak Price ($/MWh)** | **Off-Peak Price ($/MWh)** | **Monthly Payment** |
| January | | | | | |
| February | | | | | |
| March | | | | | |
| April | | | | | |
| May | | | | | |
| June | | | | | |
| July | | | | | |
| August | | | | | |
| September | | | | | |
| October | | | | | |
| November | | | | | |
| December | | | | | |

As-Available Energy

| (A) | (B) | (C) | (D)=(B)*(C) |
|---|---|---|---|
| **Month** | **As-Available Energy (MWh)** | **Market Index Settlement Price ($/MWh)** | **Monthly Payment** |
| January | | | |
| February | | | |
| March | | | |
| April | | | |
| May | | | |
| June | | | |
| July | | | |
| August | | | |
| September | | | |
| October | | | |
| November | | | |
| December | | | |

Un-Specified Energy

| (A) | (B) | (C) | (D) = (B)*(C) |
|---|---|---|---|
| **Hour** | **Un-Specified Energy (MWh)** | **Market Index Price ($/MWh)** | **Payment** |
| HE01 | | | |
| HE02 | | | |
| HE03 | | | |
| HE04 | | | |
| HE05 | | | |
| HE06 | | | |
| HE07 | | | |
| HE08 | | | |
| HE09 | | | |
| HE10 | | | |
| HE11 | | | |
| HE12 | | | |
| HE13 | | | |
| HE14 | | | |
| HE15 | | | |
| HE16 | | | |
| HE17 | | | |
| HE18 | | | |
| HE19 | | | |
| HE20 | | | |
| HE21 | | | |
| HE22 | | | |
| HE23 | | | |
| HE24 | | | |

## Example Illustrating Determination of Amount Due to PGE under Section 6.1

| (A) | (B) | (C) | (D) | (E)=Max(0,(B)*[(D)-(C)]) | (F) | (G) | (H) | (I)=Sum((E):(H)) |
|---|---|---|---|---|---|---|---|---|
| **Month** | **Energy (MWh)** | **Fixed Price ($/MWh)** | **Market Index Settlement Price ($/MWh)** | **Energy Cost** | **Incremental Carbon Emission Cost** | **Incremental Transmission & Ancillaries Cost** | **Qualifying Replacement REC Cost** | **Monthly Payment** |
| January | | | | | | | | |
| February | | | | | | | | |
| March | | | | | | | | |
| April | | | | | | | | |
| May | | | | | | | | |
| June | | | | | | | | |
| July | | | | | | | | |
| August | | | | | | | | |
| September | | | | | | | | |
| October | | | | | | | | |
| November | | | | | | | | |
| December | | | | | | | | |

## Example Illustrating Determination of Amount Due to Seller under Section 6.2

| (A) | (B) | (C) | (D) | (E)=Max(0,(B)*[(C)-(D)]) |
|---|---|---|---|---|
| **Month** | **Energy (MWh)** | **Fixed Price ($/MWh)** | **Sales Price ($/MWh)** | **Monthly Payment** |
| January | | | | |
| February | | | | |
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |

# EXHIBIT J

## Long-Term Transmission Plan

# EXHIBIT K

## Litigation

# EXHIBIT L

## Forecast Methodology

# EXHIBIT M

## Optimal Conditions/Nameplate Capacity

# EXHIBIT N

## Operational Hours and Mechanical Availability Methodology

# 12 Appendix B - Asset Purchase Agreement

# APPENDIX B

## ASSET PURCHASE AGREEMENT[1]

by and between

**PORTLAND GENERAL ELECTRIC COMPANY**

and

_____

Dated _____

[1] NTD: Bidder is advised that this form of Asset Purchase Agreement was drafted contemplating the purchase of a development stage project that would not be constructed as of the Effective Date. Terms will be adjusted to accommodate assets that are operating or in further stages of development.

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[2] NTD: The type of project assets being conveyed to PGE will dictate the appropriate forms of these exhibits.

# ASSET PURCHASE AGREEMENT

This **ASSET PURCHASE AGREEMENT** (together with all exhibits and schedules appended hereto, this "***Agreement***"), dated as of [DATE] (the "***Effective Date***"), is made by and between [COUNTERPARTY], [STATE] [ENTITY TYPE] ("***Seller***"), and Portland General Electric Company, an Oregon corporation ("***PGE***"). PGE and Seller each may be referred to herein as a "***Party***", and collectively as the "***Parties***".

## RECITALS

WHEREAS, Seller owns [and operates] the Project and owns all right, title and interest in and to the Project Assets.

WHEREAS, in accordance with the terms and conditions set forth in this Agreement, Seller desires to sell and transfer to PGE, and PGE desires to purchase from Seller, the Project and the Project Assets.

NOW, THEREFORE, in consideration of the mutual promises and covenants contained in this Agreement, the adequacy and sufficiency of which are hereby acknowledged, the Parties agree as follows:

## AGREEMENT

### ARTICLE 1
### DEFINITIONS AND CONSTRUCTION

1.1 Specific Definitions. As used in this Agreement, the following terms shall have the meanings ascribed to them below:

"***AAA***" shall mean the American Arbitration Association.

"***AAA Procedures***" shall have the meaning given to it in Section 11.4.2.

"***Account***" shall have the meaning given to it in Section 2.3.2.

"***Affiliate***" of a specified Person shall mean any other Person that directly, or indirectly through one or more intermediaries, controls, is controlled by or is under common control with the Person specified. For purposes of the immediately preceding sentence, "control" shall mean the ability to control or affect the day-to-day management and control of the Person or a fifty percent (50%) or greater beneficial ownership interest in the partnership interests, membership interests or voting stock of the Person. For purposes of this Agreement, any Person owning an interest in Seller shall be considered an "Affiliate" of Seller.

"***Affiliate Contracts***" shall have the meaning given to it in Section 5.10.1.

"***Agreement***" shall have the meaning given to it in the Preamble.

"***Allocation***" shall have the meaning given to it in Section 10.1.

"***Applicable Law***" shall mean any act, statute, law, regulation, Permit, ordinance, rule, judgment, order, decree, directive, guideline or policy (to the extent mandatory) or any similar form of decision or determination by, or any interpretation or administration of, any of the foregoing by any Governmental Authority having jurisdiction over (a) any Party, (b) the Project Assets or (c) the Project.

"***Applicable Survival Period***" shall have the meaning given to it in Section 9.2.

"***Assumed Liabilities***" shall mean those Liabilities and obligations of Seller set forth on Schedule 2.1, which shall be assumed by PGE.

"***Business Day***" shall mean a day on which national banks are not required or authorized by law or executive order to close in Portland, Oregon.

"***Claim***" shall have the meaning given to it in Section 9.5.

"***Claim Notice***" shall have the meaning given to it in Section 9.5.

"***Closing***" shall have the meaning given to it in Section 4.1.

"***Closing Date***" shall have the meaning given to it in Section 4.1.

"***Code***" shall mean the Internal Revenue Code of 1986, as amended.

"***Contracts***" shall have the meaning given to it in Section 5.10.1.

"***Debt***" of any Person at any date means, without duplication, (a) all obligations of such Person for borrowed money, (b) all obligations of such Person evidenced by bonds, debentures, notes or other similar instruments, (c) all obligations of such Person to pay the deferred purchase price of property or services, (d) all monetary liabilities of such Person under contracts, (e) all obligations of such Person to purchase securities (or other property) which arise out of or in connection with the sale of the same or substantially similar securities (or property), (f) all obligations of such Person to reimburse any bank or other Person in respect of amounts paid or advanced under a letter of credit or other instrument, (g) all obligations of others secured by a Lien on any asset of such Person, whether or not such obligation is assumed by such Person, and (h) all obligations of others guaranteed directly or indirectly by such Person or as to which such Person has an obligation substantially the economic equivalent of a guaranty.

"***Dispute***" shall have the meaning given to it in Section 11.4.1.

"***Effective Date***" shall have the meaning given to it in the Preamble.

"***Environmental Attributes***" means any and all credits, benefits, emissions reductions, offsets and allowances of any kind, howsoever entitled, attributable to an electric generating facility or the electric energy, capacity or other generator-based products produced therefrom, including (a) any avoided emissions of pollutants to the air, soil or water, such as sulfur oxides, nitrogen oxides and carbon monoxide, and any rights related thereto, (b) any avoided emissions of methane, carbon dioxide and other "greenhouse gases" that have been determined by the United Nations Intergovernmental Panel on Climate Change or any other governmental, quasi-governmental or non-governmental agency or body to contribute to the actual or potential threat of altering the Earth's climate by trapping heat in the atmosphere, and (c) any reporting rights relating to the reduction of "greenhouse gases" under Section 1605(b) of the National Energy Policy Act of 1992 or under any other federal, state, local or foreign law, rule or regulation related to the reduction of air pollutants or "greenhouse gases" or the trading of emissions or emissions credits, including so-called "green tags" or "green certificates."

"***Environmental Laws***" shall mean all laws that regulate or relate to (a) the protection or clean-up of the environment, (b) the handling of Hazardous Substances, (c) the preservation or protection of waterways, groundwater, drinking water, air, wildlife, plants or other natural resources, and (d) the health and safety of persons or property as it pertains to the environment, including, without limitation, protection of the health and safety of employees. Environmental Laws shall include, without limitation, the Resource Conservation & Recovery Act, Clean Water Act, Safe Drinking Water Act, Occupational Safety and Health Act, Toxic Substances Control Act, Clean Air Act, Comprehensive Environmental Response, Compensation and Liability Act, Emergency Planning and Community Right-to-Know Act, Hazardous Materials Transportation Act and Centers for Disease Control guidelines, policies and procedures, and all analogous or related laws.

"***Federal Funds Effective Rate***" shall mean, for any day, the weighted average (rounded upwards, if necessary, to the next 1/100 of 1%) of the rates on overnight federal funds transactions with members of the Federal Reserve System arranged by federal fund brokers, as published on the next succeeding Business Day by the Federal Reserve Bank of New York, or, if such rate is not published for any day that is a Business Day, the weighted average (rounded upwards if necessary, to the next 1/100 of 1%) of the rates on overnight federal funds transactions with the members of the Federal Reserve System arranged by federal fund brokers, as published on the next succeeding Business Day by the Federal Reserve of New York.

"***Final Order***" shall mean, with respect to a Seller Required Regulatory Approval or PGE Required Regulatory Approval, as the case may be, that such Seller Required Regulatory Approval or PGE Required Regulatory Approval has not been reversed, stayed, set aside, annulled or suspended, with respect to which any waiting period prescribed by Applicable Laws

before the transactions contemplated hereby may be consummated has expired (but without the requirement for expiration of any applicable rehearing period), and as to which all conditions to the consummation of such transactions prescribed by Applicable Laws have been satisfied.

"***Governmental Authority***" means any and all foreign, national, federal, state, county, city, municipal, local or regional authorities, departments, bodies, commissions, corporations, branches, directorates, agencies, ministries, courts, tribunals, judicial authorities, legislative bodies, administrative bodies, regulatory bodies, autonomous or quasi-autonomous entities or taxing authorities or any department, municipality or other political subdivision thereof.

"***Hazardous Material***" shall mean (a) any petroleum or petroleum products, flammable explosives, radioactive materials, asbestos in any form that is or could become friable, lead containing paints or coatings, urea formaldehyde foam insulation and transformers or other equipment that contain dielectric fluid containing levels of polychlorinated biphenyls, (b) any chemicals or other materials or substances which are defined as or included in the definition of "hazardous substances," "hazardous wastes," "hazardous materials," "extremely hazardous wastes," "restricted hazardous wastes," "toxic substances," "toxic pollutants" or words of similar import under any Environmental Law, and (c) any other chemical or other material or substance, exposure to which is prohibited, limited or regulated by any Governmental Authority under any Environmental Law.

"***Indemnified Party***" shall have the meaning given to it in Section 9.5.

"***Indemnifying Party***" shall have the meaning given to it in Section 9.5.

"***Instruments of Conveyance***" shall have the meaning given to it in Section 2.2.

"***Liabilities***" shall mean, with respect to any Person, any and all Debts, liabilities, payables, obligations, commitments, losses, damages, expenses, claims, deficiencies, guarantees or endorsements, of any kind whatsoever, in each case requiring a payment (including a potential payment of damages for non-performance), including those of a contingent or deferred nature.

"***Lien***" shall mean mortgages, deeds of trust, liens, pledges, charges, security interests, assessments, reservations, hypothecations, restrictive covenants, easements or encumbrances.

"***Losses***" shall have the meaning given to it in Section 9.3.1.

"***Material Adverse Effect***" shall mean any event, occurrence, change or effect that, individually or in the aggregate, (a) with respect to Seller, could reasonably be expected to have a material adverse effect on the ability of Seller to consummate the transactions contemplated by this Agreement and to satisfy its obligations contemplated by this Agreement, and (b) with respect to the Project or the Project Assets, could reasonably be expected to have a material adverse effect on the interconnection, ownership, operation or maintenance of the Project, or on

the fair market value of the Project Assets; *provided, however*, that a "Material Adverse Effect" shall not include any adverse change, effect or circumstance directly or indirectly resulting from or arising out of (i) actions taken or omissions made by a Party at the request or with the consent of the other Party, or the failure to take any action prohibited by this Agreement, (ii) changes in the renewable power development industry or in renewable energy markets generally or (iii) changes in economic conditions or financial markets in any country or region or globally, including changes in interest or exchange rates and changes in currency and credit markets.

"***OPUC***" shall mean the Public Utility Commission of Oregon.

"***Ordinary Course of Business***" means the ordinary course of business consistent in material respects with past practices and Prudent Utility Standards.

"***Parent Guaranty***" means a guaranty from Seller's Guarantor with a limitation of liability of not less than _____ (the "Parent Guaranty") substantially in the form set forth in Exhibit E.

"***Party***" or "***Parties***" shall have the meaning given to it in the Preamble.

"***Permits***" shall mean permits, licenses, approvals, consents, orders, registrations, privileges, franchises, memberships, certificates, entitlements variances, waivers, certificates of occupancy and other authorizations issued by any Governmental Authorities, and any siting, zoning and land use approvals required under Applicable Laws in connection with the development, construction, operation, use and/or maintenance of the Project, and all amendments, modifications, supplements, general conditions and addenda thereto.

"***Permitted Liens***" shall mean all of the following: (a) liens for property Taxes and installments of assessments and charges of Governmental Authorities not yet due and payable as of the Closing Date; (b) liens created by the act or omission of PGE; (c) any other encumbrances created or permitted with the prior written consent of PGE; and (d) any encumbrances that will not have an adverse effect on the construction, ownership, operation or performance of the Project and/or Project Assets.

"***Person***" shall mean any natural person, corporation, limited liability company, partnership, firm, association, Governmental Authority or any other entity whether acting in an individual, fiduciary or other capacity.

"***PGE***" shall have the meaning given to it in the Preamble.

"***PGE Conditions Precedent***" shall have the meaning given to it in Section 3.2.

"***PGE Confidential Information***" shall have the meaning given to it in Section 7.1.

"***PGE Indemnified Party***" shall have the meaning given to it in Section 9.3.1.

"***PGE Indemnity Cap***" shall have the meaning given to it in Section 9.7.2.

"***PGE Required Regulatory Approvals***" shall mean those items listed on Part II of Schedule 6.5.

"***Placed in Service***" means placed in service for purposes of (a) Sections 48(b)(2) and (3) of the Code (as in effect on the day before the date of the enactment of the Revenue Reconciliation Act of 1990) and (b) Section 168 of the Code.

"***Post-Closing Assets***" shall mean all assets and rights of any kind, whether tangible or intangible, real or personal, including land and properties (or interests therein, including rights of way, leaseholds and easements), buildings, equipment, machinery, improvements, fixtures, agreements, contracts, renewable resource data, reports and studies (including those related to interconnection, environmental, cultural, resource and market matters), Permits, intellectual property, inventory, books and records, proprietary rights, return and other rights under or pursuant to all warranties, representations and guarantees, cash, accounts receivable, deposits and prepaid expenses acquired by PGE after the Closing Date in connection with or associated with the Project.

"***Project***" shall mean that certain [[____] MW [solar] [wind] [hydroelectric] [OTHER TECHNOLOGY][3] energy generating project [under development] [located in _____]].

"***Project Assets***" shall mean the assets, other than Retained Contracts, set forth on Schedule 5.7, which shall include all assets and rights of any kind, related to the ownership, operation or maintenance of the Project and owned by Seller, whether tangible or intangible, real or personal, including land and properties (or interests therein including rights of way, leaseholds and easements), buildings, equipment, machinery and associated equipment, improvements, fixtures, agreements, contracts, renewable resource data, reports and studies (including those related to interconnection, environmental, cultural, resource and market matters), the ownership of Environmental Attributes created on or after the Closing Date, Permits, software and intellectual property, inventory, books and records, proprietary rights, return and other rights under or pursuant to all warranties, representations and guarantees, cash, accounts receivable, deposits and prepaid expenses.

"***Prudent Utility Standards***" shall mean those practices, methods, equipment, specifications and standards of care, skill, safety and diligence and acts as the same may change from time to time, but applied in light of the facts known at the time, as are generally applied or utilized under comparable circumstances by experienced and prudent professionals in respect of

[3] NTD: Bidder to include appropriate technology descriptor.

the interconnection, transmission, ownership, operation or maintenance of renewable resource generating facilities of comparable type and complexity to the Project and which would have been expected to accomplish the desired result in a manner consistent with Applicable Law, safety, environmental protection, economy and expedition. Prudent Utility Standards are not necessarily defined as the optimal standard practice method or act to the exclusion of others, but rather, refer to a range of actions reasonable under the circumstances.

"***Purchase Price***" shall have the meaning given to it in Section 2.3.

["***Real Property Agreements***" shall mean the agreements set forth on Schedule 5.8 evidencing the Real Property Interests.]

["***Real Property Interests***" shall mean, collectively, [_____].]

"***Renewable Resource Data***" means any and all renewable resource data measured by Seller at the Site and collected by the meteorological towers on the Site through the Closing Date and which are included as part of the Project Assets.

"***Representatives***" shall mean, with respect to a Person, such Person's directors, partners, officers, managers, employees, members, agents and representatives, including attorneys, accountants, consultants, potential lenders, lenders, potential investors, investors and financial advisors.

"***Retained Contracts***" shall have the meaning given to it in Section 5.10.5.

"***Retained Liabilities***" shall mean those obligations and Liabilities of Seller arising under [_____], which shall be retained by Seller.

"***RFP***" shall mean that certain request for proposals for renewable energy resources issued by PGE in _____ 2018 and conducted in accordance with the OPUC Competitive Bidding Guidelines set forth in OPUC Order 14-149 (Docket UM-1182), dated April 30, 2014.

"***Seller***" shall have the meaning given to it in the Preamble.

"***Seller Conditions Precedent***" shall have the meaning given to it in Section 3.3.

"***Seller Confidential Information***" shall have the meaning given to it in Section 7.2.1.

"***Seller Contracts***" shall have the meaning given to it in Section 5.10.1.

"***Seller's Exclusivity Obligations***" shall have the meaning given to it in Section 8.2.

"***Seller Indemnified Party***" shall have the meaning given to it in Section 9.4.1.

"***Seller Indemnity Cap***" shall have the meaning given to it in Section 9.7.1.

"***Seller Required Regulatory Approvals***" shall mean those items listed on Part II of Schedule 5.6.

"Seller's Guarantor" means Seller's ultimate parent company and issuer of the Parent Guaranty.

"***Site***" shall mean [_____][4].

"***Tax***" or "***Taxes***" shall mean any federal, state, local or foreign income, gross receipts, license, payroll, employment, excise, severance, stamp, occupation, premium, windfall profits, environmental, customs duties, capital stock, franchise, profits, withholding, social security, unemployment, disability, real property, personal property, sales, use, transfer, registration, value added, alternative, minimum, estimated or similar tax, levy or assessment and any related interest or penalty.

"***Tax Return***" shall mean any return, report, statement, claim for refund, information return or other document (including any amendments thereto and any related or supporting information) filed or required to be filed with any Governmental Authority in connection with the determination, assessment, collection or administration of Taxes or the administration of any Applicable Law relating to Taxes.

"***Third-Party Claim***" shall have the meaning given to it in Section 9.6.

"***Treasury***" shall mean the United States Department of Treasury, including any successor agency.

"***Treasury Regulations***" shall mean the Treasury regulations promulgated under the Code, including any successor regulations.

1.2 Construction. Headings and the rendering of text in bold and italics are for convenience and reference purposes only and do not affect the meaning or interpretation of this Agreement.

1.2.1 A reference to an Exhibit, Schedule, Article, Section or other provision shall be, unless otherwise specified, to exhibits, schedules, articles, sections or other provisions of this Agreement, which exhibits and schedules are incorporated herein by reference.

1.2.2 Any reference in this Agreement to another agreement or document shall be construed as a reference to that other agreement or document as the same may have been, or

[4] NTD: Bidder to provide description of project site.

may from time to time be, varied, amended, supplemented, substituted, novated, assigned or otherwise transferred.

1.2.3 Any reference in this Agreement to "this Agreement," "herein," "hereof" or "hereunder" shall be deemed to be a reference to this Agreement as a whole and not limited to the particular Article, Section, Exhibit, Schedule or provision in which the relevant reference appears and to this Agreement as varied, amended, supplemented, substituted, novated, assigned or otherwise transferred from time to time.

1.2.4 References to any Party shall, where applicable, include any successors, transferees and permitted assigns of the Party.

1.2.5 References to the term "includes" or "including" shall mean "includes, without limitation" or "including, without limitation."

1.2.6 Words importing the singular include the plural and vice versa and the masculine, feminine and neuter genders include all genders.

1.2.7 If the time for performing an obligation under this Agreement occurs or expires on a day that is not a Business Day, the time for performance of such obligation shall be extended until the next succeeding Business Day.

1.2.8 References to any statute, code or statutory provision are to be construed as a reference to the same as it may have been, or may from time to time be, amended, modified or reenacted, and include references to all bylaws, instruments, orders and regulations for the time being made thereunder or deriving validity therefrom unless the context otherwise requires.

1.2.9 References to any amount of money shall mean a reference to the amount in United States Dollars.

## ARTICLE 2
## PURCHASE AND SALE OF ASSETS; PURCHASE PRICE AND PAYMENT

2.1 Purchase and Sale. Subject to and upon the terms and conditions of this Agreement, including (a) the satisfaction or written waiver by PGE of the PGE Conditions Precedent, and (b) the satisfaction or written waiver by Seller of the Seller Conditions Precedent, on the Closing Date, Seller shall sell, assign, transfer, convey and deliver to PGE, and PGE shall purchase, acquire and accept from Seller, all of the Project Assets, free and clear of any and all Liens other than Permitted Liens. Upon the consummation of the purchase by PGE of the Project Assets, PGE agrees to assume and become responsible for, and shall pay, discharge or perform when due, all of the Assumed Liabilities as of and after the Closing Date. PGE and its Affiliates shall not assume or incur any Liability in respect of, and Seller shall remain bound by and be liable for, and shall pay, discharge or perform when due, the Retained Liabilities.

2.2 Instruments of Conveyance. The sale, conveyance, assignment, transfer and delivery of the Project Assets will be effected by the execution and delivery by Seller and PGE of (a) the Bill of Sale, substantially in the form of Exhibit A, (b) the Assignment and Assumption Agreement substantially in the form set forth in Exhibit B, [(c) assignments of the Real Property Interests in recordable form, substantially in the form set forth in Exhibit C,] and (d) such other agreements or documents requested by PGE, with the items described in clauses (a) through (d) of this Section 2.2 collectively referred to herein as the "***Instruments of Conveyance***."

2.3 Payments. As consideration for the sale, transfer, assignment, conveyance and delivery by Seller to PGE of the Project Assets, PGE will pay to Seller the "***Purchase Price***" in an amount equal to [_____] as further described and on the terms and conditions contained in this Agreement.

2.3.1 [Payment Terms.] [5] [_____].

2.3.2 Wiring Instructions. PGE shall pay the Purchase Price, to the extent due pursuant to the terms of this Agreement, to Seller by depositing the applicable amount for Seller's account into the account listed below (the "***Account***") by the date due (as provided in this Article 2) in accordance with the following transfer instructions, or such other instructions as Seller may provide to PGE in writing:

TO: [_____]

Account No.: [_____]

ABA Routing No.: [_____]

Bank Name: [_____]

Branch Address: [_____]

Contact: [_____]

2.4 Late Payments. Unless otherwise specified herein, the amount of any payment due by either PGE or Seller pursuant to the terms of this Agreement that is not paid when due hereunder shall bear interest at an annual rate equal to the lower of the Federal Funds Effective Rate plus two percent (2%) or the maximum rate allowed by Applicable Law, from the date such payment was required to have been made through and including the date such payment is actually received by the Party to whom such payment is due.

[5] NTD: Bidder to propose additional payment terms, as applicable.

2.5 Further Assurances; Cooperation. At any time, and from time to time after the Closing Date, at either Party's reasonable request, the other Party shall promptly execute, acknowledge and deliver all such further acts, assurances and instruments of sale, transfer, conveyance, assignment and confirmation, as are reasonably required, and take all such other action as the requesting Party may reasonably request, in connection with the performance of such Party's obligations under this Agreement. From and after the Effective Date until the Closing Date, each Party shall reasonably cooperate with the other Party in connection with the performance of such Party's obligations under this Agreement.

## ARTICLE 3
## CONDITIONS PRECEDENT

3.1 Conditions Generally. For purposes of this Agreement, there shall be conditions which must be satisfied or waived prior to the Closing. PGE's obligation to cause the Closing to occur is subject to the satisfaction, or waiver in writing by PGE, of each of the PGE Conditions Precedent, and Seller's obligation to cause the Closing to occur is subject to the satisfaction or waiver in writing by Seller, of each of the Seller Conditions Precedent, in each case within the applicable time periods herein. Seller and PGE expressly acknowledge and agree that each of the (a) PGE Conditions Precedent are for the sole benefit of and may only be waived by PGE in writing, and (b) Seller Conditions Precedent are for the sole benefit of and may only be waived by Seller in writing.

3.2 PGE Conditions Precedent to the Closing. PGE shall not be obligated to effect the Closing hereunder if the following conditions precedent (the "***PGE Conditions Precedent***") are not satisfied (or waived in writing by PGE) on or prior to the Closing Date:

3.2.1 [Project Specific Conditions. _____][6].

3.2.2 Third-Party Consents. All authorizations, approvals and consents of all Persons, including Governmental Authorities, that are required in connection with the execution, delivery, and performance of this Agreement by each of PGE and Seller shall have been received.

3.2.3 Certificates. PGE shall have received a certificate, dated as of the Closing Date, in form and substance reasonably satisfactory to PGE, of a duly authorized officer of Seller certifying that attached thereto are the following: (a) the incumbency of Seller's officers executing this Agreement and any other agreement delivered on the Closing Date and any certificate delivered in connection with the Closing; (b) true, accurate and complete copies of the

[6] NTD: PGE reserves the right to require additional conditions precedent to be met prior to the Closing, based on the nature and state of development of Bidder's project. Such conditions may include, but are not limited to, delivery of a title insurance policy, survey, Permits and environmental reports.

certificates issued by the Secretary of State of the State of [_____] within ten (10) days of the Closing Date certifying that Seller is duly [organized] [incorporated] [formed] and validly existing under the laws of the State of [_____] and is current in payment of Taxes in such state; (c) true, accurate and complete resolutions of Seller duly authorizing the execution, delivery and performance of this Agreement and all other related agreements and transactions contemplated hereby and thereby, and that such resolutions are in full force and effect as of the Closing Date; (d) the certificate of formation of Seller, as certified by the Secretary of State of the State of [_____]; and (e) the [operating agreement] [by-laws] of Seller (as amended through the Closing Date).

3.2.4 Representations and Warranties. Each of the representations and warranties of Seller in this Agreement shall be true and correct on and as of the Closing Date as though such representations and warranties were made on and as of the Closing Date (except to the extent such representations and warranties are made as of a particular date, in which case such representations and warranties shall be true and correct as of such date).

3.2.5 UCC Search Report. PGE shall have received Uniform Commercial Code search reports from the relevant jurisdictions covering the Seller with respect to the Project Assets, the results of which shall be satisfactory to PGE in its sole discretion.

3.2.6 Performance. Seller shall have performed, in all material respects, each and all of the covenants and obligations required to be performed by it prior to the Closing Date, on or prior to the Closing Date.

3.2.7 Litigation. No action or proceeding by or before any court or other Governmental Authority shall have been instituted or threatened by any Governmental Authority or Person whatsoever that (a) could reasonably be expected to impair, restrain, prohibit or invalidate the Closing, (b) could reasonably be expected to have a Material Adverse Effect on Seller, the Project or the Project Assets, (c) challenges any Permit in a way that could reasonably be expected to invalidate, impair or restrain, in a material way, such Permit, in PGE's reasonable discretion, or (d) could reasonably be expected to have a material adverse effect on PGE's ability to consummate the Closing.

3.2.8 No Material Adverse Effect. As of the Closing Date, no Material Adverse Effect shall have occurred with respect to Seller, the Project or the Project Assets.

3.2.9 Regulatory Approvals. The Seller Required Regulatory Approvals in Schedule 5.6 and the PGE Required Regulatory Approvals in Schedule 6.5 shall have been made or obtained and shall have become Final Orders.

3.2.10 FIRPTA Certificate. Seller shall have executed and delivered an affidavit, dated as of the Closing Date, stating, under penalty of perjury, Seller's United States taxpayer

identification number and that Seller is not a foreign person, pursuant to Section 1445(b)(2) of the Code and Treasury Regulation 1.1445-2(b)(2)(iii)(B) (or any similar provision under other applicable Tax law).

3.2.11 Assignment of Project Contracts and Real Property Interests.[7] PGE shall have received an assignment of each Contract (as set forth on Schedule 5.10) and each Real Property Interest (as set forth on Schedule 5.8), executed by all parties thereto, all in form and substance reasonably acceptable to PGE, and an estoppel letter from each counterparty to each Contract executed and delivered no earlier than ten (10) days prior to the Closing Date substantially similar to the form set forth in Exhibit D.

3.2.12 Parent Guaranty. PGE shall have received a copy of the Parent Guaranty signed by Seller's Parent.

3.2.13 Completion of Due Diligence. PGE shall have completed its due diligence review of the Project and the Project Assets to its satisfaction.

3.3 Seller Conditions Precedent to the Closing. Seller shall not be obligated to effect the Closing hereunder if the following conditions precedent (the "***Seller Conditions Precedent***") are not satisfied (or waived in writing by Seller) on or prior to the Closing Date:

3.3.1 Certificates. Seller shall have received a certificate, dated as of the Closing Date, in form and substance reasonably satisfactory to Seller, of a duly authorized officer of PGE certifying that attached thereto are the following: (a) the incumbency of PGE's officers executing this Agreement and any other agreement delivered on the Closing Date and any certificate delivered in connection with the Closing; (b) true, accurate and complete copies of the certificates issued by the Secretary of State of the State of Oregon within ten (10) days of the Closing Date certifying that PGE is duly organized and validly existing under the laws of the State of Oregon and is current in payment of Taxes in such state; (c) true, accurate and complete resolutions of PGE duly authorizing the execution, delivery and performance of this Agreement and all other related agreements and transactions contemplated hereby and thereby, and that such resolutions are in full force and effect as of the Closing Date; and (d) the certificate of formation of PGE, as certified by the Secretary of State of the State of Oregon.

3.3.2 Representations and Warranties. Each of the representations and warranties of PGE in this Agreement shall be true and correct on and as of the Closing Date as though such representations and warranties were made on and as of the Closing Date (except to the extent such representations and warranties are made as of a particular date, in which case such representations and warranties shall be true and correct as of such date).

[7] NTD: Any assignment of a Real Property Interest must be in recordable form and shall be recorded at Closing.

3.3.3 Performance. PGE shall have performed, in all material respects, each and all of the covenants and obligations required to be performed by it prior to the Closing Date, on or prior to the Closing Date.

3.3.4 Litigation. No action or proceeding by or before any court or other Governmental Authority shall have been instituted that seeks to impair, restrain, prohibit or invalidate the Closing (other than an action or proceeding commenced by Seller or an Affiliate of Seller).

3.3.5 Regulatory Approvals. The Seller Required Regulatory Approvals and the PGE Required Regulatory Approvals shall have been made or obtained and shall have become Final Orders. The PGE Required Regulatory Approvals shall have been made or obtained at PGE's cost.

3.4 Term; Termination.

3.4.1 Term. This Agreement shall become effective on the Effective Date and, unless terminated earlier as provided in this Agreement, shall remain in full force and effect until the obligations of each of the Parties under the Agreement shall have been satisfied in full or waived in writing by the other Party, as applicable.

3.4.2 [Termination. This Agreement may be terminated prior to the Closing as follows:

(a) By the mutual written consent of the Parties;

(b) by PGE upon written notice to Seller of such termination, in the event the Closing has not occurred on or before [_____]; provided, that the failure to consummate the transactions contemplated by this Agreement did not result from the failure by PGE to fulfill in any material respect any undertaking or commitment provided for herein that is required to be fulfilled by it prior to the Closing; or

(c) by either Party, upon written notice to the other Party of such termination due to a breach of or default under this Agreement which breach or default continues for thirty (30) days after the non-breaching Party has delivered written notice of the default or breach to the breaching Party.][8]

3.5 Effect of Termination; Remedies.

[8] NTD: This Section can be omitted for any transaction that contemplates a simultaneous signing and closing.

3.5.1 In the event that this Agreement is validly terminated in accordance with Section 3.4, this Agreement shall forthwith have no further force and effect and, except as set forth in this Agreement to the contrary, there shall be no further liability or obligation on the part of PGE or Seller under this Agreement. No such termination shall serve (a) to release any Party from any liability with respect to any breach of its duties and obligations hereunder prior to such termination, or (b) to void or terminate the limitations on liability expressly set forth in this Agreement.

3.5.2 Notwithstanding the foregoing, Article 7 (Confidential Information) shall survive the termination of this Agreement for a period of two (2) years from the date on which such termination occurs.

## ARTICLE 4
## CLOSING

4.1 Place of Closing. Upon the terms and conditions set forth in this Agreement, the sale of the Project Assets (the "***Closing***") shall take place no later than the second Business Day after satisfaction or waiver of the conditions set forth in Article 3, unless this Agreement has been terminated prior to such date in accordance with the provisions of Section 3.4 (the actual time and date of the Closing being referred to herein as the "***Closing Date***"). The Closing shall take place at PGE's offices or at such other location as the Parties may agree, on the Closing Date.

4.2 Closing Deliveries. On the Closing Date, the following shall occur:

4.2.1 Payment of Purchase Price. PGE shall deliver to Seller the Purchase Price in accordance with Section 2.3.1.

4.2.2 Delivery of Certificates by Seller. On the Closing Date, Seller shall deliver to PGE a certificate, dated as of the Closing Date, in form and substance satisfactory to PGE, stating that (a) the conditions set forth in Section 3.3 have been satisfied or waived in writing by Seller, and (b) that all representations and warranties of Seller set forth in Article 5 are true and correct as of the Closing Date (except to the extent such representations and warranties are made as of a particular date in which case such representations and warranties shall be true and correct as of such date).

4.2.3 Delivery of Certificates by PGE. On the Closing Date, PGE shall deliver to Seller one or more certificates of PGE, in form and substance satisfactory to Seller, stating that (a) the conditions set forth in Section 3.2 have been satisfied or waived in writing by PGE, and (b) that all representations and warranties of PGE set forth in Article 6 are true and correct as of the Closing Date (except to the extent such representations and warranties are made as of a

particular date in which case such representations and warranties shall be true and correct as of such date).

4.2.4 Other Items. All other items required to be delivered or received as a Seller Condition Precedent or as a PGE Condition Precedent shall have been delivered to, or received by, Seller or PGE, as applicable, unless waived. Without limiting the generality of the foregoing, unless already delivered or unless waived by the relevant Party, the following documents, instruments and certificates shall be delivered at Closing: (a) by each Party to the other Party, executed counterparts of the Instruments of Conveyance; (b) by PGE to Seller, all documents, instruments and certificates required to be delivered by PGE to Seller pursuant to this Agreement; (c) by Seller to PGE, all documents, instruments and certificates required to be delivered by Seller to PGE pursuant to this Agreement; and (d) by Seller to PGE, all books, records[ and operating logs] relating to the Project and the Project Assets, in the possession of, or subject to the control of, Seller.

## ARTICLE 5
## REPRESENTATIONS AND WARRANTIES OF SELLER

Seller represents and warrants to PGE that, as of the Effective Date [and as of the Closing Date][9], the following are true and correct:

5.1 Organization and Authority. Seller is a [_____] duly [organized] [formed], validly existing and is qualified to do business under the laws of the State of [_____], and has all requisite power and authority to own the Project Assets, to execute and deliver this Agreement, to consummate the transactions contemplated hereby and to carry on its business as now being conducted. Seller is duly qualified to do business and is in good standing in all other jurisdictions in which its ownership of property or the character of its business requires such qualification.

5.2 Binding Agreement. All necessary action on the part of Seller has been taken to authorize the execution and delivery of this Agreement, the performance of its obligations under this Agreement and the consummation of the transactions contemplated hereby. This Agreement has been, and the other documents and instruments required to be delivered by Seller in accordance with the provisions hereof at the Closing have been, or will be, duly and validly executed and delivered by Seller, and upon execution and delivery thereof by Seller, will constitute the valid and binding agreement and obligations of Seller, enforceable in accordance with their respective terms, except as the enforceability thereof may be limited by bankruptcy, insolvency, reorganization, moratorium and similar laws of general application relating to or affecting creditors' rights generally and to general principles of equity (regardless of whether

[9] NTD: This item can be omitted for any transaction that contemplates a simultaneous signing and closing.

such enforceability is considered in any proceeding in equity or at law), including the availability of injunctive relief.

5.3 No Adverse Order or Injunctions. Seller is not a party to, nor is Seller subject to or bound by, nor does there exist any agreement, or any judgment, order, writ, prohibition, injunction or decree of any Governmental Authority with respect to Seller, which would prevent the execution, delivery or performance of this Agreement by Seller, or the transfer, conveyance and sale of all of the Project Assets to PGE pursuant to the terms hereof.

5.4 Litigation. There is no action, suit, investigation or proceeding pending in which Seller has been named or served as a party or threatened against Seller before any Governmental Authority.

5.5 No Conflicts. None of the execution, delivery nor performance by Seller of this Agreement nor the consummation of the transactions contemplated by this Agreement, nor the compliance by Seller with any of the provisions of this Agreement, will result in: (a) a violation of or a conflict with any provision of the formation documents of Seller or any law, judgment, order, writ, decree, determination, award or injunction applicable to Seller; (b) a breach or violation of, a conflict with or a default under, or the creation of a right of any Person to accelerate, terminate or cancel any Contract; (c) a violation by Seller of any Applicable Laws; or (d) a violation, or conflict with, or result in a breach of any provision of, or constitute a default (or any event which, with or without due notice or lapse of time, or both, would constitute a default) under, or result in the termination, cancellation, suspension, modification or acceleration of, or result in or give to any Person any additional rights or entitlement to increased, additional, accelerated or guaranteed payments under, or result in the impairment, loss or forfeiture of any material benefit, rights or privilege under, or the creation of any Lien or other encumbrance upon any of the assets of Seller under any contract, note, bond, mortgage, indenture, deed of trust, license, lease, agreement or other instrument or obligation to which Seller is a party.

5.6 Third-Party Consents. Part I of Schedule 5.6 sets forth a true, correct and complete list of all consents and approvals of all Persons, including Governmental Authorities, (other than any Permits) that are required in connection with the execution, delivery and performance of this Agreement by Seller or the consummation by Seller of the transactions contemplated by this Agreement. Part II of Schedule 5.6 sets forth a true, correct and complete list of all Seller Required Regulatory Approvals that are required in connection with the execution, delivery and performance of this Agreement by Seller or the consummation by Seller of the transactions contemplated by this Agreement.

5.7 Project Assets.

5.7.1 Seller holds of record and owns beneficially one hundred percent (100%) of the ownership interests of the Project Assets. Seller does not currently own any asset

necessary for PGE to be able after the Closing to develop, construct, own, operate or maintain the Project in accordance with Prudent Utility Standards, except such assets that are (or by the Closing, will be) included in the Project Assets. Schedule 5.7 sets forth a true, accurate and complete list of the Project Assets owned by Seller, which constitute all of the assets and rights of any kind necessary for PGE to develop, construct, own, operate and maintain the Project.

5.7.2 [All of the Project Assets constituting physical assets, if any, including equipment, machinery, vehicles, structures, fixtures and other tangible property, have been maintained in accordance with Prudent Utility Standards and are in good operating condition and repair, ordinary wear and tear excepted.]

5.7.3 Seller has good, valid and marketable title to all the Project Assets, which are free and clear of any and all Liens, other than Permitted Liens.

5.7.4 [There are no existing or continuing claims against Seller, the Project or the Project Assets by any prior developers of the Project (or partners of or investors in Seller (with respect to the Project Assets)).]

5.8 [Real Estate.

5.8.1 Schedule 5.8 sets forth a true, accurate and complete list of the Real Property Interests Seller holds with respect to the Project and that will be assigned to PGE at Closing.]

5.8.2 [Seller represents and warrants to PGE that the Real Property Agreements: (a) comprise all of the property interests and other rights necessary in connection with the ownership, operation and maintenance of the Project in accordance with Applicable Law and Permits; (b) with respect to the Real Property Agreements, Seller has delivered to PGE correct and complete copies of each of them; (c) provide legal and practical ingress and egress rights for any reasonable purpose in connection with the development, construction, ownership, operation and maintenance of the Project; (d) each of the Real Property Agreements constitute the legal, valid and binding obligations of Seller, and the counterparties thereto, and are in full force and effect except, in each case, as enforceability may be limited by applicable bankruptcy, insolvency, moratorium, reorganization or other similar laws affecting the enforcement of creditors' rights and subject to general equitable principles; (e) each of the Real Property Agreements will continue to be legal, valid, binding and in full force and effect on identical terms immediately following the consummation of the transactions contemplated hereby (including any assignments and assumptions referred to herein) except, in each case, as enforceability may be limited by applicable bankruptcy, insolvency, moratorium, reorganization or other similar laws affecting the enforcement of creditors' rights and subject to general equitable principles; (f) no party to any Real Property Agreements is in breach or default and, no event has occurred which, with notice or lapse of time or without a cure being completed, would

constitute a breach or default or permit termination or modification thereof or acceleration thereunder; (g) no party to any Real Property Agreement has repudiated any provision thereof; (h) there are no disputes, oral agreements or representations or forbearance programs in effect as to any Real Property Agreements; (i) no Real Property Agreement has been assigned, transferred, conveyed, mortgaged, deeded in trust or encumbered by Seller; and (j) except as set forth in the Real Property Agreements, there are no rents, royalties, fees or other amounts payable or receivable by Seller or any Person in connection with any Real Property Interests.]

5.9 Tax Matters. Seller represents and warrants with respect to itself:

5.9.1 All Tax Returns required to have been filed with respect to the Project and the Project Assets have been duly and timely filed and each such Tax Return was true, correct and complete in all material respects. All Taxes required to be paid (whether or not shown on any Tax Return) with respect to the Project and the Project Assets have been duly and timely paid. Seller has adequately provided for, in its books of account and related records, liability for all unpaid Taxes with respect to the Project and the Project Assets.

5.9.2 Solely with respect to the Project or any of the Project Assets: (a) there is no action, audit, dispute or claim now pending against, or any proposed or threatened action, audit, dispute or claim against, or with respect to, Seller in respect of any Taxes; (b) no Tax Return of Seller has been subject to examination or audit; (c) Seller has not received from any Governmental Authority any written (i) notice indicating an intent to open an audit or other review, (ii) request for information related to Tax matters, or (iii) notice of deficiency or proposed adjustment for any amount of Tax proposed, asserted or assessed by any taxing authority; and (d) no written claim has been made by a Governmental Authority in any jurisdiction where Seller does not file Tax Returns that Seller is or may be subject to taxation by such jurisdiction.

5.9.3 Neither the Project nor any of the Project Assets constitutes tax-exempt bond financed property or tax-exempt use property within the meaning of Section 168 of the Code. None of Seller or any of its Affiliates has applied for, claimed or received a Cash Grant, production tax credit pursuant to Code Section 45, or an investment tax credit pursuant to Code Section 48 with respect to any of the Project Assets. At least 80% of the Project Assets constitutes "new Section 38 property," as defined in Treasury Regulation Section 1.48-2. Neither the Project nor any Project Assets have been Placed in Service. Either: (a) the Project is a "qualified facility" that produces electricity using "qualified energy resources" within the meaning of Sections 45(d)(1) and 45(a)(2)(A)(i) or the Code, respectively; (b) the Project Assets are "energy property" within the meaning of Section 48(a)(3) of the Code; or (c) the Project Assets are "qualified property" or a "qualified investment credit facility" within the meaning of Section 48(a)(5) of the Code. In respect of any financial projections setting forth the amount of depreciation deductions available under Section 168 of the Code, or any tax credits available

pursuant to either Section 45 or Section 48 of the Code, in each case in respect of the Project or any Project Assets, (i) the facts and information used to create such financial projections are true, complete and correct and (ii) such financial projections are based on reasonable assumptions and, to the knowledge of Seller, fairly represent the expected performance of the Project and the Project Assets.

5.9.4 Seller is not a "foreign person" as defined in Section 1445(f)(3) of the Code, and Seller will provide to PGE the certification described in Section 1445(b)(2) of the Code and Treasury Regulations Section 1.1445-2(b).

5.9.5 There are no Liens (other than Permitted Liens) for unpaid or delinquent Taxes, assessments or other charges or deposits upon the Project or the Project Assets.

5.10 [Contracts.]

5.10.1 [Part I of Schedule 5.10 sets forth a true, accurate and complete list of all written agreements and contracts entered into by Seller on or prior to the Effective Date for the benefit of the Project or otherwise related to the Project (the "***Seller Contracts***"). Part II of Schedule 5.10 sets forth a true, accurate and complete list of all written agreements and contracts entered into by Seller on or prior to the Effective Date for the benefit of the Project or otherwise related to the Project, which will be retained by Seller. Part III of Schedule 5.10 sets forth a true, accurate and complete list of all written agreements and contracts entered into by an Affiliate of Seller on or prior to the Effective Date for the benefit of the Project or otherwise related to the Project, which will be assigned to PGE on the Closing Date (the "***Affiliate Contracts***" and together with the Seller Contracts, the "***Contracts***"). Part IV of Schedule 5.10 sets forth a true, accurate and complete list of all written agreements and contracts entered into by an Affiliate of Seller on or prior to the Effective Date for the benefit of the Project or otherwise related to the Project, which will be retained by Seller.]

5.10.2 [Each Contract has been duly authorized, executed and delivered by Seller, is in full force and effect, and constitutes the legal, valid, binding and enforceable agreement as to Seller, the respective counterparties thereto, and will not be rendered invalid or unenforceable as a result of the transactions contemplated by this Agreement, except, in each case, as such enforceability may be limited by applicable bankruptcy, insolvency, moratorium, reorganization or other similar laws affecting the enforcement of creditors' rights and subject to general equitable principles.]

5.10.3 [Neither Seller (or its Affiliate with respect to the Affiliate Contracts), nor the counterparty thereto, is in material breach of or in default under any Contract, no event has occurred which with the passage of time or giving of notice or both would constitute such a default, result in a loss of material rights or permit termination or acceleration under, or result in the creation of any Lien (other than a Permitted Lien) under any Contract.]

5.10.4 [Neither Seller nor any of Seller's Affiliates, as the case may be, has sold or transferred, or agreed to sell or transfer, or granted any options or rights to purchase energy or Environmental Attributes related to the electric power to be generated by the Project for any period after the Closing.]

5.10.5 [Each of the Contracts listed on Parts II and IV of Schedule 5.10 (the "***Retained Contracts***") will not be assigned to PGE as part of the Project Assets. None of the Retained Contracts will provide any material ongoing benefit to the Project on or after the Closing Date.]

5.11 Legal Compliance. Seller is in compliance with all Applicable Laws (other than Environmental Laws, which are the subject of Section 5.12) with respect to the Project and the Project Assets.

5.12 [Environmental Laws.]

5.12.1 [Seller has conducted its activities with respect to the development of the Project and the Project Assets in compliance with all Environmental Laws, and no action, suit, proceeding, hearing, investigation or written charge, complaint, claim, demand or notice has been filed or commenced or threatened against Seller (with respect to the Project Assets), the Project or the Site alleging any failure to comply with or any violation of any applicable Environmental Law.]

5.12.2 [All environmental investigations, studies, audits, tests, reviews or other analyses conducted on behalf of, or that are in the possession of, Seller in relation to the Site, the Project Assets and the Real Property Interests have been delivered to PGE prior to the Effective Date of this Agreement and there are no other such items.]

5.13 [Permits. Schedule 5.13 sets forth a true, correct and complete list of all Permits that Seller is required to obtain, and has obtained, in order to develop, construct, operate, and maintain the Project.]

5.14 [Renewable Resource Data. Schedule 5.14 of this Agreement sets forth a true, correct and complete list of the Renewable Resource Data, which data does not contain any material errors. Seller has the right to use and to validly transfer to PGE the Renewable Resource Data.]

5.15 Solvency. Seller is solvent and has sufficient assets and capital to carry on its business as it is now conducted and to perform its obligations hereunder. No petition or notice has been presented, no order has been presented, no order has been made and no resolution has been passed for the bankruptcy, liquidation, winding-up or dissolution of Seller. No receiver, trustee, custodian or similar fiduciary has been appointed over the whole or any part of the

Project Assets or the income of Seller, nor does Seller have any plan or intention of, or has received any notice that any other Person has any plan or intention of, filing, making or obtaining any such petition, notice, order or resolution or of seeking the appointment of a receiver, trustee, custodian or similar fiduciary. Seller is solvent and has sufficient assets and capital to carry on its businesses as they are now conducted and to perform its obligations hereunder.

5.16 Brokers. Seller does not have any contract, arrangement or understanding with any broker or other intermediary with respect to the transactions contemplated by this Agreement.

5.17 Investment Company. Seller is not an "investment company" or a company controlled by an "investment company" within the meaning of the Investment Company Act of 1940, as amended.

5.18 [Intellectual Property. Seller has the right to use and to transfer to PGE all patents, trademarks, copyrights or other intellectual property rights used in connection with the Project Assets, and which constitute all intellectual property necessary for the operation, maintenance or use of the Project. Seller has not infringed nor has been claimed to have infringed the patent, trademark, copyright or other intellectual property rights of any Person. No Person is infringing the patent, trademark or other intellectual property rights of Seller.]

5.19 Material Misstatements or Omissions. None of the representations or warranties (a) given by Seller in this Agreement (including the Schedules hereto) or any certificate delivered by Seller at Closing, (b) included in any document, exhibit, written communication, certificate or schedule heretofore prepared by Seller, an Affiliate of Seller or a Representative (commissioned by Seller or an Affiliate of Seller) and furnished by or on behalf of Seller in connection with the transactions contemplated by this Agreement (including any and all materials delivered to and written communication made to any Governmental Authority), or (c) included in any document, exhibit, written communication, certificate or schedule heretofore furnished by or on behalf of Seller in connection with the transactions contemplated by this Agreement, that was not prepared by Seller, an Affiliate of Seller or a Representative (commissioned by Seller or an Affiliate of Seller) (including any and all materials delivered to and written communication made to any Governmental Authority), when taken as a whole, contains any untrue statement of a material fact, or omits to state any material fact necessary to make the statements or facts contained in such representations or warranties, in light of the circumstances in which they were made, not materially misleading.

5.20 [Project-Specific Representations. ][10]

## ARTICLE 6
## REPRESENTATIONS AND WARRANTIES OF PGE

PGE represents and warrants to Seller that, as of the Effective Date [and as of the Closing Date], the following are true and correct:

6.1 Organization and Authority. PGE is a corporation duly organized, validly existing and is qualified to do business under the laws of the State of Oregon, and has all requisite corporate power and authority to execute and deliver this Agreement and to perform its obligations hereunder. PGE is duly qualified to do business and is in good standing in all other jurisdictions in which its ownership of property or the character of its business requires such qualification, except where the failure to be so qualified would not reasonably be expected to have a material adverse effect with respect to PGE.

6.2 Binding Agreement. All necessary company action on the part of PGE has been taken to authorize the execution and delivery of this Agreement, the performance of its obligations under this Agreement and the consummation of the transactions contemplated hereby. This Agreement has been, and the other documents and instruments required to be delivered by PGE in accordance with the provisions hereof have been, or will be, duly and validly executed and delivered by PGE, and upon execution and delivery thereof by PGE, will constitute the valid and binding agreement and obligations of PGE, enforceable in accordance with their respective terms, except as the enforceability thereof may be limited by bankruptcy, insolvency, reorganization, moratorium and similar laws of general application relating to or affecting creditors' rights generally and to general principles of equity (regardless of whether such enforceability is considered in any proceeding in equity or at law), including the availability of injunctive relief.

6.3 No Adverse Order or Injunctions. PGE is not a party to, and to PGE's knowledge, is not subject to or bound by, any agreement, or any judgment, order or injunction of any Governmental Authority, which would prevent or have a material adverse effect on the execution, delivery or performance of this Agreement by PGE, or the purchase of the Project Assets by PGE pursuant to the terms hereof.

6.4 No Conflicts. Neither the execution, delivery nor performance by PGE of this Agreement will result in (a) a violation of or a conflict with any provision of the articles of incorporation, bylaws or other corporate documents of PGE, or (b) a violation by PGE of any

[10] NTD: PGE reserves the right to require the inclusion of additional representations and warranties based on the nature and state of development of Bidder's project. Such representations may include, but are not limited to, representations regarding permitting, regulatory status, insurance, affiliate transactions and studies and reports.

Applicable Laws, except any such conflict, breach or violation, acceleration, termination or cancellation that would not have or be expected to have a material adverse effect on PGE.

6.5 Third-Party Consents. Part I of Schedule 6.5 sets forth a true, accurate and complete list of all consents and approvals of all Persons, including Governmental Authorities, that are required in connection with the execution, delivery and performance of this Agreement or the consummation by PGE of the transactions contemplated by this Agreement. Part II of Schedule 6.55.6 sets forth a true, correct and complete list of all PGE Required Regulatory Approvals that are required in connection with the execution, delivery and performance of this Agreement by Seller or the consummation by Seller of the transactions contemplated by this Agreement.

6.6 Brokers. Neither PGE nor its Affiliates has any contract, arrangement or understanding with any broker or other intermediary with respect to the transactions contemplated by this Agreement.

## ARTICLE 7
## CONFIDENTIAL INFORMATION

7.1 PGE Confidential Information.

7.1.1 Seller acknowledges that PGE Confidential Information (as defined below) is valuable and proprietary and Seller agrees not to, directly or indirectly, use, publish, disseminate, describe or otherwise disclose any PGE Confidential Information without the prior written consent of PGE. For purposes of this Agreement, "***PGE Confidential Information***" shall mean (i) any and all information provided by PGE to Seller and identified by PGE as confidential and (ii) any and all information provided by PGE to Seller with respect to the Project or the transactions contemplated hereby. Information shall not be deemed to be PGE Confidential Information if: (a) it has become generally known or available within the industry or the public through no act or omission of Seller; (b) Seller can demonstrate that, prior to disclosure in connection with the transactions contemplated hereby, such information was already in the possession of Seller; (c) it was rightfully received by Seller from a third party who became aware of it through no act or omission of Seller and who is not under an obligation of confidentiality to PGE; or (d) Seller can demonstrate it was independently developed by employees or consultants of Seller. Notwithstanding the foregoing, from and after the Closing, PGE Confidential Information shall include any information that is a Project Asset, whether or not of the type referred to in clauses (b), (c) or (d) above.

7.1.2 Seller shall maintain any PGE Confidential Information which has been or will be disclosed directly or indirectly to Seller by or on behalf of PGE or its Affiliates in confidence and shall not disclose or cause to be disclosed by them or any third person without PGE's prior express written consent; provided, however, that Seller may disclose the PGE

Confidential Information to Persons who provide legal, accounting or other services to Seller in connection with Seller's evaluation or implementation of the transactions contemplated by this Agreement, provided that such persons have first been informed of the duties required hereby.

7.1.3 Notwithstanding the preceding Section 7.1.1 and Section 7.1.2, PGE Confidential Information may be disclosed if required by any Governmental Authority or court or otherwise by Applicable Law; provided, however, that: (a) such PGE Confidential Information is submitted under any and all applicable provisions for confidential treatment and (b) PGE is given written notice of the requirement for disclosure promptly after such disclosure is requested, so that it may take whatever action it deems appropriate, including intervention in any proceeding and seeking a protective order or an injunction, to prohibit such disclosure.

7.1.4 Seller agrees that it will not make any use of any PGE Confidential Information received pursuant to this Agreement except in connection with the transactions contemplated by this Agreement, unless specifically authorized to do so in writing by PGE, and this Agreement shall not be construed as a license or authorization to Seller to utilize the PGE Confidential Information except for such purpose.

7.1.5 Seller acknowledges that a breach of the covenants contained in this Section 7.1 will cause irreparable damage to PGE, the exact amount of which will be difficult to ascertain, and that the remedies at law for any such breach will be inadequate. Accordingly, Seller agrees that if Seller breaches any of the covenants contained in this Section 7.1, in addition to any other remedy that may be available at law or in equity, PGE shall be entitled to injunctive relief, without posting bond or other security and Seller shall have no right or power to raise the defense of adequate remedy at law.

7.2 Seller Confidential Information.

7.2.1 PGE acknowledges that Seller Confidential Information (as defined below) is valuable and proprietary to Seller and PGE agrees not to, directly or indirectly, use, publish, disseminate, describe or otherwise disclose any Seller Confidential Information in respect of the Project without the prior written consent of either Seller. For purposes of this Agreement, "***Seller Confidential Information***" shall mean (i) any and all information provided by Seller to PGE and identified by Seller as confidential and (ii) any and all information provided by Seller to PGE with respect to the Project or the transactions contemplated hereby. Information shall not be deemed to be Seller Confidential Information if: (a) the Closing has occurred and such information is also an a Project Asset and/or Post-Closing Asset under this Agreement; (b) it has become generally known or available within the industry or the public though no act or omission of PGE; (c) PGE can demonstrate that, prior to disclosure in connection with the transactions contemplated hereby, such information was already in the possession of PGE; (d) it was rightfully received by PGE from a third party who became aware of it through no act or omission of PGE and who is not under an obligation of confidentiality to

Seller; or (e) PGE can demonstrate it was independently developed by employees or consultants of PGE.

7.2.2 PGE shall maintain any Seller Confidential Information which has been or will be disclosed directly or indirectly to PGE by or on behalf of Seller in confidence by it and shall not disclose or cause to be disclosed by PGE or any third person without Seller's prior express written consent; provided, however, that PGE may disclose Seller Confidential Information to its Representatives and to Persons who provide financial analysis, banking, legal, accounting or other services to PGE provided that such Persons have first been informed of the duties required hereby.

7.2.3 Notwithstanding the preceding Section 7.2.1 and Section 7.2.2, Seller Confidential Information may be disclosed (a) if required by any Governmental Authority or court or otherwise by Applicable Law and (b) to the OPUC and/or the independent evaluator retained by PGE and approved by the OPUC in connection with the RFP; provided, however, that (i) such Seller Confidential Information is submitted under any and all applicable provisions for confidential treatment and (ii) if PGE is permitted to do so, Seller is given written notice of the requirement for disclosure promptly after such disclosure is requested, so that it may take whatever action it deems appropriate, including intervention in any proceeding and seeking a protective order or an injunction, to prohibit such disclosure.

7.2.4 PGE agrees that it will not make any use of any Seller Confidential Information received pursuant to this Agreement except in connection with the transactions contemplated by this Agreement, unless specifically authorized to do so in writing by Seller, and this Agreement shall not be construed as a license or authorization to PGE to utilize Seller Confidential Information except for such purpose.

7.2.5 PGE acknowledges that a breach of the covenants contained in this Section 7.2 will cause irreparable damage to Seller and Seller's Affiliates, the exact amount of which will be difficult to ascertain, and that the remedies at law for any such breach will be inadequate. Accordingly, PGE agrees that if PGE breaches any of the covenants contained in this Section 7.2, in addition to any other remedy that may be available at law or in equity, Seller and its Affiliates shall be entitled to injunctive relief, without posting bond or other security, and PGE shall have no right or power to raise the defense of adequate remedy at law.

## ARTICLE 8
## [COVENANTS OF PGE AND SELLER][11]

[11] NTD: This Article 8 can be omitted for any transaction that contemplates a simultaneous signing and closing.

8.1 [Conduct Pending the Closing.] Between the Effective Date and the earlier to occur of the termination of this Agreement and the Closing Date, Seller shall:

8.1.1 [continue to operate the Project and conduct its business in the Ordinary Course of Business;]

8.1.2 [maintain and keep the Project and the Project Assets in a state of repair and condition as good as at the Effective Date, ordinary wear and tear excepted, and in accordance with the Ordinary Course of Business;]

8.1.3 [maintain relationships with landowners and suppliers in accordance with the Ordinary Course of Business;]

8.1.4 [maintain the Permits and comply with Applicable Law affecting the Project or the Project Assets;]

8.1.5 [perform and comply in all material respects with [the Contracts, the Real Property Agreements and the Permits] and Seller shall not, without PGE's consent, (a) amend or modify, or consent to the amendment or modification of, any of the [Contracts, the Real Property Agreements and the Permits] which amendments, modifications or consents would remain in effect for any period after Closing, or (b) enter into any new or additional contracts, real property agreements or permits relating to the Project that would remain in effect for any period after the Closing;]

8.1.6 [continue development of the Project as provided on Schedule 8.1.6;]

8.1.7 [not, without PGE's prior written consent, (a) sell, transfer or otherwise dispose of, or agree to sell, transfer or otherwise dispose of, any of the Project Assets, or (b) lease, mortgage or pledge any of the Project Assets and which such lease, mortgage or pledge would remain in effect for any period after the Closing;]

8.1.8 [not place or cause to be Placed in Service the Project or any of the Project Assets, in each case for purposes of Section 45 or Section 48 of the Code;

8.1.9 [not claim or permit any Person to claim any tax credit pursuant to Section 45 or Section 48 of the Code with respect to the Project or any Project Asset;]

8.1.10 [not cause or permit the Project or any Project Assets to become tax-exempt bond financed property or tax-exempt use property within the meaning of Section 168 of the Code;]

8.1.11 [not make any election or take any action that would limit, prevent or preclude the Project or any of the Project Assets from being classified in the hands of PGE as: (a)

"qualified energy resources" and "qualified facilities" within the meaning of Sections 45(a)(2)(A)(i) and 45(d)(1) of the Code; (b) "energy property" in the hands of PGE within the meaning of Section 48(a)(3) of the Code; or (c) "qualified property" or a "qualified investment credit facility" within the meaning of Section 48(a)(5) of the Code]

8.1.12 [maintain all books and records of Seller relating to the Project Assets in the Ordinary Course of Business.]

8.2 [Exclusivity. From and after the Effective Date, Seller agrees that it shall not (and shall not permit or cause any of its Affiliates to) solicit, initiate, encourage, entertain, make or accept offers with respect to the sale of the Project or the Project Assets (the "***Seller's Exclusivity Obligations***").]

8.3 [Site and Project Access. From and after the Effective Date, Seller shall allow, permit or obtain the right of PGE to reasonable access to the Site and the Project (all in accordance with the limitations imposed by the Real Property Agreements and other Project safety rules and regulations and security limitations imposed by Seller or the relevant landowners), upon reasonable prior notice, in order to perform its due diligence review, including physical inspection and analysis of the Project Assets.]

8.4 [Due Diligence. From and after the Effective Date, Seller shall allow, permit or obtain the right of PGE (a) to access to the management, development and operational personnel of Seller and (b) to review and make copies of the books and records of Seller. Any and all such access to Seller's management, development and operational personnel shall take place during normal business hours.]

8.5 [Notice of Developments. Seller shall, from time to time prior to the Closing, promptly (a) supplement or amend the Schedules referred to in Article 5, with respect to any matter that arises after the Effective Date, which if existing as of the Effective Date, would have been required to be set forth or described in such Schedules in order to make any representation or warranty set forth in Article 5 true and correct, and (b) notify PGE of any conditions, circumstances or events that could reasonably be expected to have a Material Adverse Effect.]

## ARTICLE 9
## **INDEMNIFICATION**

9.1 Survival. Except as set forth in Sections 9.1.1, all representations, warranties and related indemnification obligations contained in this Agreement and any Schedule, certificate or other document delivered pursuant to this Agreement at Closing, shall survive the Closing for a period of twenty-four (24) months.

9.1.1 The representations, warranties and related indemnification obligations of (a) Seller contained in Section 5.1 (Organization and Authority) and Section 5.7 (Project Assets), and (b) PGE contained in Section 6.1 (Organization and Authority) shall survive termination of this Agreement. The representations, warranties and related indemnification obligations of Seller contained in Section 5.9 (Tax Matters) and Section 5.12 (Environmental Laws) shall survive the Closing until the expiration of the applicable statute of limitations. The obligations of (i) Seller pursuant to Sections 9.3.1(d) and (e) or (ii) PGE pursuant to Sections 9.4.1(c) and (d) shall survive the Closing indefinitely.

9.2 Applicable Survival Period. The period for which a representation, warranty or indemnification obligation survives the Closing is referred to herein as the "***Applicable Survival Period***." In the event notice of claim for indemnification under Sections 9.3 or 9.4 is given within the Applicable Survival Period, the representation, warranty or indemnification obligation that is the subject of such indemnification claim (whether or not formal legal action shall have been commenced based upon such claim) shall survive with respect to such claim until such claim is finally resolved. All claims for indemnification shall be made no later than ninety (90) days after the Applicable Survival Period. In the event notice of claim for indemnification under Sections 9.3 or 9.4 is not given within ninety (90) days after the Applicable Survival Period, such claim shall be null and void and no remedy, relief or recourse will be available to the indemnified party with respect to such claim.

9.3 Indemnification by Seller.

9.3.1 Seller shall indemnify and defend PGE and its Affiliates and their respective stockholders, members, managers, officers, directors, employees, agents, successors and assigns (each, a "***PGE Indemnified Party***") against, and shall hold them harmless from, any and all losses, damages, claims (including third-party claims), charges, interest, penalties, Taxes, costs and expenses (including legal, consultant, accounting and other professional fees, costs of sampling, testing, investigation, removal, treatment and remediation of contamination and fees and costs incurred in enforcing rights under this Section 9.3) (collectively, "***Losses***") resulting from, arising out of, or incurred by any PGE Indemnified Party in connection with, or otherwise with respect to:

(a) the failure of any representation and warranty or other statement by Seller contained in this Agreement or any certificate or other document furnished to PGE at Closing, to be true and correct in all respects as of the Effective Date [or the Closing Date, as applicable];

(b) any material breach of any covenant or agreement of Seller contained in this Agreement or any certificate or other document furnished to PGE at the Closing;

(c) any Retained Liabilities;

(d) any fraud, intentional misrepresentation, willful misconduct by or gross negligence of Seller in connection with this Agreement or the transactions contemplated by this Agreement;

(e) any claims, actions or suits made by third parties (before, on or after the Closing Date) against any PGE Indemnified Party arising from or as a result of the acts or omissions of Seller or any of its Affiliates in connection with the development, ownership or operation of the Project or the Project Assets; and

(f) any liability for Taxes (including Tax Liens) imposed on or incurred by PGE relating to any taxable period ending on or before the time of the Closing or the portion of any other taxable period beginning before and occurring on or before the time of the Closing relating to the Project or the Project Assets.

9.4 Indemnification by PGE.

9.4.1 PGE shall indemnify and defend Seller and its Affiliates and their respective stockholders, members, managers, officers, directors, employees, agents, successors and assigns (each, a "***Seller Indemnified Party***") against, and shall hold them harmless from, any and all Losses resulting from, arising out of, or incurred by any Seller Indemnified Party in connection with, or otherwise with respect to:

(a) the failure of any representation and warranty or other statement by PGE contained in this Agreement or any certificate or other document furnished to Seller at Closing, to be true and correct in all respects as of the Effective Date [and as of the Closing Date, as applicable;]

(b) any material breach of any covenant or agreement of PGE contained in this Agreement, or any certificate or other document furnished to Seller at the Closing;

(c) any claims, actions or suits made by third parties (before, on or after the Closing Date) against any Seller Indemnified Party arising from or as a result of the acts or omissions of PGE or any of its Affiliates in connection with its ownership or operation of the Project, the Project Assets or the Post-Closing Assets;

(d) any fraud, intentional misrepresentation, willful misconduct by or gross negligence of PGE in connection with this Agreement or the transactions contemplated by this Agreement;

(e) any liability for Taxes (including Tax Liens) imposed on or incurred by Seller relating to any taxable period ending on or after the time of the Closing or the portion of any other taxable period beginning before and occurring on or after the time of the Closing relating to the Project and the Project Assets; and

(f) Assumed Liabilities.

9.5 Claims for Indemnification. A Party seeking indemnification (the "***Indemnified Party***") under this Article 9 shall give written notice (a "***Claim Notice***") to the other Party (the "***Indemnifying Party***") as soon as practicable after the Indemnified Party becomes aware of any fact, condition or event which may give rise to Losses for which indemnification may be sought under this Article 9 (a "***Claim***"). Except as set forth in Section 9.2, the failure of the Indemnified Party to timely give a Claim Notice to the Indemnifying Party hereunder shall not affect the Indemnified Party's rights to indemnification hereunder, except and only to the extent that the Indemnifying Party is materially prejudiced by such delay.

9.6 Defense. In the case of a Claim involving the assertion of a claim by a third party (whether pursuant to a lawsuit or other legal action or otherwise, a "***Third-Party Claim***"), the Indemnifying Party may, upon written notice to the Indemnified Party, take control of the defense and investigation of such Third-Party Claim if the Indemnifying Party acknowledges to the Indemnified Party in writing the obligation of the Indemnifying Party to indemnify the Indemnified Party with respect to all elements of such Third-Party Claim. If the Indemnifying Party assumes the defense of any such Third-Party Claim, the Indemnifying Party shall select counsel reasonably acceptable to the Indemnified Party (and separate from counsel to the Indemnifying Party if there is any conflict or divergence of interest between the Indemnifying Party and the Indemnified Party) to conduct the defense of such claims or legal proceedings and, at the sole cost and expense of the Indemnifying Party, shall take all steps necessary in the defense or settlement thereof. The Indemnifying Party shall not consent to a settlement of or the entry of any judgment arising from any such Third-Party Claim without the prior written consent of the Indemnified Party (which consent shall not be unreasonably withheld or delayed). The Indemnified Party shall be entitled to participate in (but not control) the defense of any such Third-Party Claim, with its own counsel and at its own expense; *provided*, *however*, that the Indemnified Party shall be entitled to settle any Third-Party Claim involving criminal penalties, civil fines or harm without the consent, but at the expense, of the Indemnifying Party if the Indemnifying Party shall unreasonably fail to do so after being requested to do so by the Indemnified Party. If the Indemnifying Party does not notify the Indemnified Party that it will assume the defense of such Third-Party Claim within thirty (30) days after the Indemnifying Party receives notice of such claim from the Indemnified Party: (a) the Indemnified Party may defend against such Third-Party Claim in such manner as it may deem reasonably appropriate, *provided* that the Indemnified Party shall not consent to a settlement of or the entry of any judgment arising from such Third-Party Claim without the prior written consent of the

Indemnifying Party (which consent shall not be unreasonably withheld or delayed); and (b) the Indemnifying Party shall be entitled to participate in (but not control) the defense of such action, with its counsel and at its own expense. Regardless of which Party shall assume the defense of the Third-Party Claim, the Parties agree to cooperate fully with one another in connection therewith. Such cooperation shall include the providing of records and information which are relevant to such Third-Party Claim and making employees and officers available on a mutually convenient basis to provide additional information and explanation of any material provided hereunder and to act as a witness or respond to legal process, in each case to the extent that the Party being requested to provide records and information or to make employees and officers available can do so without waiving any evidentiary privileges to which it is entitled.

9.7 Limitations on Liability.

9.7.1 Notwithstanding any provision in this Agreement to the contrary, the aggregate maximum liability of Seller for indemnity under this Agreement shall not exceed the sum of one hundred percent (100%) of the Purchase Price (the "***Seller Indemnity Cap***"); provided, however, that the Seller Indemnity Cap shall not apply to any breach by Seller of Sections 5.1 (Organization and Authority), 5.7 (Project Assets), 5.15 (Solvency) or 5.17 (Investment Company), any Third-Party Claim or any claims based upon fraud or willful misconduct of Seller.

9.7.2 Notwithstanding any provision in this Agreement to the contrary, the aggregate maximum liability of PGE for indemnity under this Agreement shall not exceed the sum of one hundred percent (100%) of the Purchase Price (the "***PGE Indemnity Cap***"); provided, however, that the PGE Indemnity Cap shall not apply to any breach by PGE of Section 6.1 (Organization and Authority) or any Third-Party Claim or any claims based upon fraud or willful misconduct of PGE.

9.7.3 No Indemnified Party shall be entitled to indemnification under Sections 9.3 or 9.4 for Losses to the extent directly or indirectly caused by the willful misconduct, fraud or a negligent act of such Indemnified Party, or any of its Affiliates, or a breach by such Indemnified Party, or any of its Affiliates, of any representation, warranty, covenant or other agreement set forth in this Agreement. Any Indemnified Party making a claim under Sections 9.3 or 9.4 shall take such commercially reasonable steps to mitigate its Losses upon becoming aware of any event which could reasonably be expected to give rise thereto.

9.7.4 Any Claim made or Losses claimed under this Article 9 shall be reduced to the extent the Seller Indemnified Party or PGE Indemnified Party, as applicable, recovers any insurance proceeds in respect of such Claim or Loss.

## ARTICLE 10
## TAX MATTERS

10.1 Allocation of Purchase Price. The allocation of the Purchase Price (the "***Allocation***") shall be agreed between the Parties each acting reasonably as soon as practicable, but in no event later than sixty (60) days after the Closing Date. The Allocation agreed to by the parties shall be consistent with Section 1060 of the Code and the Treasury Regulations promulgated thereunder, and any analogous provisions of state, local or foreign law. If any adjustment is subsequently made to the Purchase Price or other relevant items, the Parties shall reasonably cooperate with each other to promptly amend the Allocation to reflect such adjustment. The Allocation (as so adjusted) shall be binding on the Parties and each of their respective Affiliates for all purposes. The Parties and each of their respective Affiliates shall report, act and file Tax Returns (including Internal Revenue Service Form 8594) in all respects and for all purposes consistent with the Allocation, to the extent permitted by Applicable Law. Neither the Parties nor their respective Affiliates shall take any position on any Tax Return, before any Governmental Authority or in any judicial proceeding, that is inconsistent with the Allocation, unless taking such a position is required by Applicable Law.

10.2 Sales, Transfer and Documentary Taxes. Seller shall be responsible for all federal, state and local sales, documentary and other transfer taxes, if any, due as a result of the purchase, sale or transfer of the Project Assets in accordance herewith, whether imposed by law on Seller or PGE.

10.3 Treatment of Indemnity Payments. The Parties shall treat all payments made by Seller to or for the benefit of PGE and all payments by PGE to or for the benefit of Seller under any indemnity provision of this Agreement, as adjustments to the Purchase Price, unless otherwise required by Applicable Law (taking into account all relevant facts and circumstances underlying such payment), in which case any such payment will be increased by any Tax cost actually incurred by the recipient or reduced by any Tax benefit actually realized by the recipient, as applicable.

## ARTICLE 11
## MISCELLANEOUS

11.1 Successors and Assigns. This Agreement shall be binding upon and inure to the benefit of the Parties and their respective successors and assigns, except that PGE, on the one hand, and Seller, on the other hand, may not assign their respective obligations hereunder without the prior written consent of the other Party.

11.2 Entire Agreement; Amendments; Attachments. This Agreement, and all exhibits and schedules hereto, represents the entire understanding and agreement between the Parties with respect to the subject matter hereof and supersedes all prior oral and written and all contemporaneous oral negotiations, commitments and understandings between the Parties. PGE and Seller may amend or modify this Agreement, in such manner as may be agreed upon, by a written instrument executed by PGE and Seller. If the provisions of any exhibit or schedule are

inconsistent with the provisions of this Agreement, the provisions of this Agreement shall prevail. The exhibits and schedules attached hereto are hereby incorporated as integral parts of this Agreement.

11.3 Severability. Any provision of this Agreement which is invalid, illegal or unenforceable shall be ineffective to the extent of such invalidity, illegality or unenforceability, without affecting in any way the remaining provisions hereof or rendering that or any other provision of this Agreement invalid, illegal or unenforceable. Upon such determination that any term or other provision is invalid, illegal or incapable of being enforced, the Parties shall negotiate in good faith to modify this Agreement so as to effect the original intent of the Parties as closely as possible in an acceptable manner to the end that the transactions contemplated hereby are fulfilled to the fullest extent possible.

11.4 Dispute Resolution Process; Consent to Jurisdiction.

11.4.1 Avoidance and Mediation. The Parties agree to cooperate with each other and agree to communicate regularly with each other at all times so as to avoid or minimize disputes. In the event of any controversy, claim or dispute between the Parties arising out of or related to this Agreement ("***Dispute***"), within three (3) Business Days following the date of delivery of a written request by either Party, (a) each Party shall appoint as its representative a senior officer, and (b) such senior officers shall meet, negotiate and attempt in good faith to resolve the Dispute quickly, informally and inexpensively.

11.4.2 Mandatory Mediation. Any Dispute that is not resolved pursuant to Section 11.4.1 may be submitted for mediation before a single mediator in accordance with the provisions contained herein and in accordance with the Commercial Mediation Procedures of the AAA in effect at the time of the mediation ("***AAA Procedures***"); provided, however, that in the event of any conflict between the procedures herein and the AAA Procedures, the procedures herein shall control. The mediator will be named by mutual agreement of the Parties or by obtaining a list of five (5) qualified Persons from the Parties and alternately striking names. All mediation shall be administered by the AAA. All mediation shall take place in the City of Portland, Oregon, unless otherwise agreed to by the Parties. Each Party shall be required to exchange documents to be used in the mediation not less than five (5) Business Days prior to the mediation. The Parties shall use all commercially reasonable efforts to conclude the mediation as soon as practicable. All aspects of the mediation shall be treated as Confidential Information. Neither the Parties nor any mediator may disclose the content or results of the mediation, except as necessary to comply with legal, audit or regulatory requirements. Before making any such disclosure, a Party shall give written notice to the other Party and shall afford such Party a reasonable opportunity to protect its interests. Each Party shall be responsible for its own expenses and one-half of any mediation expenses incurred to resolve the dispute. The mediator will provide the Parties with a fee and expense schedule in advance of mediation. Mediation will

terminate by (a) written agreement signed by both Parties, (b) determination by the mediator that the Parties are at an unresolvable impasse, or (c) two unexcused absences by either Party from the mediation sessions. The mediator will never participate in any claim or controversy covered by this Article as a witness, collateral contract or attorney and may not be called as a witness to testify in any proceeding involving the subject matter of mediation. O.R.S. §§ 36.100 to 36.238 will apply to the entire process of mediation.

11.4.3 If the Parties are still unable to resolve their differences after good faith consideration of a resolution through mediation pursuant to Section 11.4.2, then each of the Parties hereby irrevocably consents and agrees that any legal action or proceedings with respect to this Agreement may be brought in any of the courts of the State of Oregon located in the City of Portland or the courts of the United States of America for the District of Oregon having subject matter jurisdiction. By execution and delivery of this Agreement and such other documents executed in connection herewith, each Party hereby (a) accepts the exclusive jurisdiction of the aforesaid courts, (b) irrevocably agrees to be bound by any final judgment (after any and all appeals) of any such court with respect to such documents, (c) irrevocably waives, to the fullest extent permitted by law, any objection it may now or hereafter have to the laying of venue of any action or proceeding with respect to such documents brought in any such court, and further irrevocably waives, to the fullest extent permitted by law, any claim that any such action or proceeding brought in any such court has been brought in any inconvenient forum, and (d) agrees that services of process in any such action or proceeding may be effected by mailing a copy thereof by registered or certified mail (or any substantially similar form of mail), postage prepaid, to such Party at its address set forth in Article 12, or at such other address of which the Parties have been notified.

11.4.4 EACH PARTY IRREVOCABLY WAIVES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, ANY AND ALL RIGHTS TO TRIAL BY JURY IN ANY LEGAL PROCEEDING ARISING OUT OF OR RELATING TO THIS AGREEMENT OR THE TRANSACTIONS CONTEMPLATED HEREBY.

11.4.5 If either Party institutes any legal suit, action or proceeding against the other Party arising out of or relating to this Agreement, including, but not limited to, contract, equity, tort, fraud and statutory claims, the prevailing Party in the suit, action or proceeding will be entitled to receive, in addition to all other remedies to which the prevailing Party may be entitled, the costs and expenses incurred by the prevailing Party in conducting the suit, action or proceeding, including reasonable attorneys' fees and expenses, court costs and other legal expenses such as expert witness fees, and all fees, taxes, costs and expenses incident to appellate, bankruptcy and post-judgment proceedings.

11.4.6 The provisions set forth in this Section 11.4 shall survive the termination or expiration of this Agreement.

11.5 Consequential Damages. EXCEPT WITH RESPECT TO LOSSES DIRECTLY OR INDIRECTLY CAUSED BY A PARTY'S WILLFUL MISCONDUCT OR FRAUD, IN NO EVENT SHALL SELLER OR PGE OR ANY OF THEIR RESPECTIVE OFFICERS, DIRECTORS, MEMBERS, PARTNERS, SHAREHOLDERS, EMPLOYEES, AGENTS OR AFFILIATES BE LIABLE FOR ANY SPECIAL, INDIRECT, NON-COMPENSATORY, CONSEQUENTIAL, INCIDENTAL, PUNITIVE OR EXEMPLARY DAMAGES, LOST OR PROSPECTIVE PROFITS, LOSS OF BUSINESS OPPORTUNITY OR BUSINESS INTERRUPTIONS UNDER OR IN RESPECT TO THIS AGREEMENT OR FOR ANY FAILURE OF PERFORMANCE RELATED HERETO, IRRESPECTIVE OF WHETHER SUCH DAMAGES ARE REASONABLY FORESEEABLE OR WHETHER SUCH CLAIMS ARISE IN CONTRACT, TORT (INCLUDING NEGLIGENCE, WHETHER SOLE, JOINT OR CONCURRENT OR STRICT LIABILITY) OR OTHERWISE.

11.6 Governing Law. This Agreement shall be governed by and construed in accordance with the laws of the State of Oregon applicable to contracts made and to be performed in the State of Oregon and without reference to the conflicts of laws rules thereof.

11.7 Section Headings. The Section headings are for the convenience of the Parties and in no way alter, modify, amend, limit or restrict the contractual obligations of the Parties.

11.8 Counterparts. This Agreement may be executed in one or more counterparts, each of which shall be deemed to be an original, but all of which shall be one and the same document.

11.9 No Third-Party Beneficiaries. This Agreement is entered into for the sole benefit of the Parties, and except as specifically provided herein, no other Person shall be a direct or indirect beneficiary of, or shall have any direct or indirect cause of action or claim in connection with, this Agreement.

11.10 Waiver. At any time prior to the Closing Date, any Party may (a) extend the time for the performance of any of the obligations or other acts of the other Parties hereto, (b) waive any inaccuracies in the representations and warranties of the other Parties contained herein or in any document delivered pursuant hereto and (c) waive compliance by any other Party with any of the agreements or conditions contained herein. Any such extension or waiver shall be valid only if set forth in an instrument in writing signed by the Party or Parties to be bound thereby. The failure of any Party to this Agreement to assert any of its rights under this Agreement or otherwise shall not constitute a waiver of such rights.

11.11 Costs. Each Party shall pay all of its own costs and expenses, including the fees and costs of its attorneys, consultants, contractors and representatives and internal overhead costs, incurred in connection with the negotiation, authorization, execution and delivery of this Agreement and the agreements, Permits and other documents prepared or to be entered into in connection with the transactions contemplated herein. In the event of legal action to enforce or

interpret any provision of this Agreement or the agreements, instruments or certificates delivered pursuant hereto, the prevailing Party shall be entitled to recover from the other Party its reasonable attorneys' fees and other costs of suit so incurred from the losing Party, at trial, on any appeal, and on any petition for review or other proceeding, in addition to all other sums provided by law.

11.12 Relationship of Parties.

11.12.1 The duties, obligations and Liabilities of the Parties are intended to be several and not joint or collective. This Agreement shall not be interpreted or construed to create an association, joint venture, fiduciary relationship or partnership between Seller and PGE or to impose any partnership obligation or liability or any trust or agency obligation or relationship upon either Party. Seller and PGE shall not have any right, power or authority to enter into any agreement or undertaking for, or act on behalf of, or to act as or be an agent or representative of, or to otherwise bind, the other Party.

11.12.2 The relationship between PGE and Seller shall be that of contracting party to independent contractor. Accordingly, subject to the specific terms of this Agreement, PGE shall have no general right to prescribe the means by which Seller shall meet its obligations under this Agreement.

## ARTICLE 12
## **NOTICES**

Any communications between the Parties hereto or regular notices provided herein to be given shall be given to the following addresses:

To PGE:

Portland General Electric Company
121 SW Salmon St.
1 WTC 1700
Portland, Oregon 97204
Attention: [_____]
Facsimile: [_____]

To Seller:

[_____]
[_____]
[_____]
[_____]
Attention: [_____]
Facsimile: [_____]

Any notice which is personally served shall be effective upon the date of service; any notice given by U.S. Mail shall be deemed effectively given, if deposited in the U.S. Mail, registered or certified with return receipt requested, postage prepaid and addressed as provided above, on the date of receipt, refusal or non-delivery indicated on the return receipt. In addition, either Party may send notices by electronic mail, facsimile or by a nationally recognized overnight courier service which provides written proof of delivery (such as U.P.S. or Federal Express). Any notice sent by electronic mail or facsimile shall be effective upon confirmation of receipt in legible form, and any notice sent by a nationally recognized overnight courier shall be effective on the date of delivery to the Party at its address specified above as set forth in the courier's delivery receipt. Either Party may, by notice to the other from time to time in the manner herein provided, specify a different address for notice purposes.

**[SIGNATURE PAGE FOLLOWS]**

IN WITNESS WHEREOF, this Agreement has been duly executed by the Parties hereto as of and on the date first above written.

| | |
|---|---|
| SELLER: | PORTLAND GENERAL ELECTRIC COMPANY |
| [_____] | |
| By:_____ | By:_____ |
| Name: | Name: |
| Title: | Title: |
| By:_____ | |
| Name: | |
| Title: | |

# 13 Appendix C - Engineering Procurement and Construction Agreement

# ENGINEERING, PROCUREMENT AND CONSTRUCTION AGREEMENT

# ENGINEERING, PROCUREMENT AND CONSTRUCTION AGREEMENT

**by and between**

**PORTLAND GENERAL ELECTRIC COMPANY**

**as Owner**

**and**

**as Contractor**

**dated as of**

**_____, 2018**

**for the**

**PROJECT**

Legal Notice: The drawings and specifications of this Agreement will contain the following requisite statutory notices: (i) "Notice of Alternative Billing Cycle" (O.R.S. 701.625(2)) (as applicable to the extent that any payments to Contractor as described in this Agreement are not considered monthly progress payments), (ii) "Notice of Extended Certification Period Provision" (O.R.S. 701.625(6)) (as with respect to Owner's making of progress payments and final payment as described in this Agreement ), and (iii) "Notice of Extended Payment Provision" (O.R.S. 701.625(3)(b)) (as regards the timing of Owner's payments to Contractor as described in this Agreement).

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# ENGINEERING, PROCUREMENT AND CONSTRUCTION AGREEMENT

THIS ENGINEERING, PROCUREMENT AND CONSTRUCTION AGREEMENT (this "Agreement"), is made, entered into and is effective as of _____, 2018 (the "Effective Date"), by and between _____ ("Owner"), and _____ ("Contractor").

## RECITALS

Owner is developing a renewable energy generation facility (defined as the Project below) and all services and utilities related thereto, all to be located near the town of _____in ____ County, _____.

In connection with such Project, Owner desires to obtain and Contractor desires to provide certain work, including, among other things, procurement, installation, construction and related services for the Project, all for the Contract Price (as hereinafter defined).

NOW, THEREFORE, the Parties agree as follows:

## ARTICLE I

## DEFINITIONS

1.1 Definitions. As used in this Agreement, the following terms have the meanings indicated:

"AAA" means the American Arbitration Association.

"AAA Procedures" has the meaning set forth in Section 14.2.

"Affiliate" means, in relation to any Person, any other Person, who: (a) directly or indirectly controls, or is controlled by, or is under common control with, such Person; or (b) directly or indirectly beneficially owns or holds fifty percent (50%) or more of any class of voting stock or other equity interests of such Person; or (c) has fifty percent (50%) or more of any class of voting stock or other equity interests that is directly or indirectly beneficially owned or held by such Person, or (d) either holds a general partnership interest in such Person or such Person holds a general partnership interest in the other Person. For purposes of this definition, the word "controls" means possession, directly or indirectly of the power to direct or cause the direction of the management or policies of a Person, whether through the ownership of voting securities or otherwise.

"Agreement" has the meaning set forth in the preamble hereto, as the same may be amended, supplemented or modified from time to time in accordance with the terms hereof.

"Applicable Laws" means any act, statute, law, regulation, Permit (including Applicable Permits), ordinance, rule, judgment, order, decree, directive, guideline or policy (to the extent mandatory) or any similar form of decision or determination by, or any interpretation or

administration of, any of the foregoing by any Government Authority with jurisdiction over Contractor, Owner, the Project, the Project Site, the performance of the Work or other services to be performed under the Agreement, and includes any of the same as they may be amended or imposed from time to time.

"Applicable Permits" means any and all Permits from or required by any Government Authority that are necessary for the performance of the Work or the completion or operation of the Project.

"As-Built Drawings" means final Drawings for the Work, as revised to reflect the changes in the Work during construction, and shall include as-built drawings that show the physical placement and location of all improvements, including the equipment, roads, overhead electric transmission line, underground collection lines, communication lines (both above and below ground), the Transformer Substation, electric one-line drawings, electric schematics and connection diagrams.

"Bankruptcy or Insolvency Event" has the meaning set forth in Section 12.1.(a).

"Builder's Risk Policy" has the meaning set forth in Exhibit P-1.

"Business Day" means every day other than a Saturday, Sunday or a day which is a legal holiday in the state in which the Project is located.

"Change" has the meaning set forth in Section 9.1.

"Change Order" has the meaning set forth in Section 9.1.

"Change Order Request" has the meaning set forth in Section 9.4.

"Commence Construction" has the meaning as such term is defined in the US Tax Code.

"Commencement of Construction Liquidated Damages" has the meaning set forth in Section 6.1.1.

"Confidential Information" has the meaning set forth in Section 16.1.1.

"Consequential Damages" has the meaning set forth in Section 16.2.

"Consumable Parts" has the meaning set forth in Section 2.3.6.

"Contractor" has the meaning set forth in the preamble hereto and includes its legal successors and permitted assignees as may be approved by Owner, in writing, pursuant to the terms of the Agreement.

"Contractor Deliverables" means all Drawings, Job Books, Operating Manuals, all written comments, field changes, and redlined drawings for incorporation into the final As-Built Drawings, and other documents and similar information prepared or modified by Contractor or

any of its Subcontractors and delivered or required to be delivered hereunder, including all subcontractor payment records as required by Section 3.3.

"Contractor Event of Default" has the meaning set forth in Section 12.1.1.

"Contractor Permits" means those Permits required to be obtained by Contractor, as set forth in Exhibit H.

"Contractor Termination for Cause" has the meaning set forth in Section 12.2.

"Contractor's Equipment" means all of the equipment, materials, apparatus, structures, tools, supplies and other goods provided and used by Contractor and its Subcontractors for performance of the Work, but which are not intended to be incorporated into the Project.

"Contractor's Project Manager" means the Person designated by Contractor as having the responsibility, authority and supervisory power of Contractor for design, construction, procurement, testing and start-up of the Work, as well as all matters relating to the administration of the provisions of the Agreement, and who will be primarily located at the Project Site on a daily basis.

"Contractor's Taxes" has the meaning set forth in Section 4.2.1(a).

"Contract Price" has the meaning set forth in Section 4.1.

"Day" or "day" means a period of twenty-four (24) consecutive hours from 12:00 midnight, and shall include Saturdays, Sundays and all holidays.

"Defect" or "Defective" means, any condition, characteristic or item of the Work that (a) does not conform to the terms or requirements of the Agreement (including Prudent Industry Practices), (b) is not of uniform good quality, free from defects or deficiencies in design, manufacture or workmanship, or (c) would adversely affect (i) the performance of the Project under anticipated operating conditions, (ii) the continuous safe operation of the Project during the Project's design life, or (iii) the structural integrity of the Project.

"Delay Liquidated Damages" has the meaning set forth in Section 6.6.

"Direct Costs" has the meaning set forth in Section 9.5.3(c).

"Dispute" has the meaning set forth in Section 14.1.

"Dollar" or "$" means a dollar of the currency of the United States of America.

"Drawings" means (a) all specifications, calculations, designs, plans, drawings, engineering and analyses, and other documents which determine, establish, define or otherwise describe the scope, quantity, and relationship of the components of the Project, including the structure and foundation thereof, and (b) all technical drawings, specifications, shop drawings, diagrams, illustrations, schedules and performance charts, calculations, samples, patterns, models, operation and maintenance manuals, piping and instrumentation diagrams, underground

structure drawings, conduit and grounding drawings, lighting drawings, conduit and cable drawings, electric one-line's, electric schematics, connection diagrams and technical information of a like nature, prepared or modified by Contractor or any of its Subcontractors all of which are and required to be submitted by Contractor or any Subcontractor, from time to time under the Agreement or at Owner's request which illustrates any of the Equipment or any other portion of the Work, either in components or as completed.

"Effective Date" has the meaning set forth in the preamble to this Agreement.

"Equipment" means all of the equipment, materials, apparatus, structures, tools, supplies, goods and other items required to complete the Project excluding the Contractor's Equipment and Major Equipment. The Parties acknowledge that Contractor will provide, install and incorporate the Equipment into the Project as described in this Agreement.

"Final Completion" has the meaning set forth in Section 6.5.1.

"Final Completion Certificate" means the certificate by this name as described in, and in the form set forth in, Exhibit Q.

"Final Completion Date" means the date on which Final Completion occurs as per Section 6.5.1.

"Final Punch List" has the meaning set forth in Section 6.4.1.

"Force Majeure Event" means any event or circumstance, or combination of events or circumstances, that meets all of the following criteria:

(a) arises after the Effective Date,

(b) was not caused by and is unforeseeable and beyond the reasonable control of the Party claiming the Force Majeure Event,

(c) is unavoidable or could not be prevented or overcome by the reasonable efforts and due diligence of the Party claiming the Force Majeure Event, and

(d) either (i) as with respect to Owner as the impacted Party, has an impact which will actually, demonstrably and adversely affect Owner's ability to perform its obligations (other than payment obligations) in accordance with the terms of the Agreement or (ii) as with respect to Contractor as the impacted Party, has an impact which will actually, demonstrably and adversely affect Contactor's ability to perform Work on the Project Site so as to achieve a Key Milestone by the scheduled completion date for such Key Milestone as set forth in the Project Schedule.

Provided they meet all of the criteria described above, Force Majeure Events may include the following: acts of God, natural disasters, wildfires, earthquakes, tornadoes, lightning, floods, civil disturbances, riots, war and military invasion, physical damage to the Project caused by third parties who are not Subcontractors or representatives, employees or agents of the impacted Party, national, regional and area-wide strikes and other national, regional and area-wide labor

disputes (including collective bargaining disputes and lockouts) involving Contractor or Subcontractors and not directed exclusively at Contractor or such Subcontractor; a severe inclement weather condition not mentioned above, which prevents or substantially hinders the safe performance of the Work at the Project Site; acts of the public enemy; blockade; acts of terrorism; insurrection, riot or revolution; sabotage or vandalism; embargoes, and actions of a Governmental Authority (other than in respect of or in relation to or resulting from Contractor's non-compliance with Applicable Laws). Notwithstanding anything in the foregoing to the contrary, in no event shall any of the following constitute a Force Majeure Event: (i) strikes, and other labor disputes (including collective bargaining disputes and lockouts) of the labor force under the control of the Party claiming the Force Majeure Event or its Affiliates or with respect to the Work by a Subcontractor on the Project Site unless the strike is part of a more widespread or general strike extending beyond the Party, Affiliate or Subcontractor; (ii) cost or shortages of labor or manpower; (iii) unavailability, late delivery, failure, breakage or malfunction of equipment or materials unless there is an independent, identifiable Force Majeure Event causing such condition; (iv) events that affect the cost of equipment or materials; (v) economic hardship (including lack of money) of any entity or its Affiliates or their respective Subcontractors or suppliers; (vi) delays in transportation (including delays in clearing customs) other than delays in transportation resulting from accidents or closure of roads or other transportation route by Government Authorities; (vii) any weather conditions which are not defined above as Force Majeure Events; (viii) actions of a Government Authority in respect of or in relation to or resulting from Contractor's compliance or non-compliance with Applicable Laws; (ix) any failure by Contractor to obtain and maintain any Applicable Permit it is required to obtain or maintain hereunder; (x) any other act, omission, delay, default or failure (financial or otherwise) of a Subcontractor or other Personnel of Contractor.

"Force Majeure Notice" has the meaning set forth in Section 8.1.1.

"Geotechnical Survey" means that certain geotechnical reports referenced in Exhibit F.

"Government Authority" means any and all foreign, national, federal, state, county, city, municipal, local or regional authorities, departments, bodies, commissions, corporations, branches, directorates, agencies, ministries, courts, tribunals, judicial authorities, legislative bodies, administrative bodies, regulatory bodies, autonomous or quasi-autonomous entities or taxing authorities or any department, municipality or other political subdivision thereof.

"Grid" means the interconnected high voltage transmission facilities that are a part of the transmission system to which the Project connects.

"Guaranteed Substantial Completion Date" shall mean _____, as set forth in the Initial Project Schedule.

"Guarantor" means _____, issuer of a parent guaranty with respect to Contractor's obligations hereunder.

"Hazardous Material" means any and all chemicals, constituents, contaminants, pollutants, materials, and wastes and any other carcinogenic, corrosive, ignitable, radioactive, reactive, toxic or otherwise hazardous substances or mixtures (whether solids, liquids, gases), or

any similar substances now or at any time subject to regulation, control, remediation or otherwise addressed under Applicable Laws, including those laws, regulations and policies relating to the discharge, emission, spill, release, or threatened release into the environment or relating to the disposal (or arranging for the disposal), distribution, manufacture, processing, storage, treatment, transport, or other use of such substances.

"Indemnified Person" has the meaning set forth in Section 10.2.1.

"Indemnifying Party" has the meaning set forth in Section 10.2.1.

"Initial Project Schedule" means the "Level 2" (as defined by the Association for the Advancement of Cost Engineering International) Gantt Chart that sets forth the schedule of dates and milestones (including Key Milestones) for timely completion of the Work as set forth in Exhibit C-1 with specific start and end dates for each activity comprising (or relating to) the Work.

"Intellectual Property Rights" has the meaning set forth in Section 2.11.

"Interconnect Switchyard" means the Utility-owned electric transmission switchyard to be located at the end of the Transmission Corridor, immediately adjacent to the connection to the Grid, including all necessary breakers, protection equipment, metering and associated control buildings and other infrastructure associated therewith.

"Job Book" means all documentation specified in the Scope of Work, which shall include all engineering, design, purchasing and other information relating to the Project, including: (a) a drawing index; (b) a reference index; (c) copies of Contractor's and Subcontractors' Permits; (d) copies of all contracts and purchase orders for Major Subcontractor's equipment (non-priced); (e) Subcontractor information for equipment purchased (as received from Subcontractors) including instruction and maintenance manuals from Subcontractors; (f) one copy of the As-Built Drawings and documentation; (g) training manuals; (h) the Operating Manuals; (i) electrical one-line diagrams for the Project; (j) a cable and raceway schedule for the Project; (k) connection report/loop diagrams for the Project; and (l) a final list and summary of the work performed by all Subcontractors.

"Key Milestones" means the milestones identified as such in the Initial Project Schedule (Exhibit C-1).

"Key Personnel" means the persons designated as "Key Personnel" in Exhibit I-2.

"Labor" means the workforce of the relevant Person, including its staff and employee and non-employee and skilled and unskilled workers (and including those provided by Subcontractors).

"Letter of Credit" means a letter of credit in substantially the form set forth in Exhibit P-5 issued by a United States bank (with a branch office in Portland, Oregon) rated at least 'A' by Standard & Poor's Rating Services or 'A2' by Moody's Investor Service.

"Lien" means any lien, security interest, mortgage, hypothecation, encumbrance or other restriction on title or property interest.

"Lien Waiver and Release" means waivers to lien rights and may be conditional or unconditional. Lien Waiver and Releases will follow the form as set forth in Exhibit O-1, Exhibit O-2, Exhibit O-3, and Exhibit O-4, as required.

"Limited Notice to Proceed" or "LNTP" means a written notice, substantially in form as shown in Exhibit S-1, issued by Owner on or after the Effective Date to Contractor in accordance with this Agreement that is signed by both Parties and directing Contractor to commence the Work set forth in the LNTP in accordance with the terms of this Agreement in advance of the Notice to Proceed.

"Major Equipment" shall be as defined in the Scope of Work (Exhibit A).

"Major Equipment Warranties" shall be as defined in Section 7.4.

"Major Subcontract" means any agreement or purchase order with a Subcontractor for performance of any part of the Work that has an aggregate value in excess of _____ Dollars ($_____).

"Major Subcontractor" means, any Owner-approved Subcontractor with whom Contractor will enter (or has entered) into a Major Subcontract.

"Mechanical Completion" has the meaning set forth in Section 6.2.

["Mechanical Completion Certificate" means the certificate by this name as described in, and in the form set forth in, Exhibit Q.]

["Mechanical Completion Checklist" means the checklist by this name as described in Exhibit Q.]

"Monthly Progress Report" means a monthly written report that complies with the requirements of Exhibit C-2 and includes a description of the progress and status of the Work compared to the Project Schedule, the Subcontractors' activities, engineering and design progress, a summary of any Change Orders executed by the Parties as of the date of such report and a summary of any events that may affect the Project Schedule (including, without limitation, any Force Majeure Events, Owner-Caused Delays, Liens on the Project Site, or the Project, and any asserted violations of Applicable Laws).

"Tangible Net Worth" means the total assets minus intangible assets minus the total liabilities of Guarantor and its consolidated subsidiaries, all determined on a consolidated basis as in accordance with generally accepted accounting principles.

"Notice to Proceed" means a written notice issued by Owner to Contractor pursuant to Section 2.1, and substantially in form as shown in Exhibit S-2, that is signed by both Parties directing Contractor to commence the Work in accordance with the terms of this Agreement.

"Notice to Proceed Date" or "LNTP Date" means the date on which Notice to Proceed occurs as per Section 2.1.

"O&M Personnel" has the meaning set forth in Section 2.3.12.

"Operating Manual" means the complete system instructions and procedures for the operation and maintenance of the Work, which shall comply with the requirements of the Scope of Work, including Contractor's manufacturers', vendors', suppliers' and Subcontractors' recommended list of Spare Parts, all safety information, equipment and maintenance manuals and any precautionary measures therefor.

"Other Owner Contractors" means those Persons, other than Contractor, with whom Owner contracts or subcontracts to perform work in connection with the Project, including the Equipment Provider and the Owner Engineer. Owner Contractors may also include Owner in the event Owner elects to perform any work in connection with the Project.

"Owner" has the meaning set forth in the preamble hereto.

"Owner-Caused Delay" means a delay in Contractor's or a Subcontractor's performance of the Work or an increase in Contractor's or a Subcontractor's costs that has been demonstrably caused by the failure of Owner, Other Owner Contractors (other than Equipment Provider) to perform any material obligation of Owner under this Agreement (other than by exercise of rights under this Agreement, including the exercise by Owner of the right to have Defective or nonconforming Work corrected or re-executed) or by the acts or omissions of Owner, Other Owner Contractors (other than Equipment Provider). Any delay that is due in part to Contractor's or any of its Subcontractors' actions or inactions shall not be an Owner-Caused Delay.

"Owner Engineer" means _____.

"Owner Event of Default" has the meaning set forth in Section 12.2.

"Owner Indemnified Party" has the meaning set forth in Section 10.1.1.

"Owner Permits" means those Permits required to be obtained by Owner, as set forth on Exhibit H.

"Owner's Project Manager" means the individual appointed by Owner to act on its behalf in connection with this Agreement.

"Owner's Taxes" has the meaning set forth in Section 4.2.2(b).

"Parent Guaranty" has the meaning set forth in Section 2.12.1.

"Party" or "Parties" means, respectively, a party or both parties to this Agreement.

"Payment and Performance Bond" has the meaning set forth in Section 2.12.1.

"Payment Schedule" means the milestone payment schedule attached as Exhibit B-2, which sets forth an allocation of the Contract Price to the milestones described therein.

"Permit" means permits, licenses, approvals, consents, orders, registrations, privileges, franchises, memberships, certificates, entitlements variances, waivers, certificates of occupancy and other authorizations issued by any Governmental Authorities, and any siting, zoning and land use approvals required under Applicable Laws in connection with the development, construction, operation, use and/or maintenance of the Project, and all amendments, modifications, supplements, general conditions and addenda thereto.

"Person" means any individual, corporation, partnership, limited liability company, association, joint stock company, trust, unincorporated organization, joint venture, or Government Authority or other entity of whatever nature.

"Personnel" means, with respect to a Party or entity, such Party's or entity's employees, agents, personnel, representatives, invitees, subcontractors, vendors and any other third party independent contractors with whom such Party or entity has contracted, and its agents', personnel's, representatives', invitees', subcontractors', vendors' or third party independent contractors' respective employees, agents, personnel, representatives, invitees, subcontractors, vendors or third party independent contractors.

"Pre-Existing Hazardous Material" means any Hazardous Material (a) that existed on or in the Project Site prior to the date when Contractor or any of its Subcontractors or other representatives is present thereon following the Effective Date or (b) brought to the Project Site by Owner, any Other Owner Contractor or any third party other than Contractor or its Personnel after the Effective Date.

"Prime Rate" means _____.

"Project" means the electric generation project that is the subject of this Agreement, as described in the Scope of Work (Exhibit A).

"Project Schedule" has the meaning set forth in Section 2.5.2.

"Project Site" means all those parcels of land subject to the Real Property Rights in favor of Owner including the Transmission Corridor on which the Work will be located as shown in Exhibit G-1.

"Project Substantial Completion" has the meaning set forth in Section 6.3.1.

"Project Substantial Completion Certificate" means the certificate by this name as described in, and in the form set forth in Exhibit Q.

"Project Substantial Completion Date" means the date on which the Project achieves Project Substantial Completion, per Section 6.3.2.

"Prudent Industry Practices" means, in connection with the design and construction of renewable energy power generation systems of a type and size and having geographical and

climatic attributes similar to the Project, those practices, methods, specifications and standards of safety, performance, dependability, efficiency and economy generally recognized by industry members in the United States as good and proper, and such other practices, methods or acts which, in the exercise of reasonable judgment by those reasonably experienced in the industry in light of the facts known at the time a decision is made, would be expected to accomplish the result intended at a reasonable cost and consistent with Applicable Laws, reliability, safety and expedition. Prudent Industry Practices are not intended to be limited to the optimum practices, methods or acts to the exclusion of all others, but rather to be a spectrum of good and proper practices, methods and acts.

"Punch List" means any punch list as described in Section 6.4.1, as applicable.

"Quality Assurance Procedures" means the quality assurance and quality control procedures as set forth in Exhibit N.

"Real Property Requirements" means the applicable covenants, agreements, restrictions, limitations, or requirements of the Real Property Rights imposed upon Owner or its assignees, contractors, licensees, or invitees regarding the use and possession of the Project Site, the construction, operation, and maintenance of the Project on the Project Site, and any other activities on or over the Project Site, a summary of which is attached hereto as Exhibit G-2.

"Real Property Rights" means all rights in or to real property (such as leasehold or other rights to use or access the Project Site), leases, agreements, Permits, easements, including licenses, private rights-of-way, and utility and railroad crossing rights required to be obtained or maintained by Owner in connection with construction of the Project on the Project Site, transmission of electricity to the Grid, performance of the Work, or operation of the Project.

"Request for Payment" means the written requests from Contractor to Owner for payment, as described in Exhibit B-2.

"Retainage" has the meaning set forth in Section 4.4.1.

"Safety Plan" has the meaning set forth in Section 2.3.14(a).

"Schedule of Values" means that schedule set forth in Exhibit B-1 which apportions the Contract Price among all cost code divisions or portions of the Work.

"Scope of Work" means the services and work to be provided, or caused to be provided, by or through Contractor under the Agreement, as more particularly described in Exhibit A, and the other obligations of Contractor under the Agreement, as the same may be amended from time to time in accordance with the terms hereof.

"Spare Parts" has the meaning set forth in Section 2.3.10.

"Subcontract" means an agreement between Contractor and any Subcontractor.

"Subcontractor" means any Person other than Contractor performing any portion of the Work, including every tier of subcontractor, vendor or supplier of equipment, materials or

services to Contractor or any subcontractor of any Person engaged or employed by Contractor or any subcontractor in connection with the performance of the Work, whether or not incorporated into the Project.

"Substantial Completion of Liquidated Damages" has the meaning set forth in Section 6.1.2.

"Termination for Cause" has the meaning set forth in Section 12.1.2.

"Termination Payment" has the meaning set forth in Section 12.4.1.

"Termination Without Cause" has the meaning set forth in Section 12.3.

"Transmission Corridor" means, as part of the Project Site, those connected parcels of land subject to the Real Property Rights in favor of Owner on which certain Project, including transmissions lines, electrical works and the Interconnect Switchyard, will be located.

"Equipment Provider" means _____.

"Unforeseen Subsurface Condition" has the meaning set forth in Section 2.3.1(b).

"Warranty" has the meaning set forth in Section 7.1.1.

"Warranty Period" has the meaning set forth in Section 7.1.2.

"Warranty Service" has the meaning set forth in Section 7.1.3.

"Work" has the meaning set forth in Section 2.1 and includes Contractor Deliverables, the Project, the Equipment, and any other product or result of the Work, and further described in Exhibit A.

"Working Day" means the hours from 7:00 am to 7:00 pm, Monday through Saturday, excluding holidays, at the Project Site.

1.2 Rules of Interpretation. Unless otherwise required by the context in which any term appears: (a) unless otherwise specified, references to "Articles," "Sections," or "Exhibits" (if any) shall be to Articles, Sections, or Exhibits (if any) of this Agreement, as the same may be amended, supplemented or replaced from time to time hereunder; (b) all references to a Person shall include a reference to such Person's successors and permitted assigns; (c) references to any agreement, document or instrument shall mean a reference to such agreement, document or instrument as the same may be amended, modified, supplemented or replaced from time to time; (d) the use of the word "including" or "include" in this Agreement to refer to specific examples shall be construed to mean "including, without limitation" and shall not be construed to mean that the examples given are an exclusive list of the topics covered; and (e) the headings contained herein are used solely for convenience and should not be used to aid in any manner to construe or interpret this Agreement. The Parties collectively have prepared this Agreement, with advice of legal counsel; none of the provisions hereof shall be construed against one Party on the ground that such Party is the author of this Agreement or any part hereof.

1.3 Order of Precedence. In the event of any inconsistencies in this Agreement, the following order of precedence in the interpretation hereof or resolution of such conflict hereunder shall prevail:

1.3.1 Amendments, addenda or other modifications to the Agreement (including Change Orders) duly signed and issued after the signing of this Agreement, with those of a later date having precedence over those of an earlier date;

1.3.2 This Agreement (excepting Exhibits hereto);

1.3.3 Exhibit A through Exhibit S-2;

1.3.4 Drawings produced and delivered pursuant hereto (in respect of which, precedence shall be given to drawings of a larger scale over those of smaller, figured dimensions on the drawings shall control over scaled dimensions, and noted materials shall control over undimensioned graphic indications).

Notwithstanding the foregoing provisions of this Section 1.3, if a conflict exists within a part of the Agreement as listed in a lettered subclause above, or between or among the Agreement and Applicable Laws, the Real Property Requirements, then the more stringent or higher quality requirements shall control. Where a conflict exists among codes and standards applicable to the Project or Contractor's performance of the Work, the most stringent provision of such codes and standards shall govern.

## ARTICLE II

## RETENTION OF CONTRACTOR; CONTRACTOR RESPONSIBILITIES

2.1 Work to be Performed. Commencing on the date specified in the Notice to Proceed, or earlier with respect to Work authorized pursuant to the Limited Notice to Proceed ("LNTP"), and except as otherwise expressly set forth in Article V or elsewhere in this Agreement as being the responsibility of Owner or Equipment Provider, Contractor shall perform or cause to be performed all necessary work and services (the "Work") required in connection with (a) the design, procurement, engineering, specified permitting, construction, assembly, installation and, where applicable, the start-up and testing, of the Project to Final Completion, (b) the provision, management and supervision of all Labor, transportation, administration and other services as required in connection with any of the foregoing, (c) the inspection and furnishing of all materials, equipment, machinery, tools, temporary structures, temporary utilities as required in connection with the foregoing including the performance obligations described in this Article II and the Scope of Work, and (d) the performance of Contractor's warranty obligations hereunder. Owner hereby retains Contractor, and Contractor hereby agrees to be retained by Owner, to perform or cause to be performed the Work in accordance with the terms and conditions of this Agreement. Contractor hereby represents that it has ascertained the nature and location of the Work, the general character and accessibility of the Project Site, the existence of known obstacles to construction, the location and character of existing or adjacent work or structures, and other general and local conditions including Applicable Laws, and the availability and productivity of Labor which might affect its

performance of the Work or the cost thereof and that, based upon the same, but subject to Section 9.5.1, commits that it can complete the Work for the Contract Price in accordance with the Initial Project Schedule.

2.2 Project. Contractor shall construct the Project and all other components of the Work that are set forth in Exhibit A as part of Contractor's Scope of Work.

2.2.1 Interconnection to Grid. As further described in the Scope of Work, Contractor shall be responsible for all interconnection up to and including provision of and connection to the Interconnect Switchyard. Contractor shall coordinate with and permit the Utility to install the interconnection works between such point and the Grid.

2.2.2 Start-up and Testing of Project. Contractor shall perform the start-up and testing of the Project, including the calibration and functional testing of all controls and equipment in accordance with Exhibit A. If the Scope of Work requires that any item comprising the Project be tested by Contractor, Contractor shall notify Owner in writing at least ten (10) Business Days prior to the commencement of any such test. Contractor shall coordinate with Owner the scheduling of any test and Owner shall coordinate such test with Equipment Provider, so as not to interfere, in either case, with either Party's obligations with respect thereto. Owner shall witness such tests and will, within three (3) Business Days after receipt of written results of such tests, deliver to Contractor a written notice either (a) accepting such tests as having been passed, or (b) rejecting such tests as having demonstrated that the tested item failed to comply with the performance requirements therefor under this Agreement. Any rejection shall include a detailed description of the basis for rejection.

2.3 Further Work Responsibilities and Commitments.

2.3.1 Site Clearance and Preparation.

(a) Topography. Contractor has surveyed the general surface conditions of the Project Site topography and represents that, subject to Unforeseen Subsurface Conditions, the same are sufficient for Contractor to construct the Project and perform the Work. Contractor will be responsible for clearance of the Project Site, including the removal of obstructions. Contractor will be responsible for access road construction as described in the Scope of Work. Contractor shall provide for the procurement of or disposal of, as necessary, all soil, gravel and similar materials required for the performance of or otherwise in connection with the Work. Contractor will provide adequate treatment of and protection against water runoff resulting from Contractor's and its Subcontractor's work. Contractor will provide for the collection, treatment and disposal of groundwater resulting from Contractor's and its Subcontractors' work.

(b) Geotechnical Survey; Subsurface Risk. "Unforeseen Subsurface Conditions" shall mean: (i) subsurface or latent physical conditions at the Project Site, differing materially from those indicated in the Geotechnical Survey, or (ii) previously unknown physical conditions at the Project Site of an unusual nature (including unknown and unexpected archaeological or religious sites, places, monuments or areas) or conditions that differ materially from those ordinarily encountered and generally recognized as inherent in work similar to the

Work or which should have been known or discoverable Contractor based upon the information in the Geotechnical Survey. If Contractor encounters any condition that Contractor believes is or may be an Unforeseen Subsurface Condition, Contractor shall notify Owner of the same promptly, but in any event no later than three (3) days after becoming aware of the condition. If the condition at issue is indeed an Unforeseen Subsurface Condition as defined herein and Contractor has delivered such notice within such time period, then Contractor will be entitled to a Change Order to the extent so provided in Section 9.5.1(d). If Contractor fails to notify Owner of such a condition within such three (3) day period, then Contractor shall not be entitled to and will thereby be deemed to have waived its rights to receive any Change Order as with respect to such condition.

2.3.2 Storage. At all times prior to the date of Project Substantial Completion, Contractor shall provide appropriate storage for the Consumable Parts, Equipment, and all other materials, supplies and other equipment utilized in connection with the Work and all other personal property owned or leased by Contractor or any Subcontractor located at the Project Site. At a minimum, Contractor shall comply with all Equipment manufacturer recommendations and requirements and shall comply with requirements in the Scope of Work.

2.3.3 Transportation and Delivery Specification. ***[To Be Discussed as appropriate to equipment.]***

2.3.4 Drawings and Documents.

(a) Ownership of Drawings. All drawings, specifications and other documents prepared by or for Contractor in respect of the Project and all drawings, specifications, calculations, memoranda, data, notes and other materials containing information supplied by Owner which shall come into Contractor's possession during its performance hereunder, shall be the property of Owner, and such Owner documents and other materials shall be returned to Owner upon the earlier of the Project Substantial Completion Date or termination of this Agreement. Owner shall have the right to retain a reproducible set of all Contractor's proprietary drawings, specifications and other documents for use in respect of the Project. Review (or lack thereof) by Owner or its designees of any Project documents provided by Contractor, and the fact that Owner has not discovered any errors reflected in such Project documents, shall not relieve or release Contractor of any of its duties, obligations or liabilities under the terms of this Agreement.

(b) As-Built Drawings. During construction, Contractor shall keep on file one set of current as-built drawings reflecting all field deviations from the design drawings. As a condition to Final Acceptance, Contractor shall provide to Owner, for Owner's approval, a set of as-built drawings which have been fully conformed to the construction records as of the completion of the Work. Drawings shall be provided in AutoCAD DWG/DWF and Adobe PDF format.

2.3.5 Religious and Archaeological Resources. If any archaeological or religious sites, places, monuments or areas are discovered or identified by Contractor during the performance of Work under the Agreement, Contractor shall leave such sites untouched and protected by fencing and shall immediately stop any Work affecting the area and shall comply

with any applicable Real Property Requirements. Contractor shall notify Owner of any such discovery as soon as practicable, and Contractor shall carry out Owner's reasonable instructions for dealing with the same. All fossils, coins, articles of value or antiquity and structures and other remains or things of geological, archaeological, historical, religious, cultural or similar interest discovered on the Project Site shall, as between Owner and Contractor, be deemed to be the property of Owner. Contractor shall prevent its and its Subcontractors' Labor from removing or damaging any such article or thing.

2.3.6 Equipment, Consumables, Construction Utilities and Related Services. Except to the extent provided by Owner or Equipment Provider as described in Article V or as part of the Work, Contractor shall procure and supply, at its own expense, all Equipment required to complete the Work, including without limitation all Equipment as necessary for performance and completion of its obligations under this Agreement (whether on or off the Project Site). Contractor shall inspect or cause to be inspected all such Equipment and shall reject those items determined not to be in compliance with the requirements of this Agreement. Contractor shall be responsible, at its sole expense, for furnishing and installation of all temporary utilities, telephone, data lines, cabling and wiring necessary for all activities associated with the completion of the Work. All Equipment provided by Contractor shall be new and of suitable grade for its intended purpose. With the exception of those consumable items expressly stated to be provided by Equipment Provider as described in Exhibit D, Contractor shall supply all consumable parts and supplies required for the Work including, but not limited to, cable ties, cable wraps, splices, wire nuts, lubricants, greases and other consumable materials (collectively, the "Consumable Parts").

2.3.7 Obtaining, Maintaining and Identifying Permits. Contractor shall timely obtain and maintain all Contractor Permits. In addition, Contractor shall provide all assistance reasonably requested by Owner in connection with Owner's efforts to obtain and maintain the Owner Permits. If any Applicable Permit is required for the Project or to perform the Work that is not identified in Exhibit H, Contractor or Owner, as applicable, shall promptly, after it becomes aware of the need for such Applicable Permit, notify the other Party that such Applicable Permit is required. If such Applicable Permit is of a nature typically obtained by contractors in similar projects, Contractor shall, at its sole cost and expense, be obligated to obtain and maintain such Applicable Permit. Otherwise, Owner shall obtain and maintain such Applicable Permit. All Applicable Permits (other than any building permits) designated as either "To be issued in the name of Owner" or "To be issued in the name of the Owner and Contractor" on Exhibit H shall be issued in the name of Owner or Owner and Contractor, as required, to the best of Contractor's ability unless otherwise required by Applicable Law or such Applicable Permit. If any Contractor Permit (or application therefor) is in the name of Owner or otherwise requires action by Owner, Owner shall, upon the request of Contractor, sign such application or take such action as reasonably appropriate. Owner reserves the right to review any such application of Contractor; provided, however, that Owner's exercise of such right shall not under any circumstances, be considered an approval of the necessity, effect or contents of such application or related Permit nor shall it be allowed to unreasonably delay the submittal of such application. Contractor shall deliver to Owner true and complete copies of all Permits obtained by Contractor upon its receipt thereof.

2.3.8 Real Property Requirements and Real Property Rights. Contractor shall comply with those Real Property Requirements as summarized in Exhibit G-2. In addition, Contractor shall provide such assistance as may be reasonably requested by Owner in connection with Owner's efforts to observe and maintain the Real Property Requirements, including efforts to obtain any necessary revisions or adjustments thereof. As of the date hereof, subject to Section 2.3.1(b) as regards Unforeseen Subsurface Conditions, Contractor represents and warrants that it has inspected and is fully familiar with the Project Site, including the boundaries thereof, and that (a) they are sufficient for Contractor to undertake and complete that portion of the Work to be located thereon in accordance with the Agreement, the Real Property Requirements and Applicable Laws, and (b) Contractor has not discovered any conditions that in Contractor's reasonable judgment would be a basis for claiming a Change. In the performance of the Work, Contractor and its Subcontractors shall abide by any restrictions in regard to the location of facilities that are part of the Real Property Requirements. Owner shall enforce the Real Property Requirements for the benefit of Contractor and shall indemnify Contractor with respect to any claims by the Owners other than those claims caused by Contractor or its Personnel. Contractor shall indemnify Owner from any claims or expenses arising out of the failure of Contractor or its Subcontractors to comply with the Real Property Requirements. Contractor shall provide all necessary information and documents and use all reasonable efforts to assist Owner in obtaining any Real Property Rights that Owner at any time is seeking within the Project Site. Contractor shall notify Owner upon the occurrence, or likely occurrence, of a dispute, conflict, confrontation, or other similar problem, or potential problem, involving one or more owners or occupiers of land so situated as to potentially result in a situation that may have a material adverse effect upon the performance of the Work. Contractor shall, at Owner's expense, cooperate with Owner in resolving all such problems.

2.3.9 Environmental Compliance. Contractor shall comply with all Environmental Assessment requirements applicable to Contractor or the Work as set forth in Exhibit R-1 and the Environmental Permit Matrix as set forth in Exhibit R-2.

2.3.10 Spare Parts. Set forth in Exhibit J-2 is a list of spare parts that are necessary to operate and maintain the Project (the "Spare Parts"). Owner may at any time prior to Project Substantial Completion notify Contractor in writing that Owner wishes to purchase certain Spare Parts, and therein request pricing for the Spare Parts in question and the quantities desired. Contractor will supply the pricing for such identified Spare Parts to Owner as soon as practicable after such request. Owner may thereafter order those of such Spare Parts as Owner desires. Contractor shall thereafter deliver such Spare Parts Duty Paid (DDP) (Incoterms 2000) to Project Site, using commercially reasonable efforts to complete such delivery within two (2) weeks after Owner's placement of such order. Title and risk of loss to such Spare Parts will transfer to Owner upon such delivery. After such delivery is completed, Contractor will invoice Owner for the Spare Parts (based upon the quoted pricing), and the undisputed portions of such invoice shall be payable by Owner within thirty (30) days after Owner's receipt of such invoice. Should a component of the Equipment fail during commissioning, start-up or testing, Contractor may utilize a Spare Part of that component from Owner's inventory in order to return the Equipment to operating condition. Contractor shall at its cost promptly replace any such Spare Parts so utilized.

2.3.11 Operating Manuals and Job Books.

(a) Operating Manuals. Within 30 days after finalizing the equipment selection the Contractor shall prepare and deliver to the Customer the following documents: (i) Operating Manuals in an electronic draft version, (ii) recommended spare parts list, and (iii) lubrication schedule. Prior to commencing commissioning activities, Contractor shall prepare and deliver to Owner the documentation as required in the Scope of Work. In the event of total or partial rejection or revisions of the draft Operating Manuals by Owner, within fifteen (15) days after receipt of notice of such revisions or rejection Contractor shall make appropriate changes to the drafts to respond to Owner's revisions or reasons for rejection and shall resubmit such draft to Owner or shall explain why such revisions are not necessary. Such procedure shall be repeated until receipt of Owner's written approval therefore. Upon the earlier of Final Completion and thirty (30) days after Project Substantial Completion, Contractor shall prepare in individually numbered bound volumes and deliver to Owner two (2) sets of such approved Operating Manuals (which may be combined with the other Operating Manuals) and shall also provide three (3) copies of the Operating Manuals to Owner in electronic format.

(b) Job Books. As a condition to Project Substantial Completion, Contractor shall deliver to Owner two (2) copies of the semi-final draft of the Job Books, either in job book format or in form and format then available as a result of the design and construction process, as appropriate. A semi-final draft shall mean a draft that does not contain final As-Built Drawings and documentation, but is as reasonably complete as available information will allow, containing at a minimum sufficient information to permit the conduct of operator training and operation, repair and modification of the Project by Persons generally familiar with machinery and equipment similar to that comprising the same. Upon the earlier of Final Completion and thirty (30) days after Project Substantial Completion, Contractor shall provide two (2) original hard copies and three (3) electronic copies (on CD Roms) of the final and complete Job Books to Owner. Where any of the information in the Job Books was produced by computer-aided design and is available to Contractor or any Subcontractor, Contractor shall provide or cause to be provided to Owner an electronic copy of such information.

2.3.12 Contractor-Provided Training. Commencing at least thirty (30) days prior to the then-scheduled date for achievement of Mechanical Completion, Contractor shall provide, at its own expense, a training program in the operation and maintenance of the Project for Owner's Project Personnel and the operation and maintenance contractor's Project Personnel (collectively, "O&M Personnel"). The training program provided by Contractor shall be as described on Exhibit J-1 and shall (a) include classroom and field training, (b) include all educational materials necessary for such training, and (c) establish quality controls so that O&M Personnel are suitably trained and capable of operating and maintaining the Project after Project Substantial Completion. Contractor shall make every reasonable effort to use the O&M Personnel during start-up and initial operation of the Project; provided, however, Owner shall not be obligated to supply (i) O&M Personnel for the construction of the Project or (ii) provide during Project start-up and initial operation more O&M Personnel than the number of O&M Personnel Owner an Operations and maintenance contractor would use during normal Project operation as determined by Owner. Contractor shall remain solely responsible for performing the Work in accordance with this Agreement, including Contractor's obligation to achieve Project Substantial Completion, and achieve Final Completion, subject to Contractor's right to a Change Order in the event of an Owner-Caused Delay. The cost of the O&M Personnel's salary, travel, lodging, food and other living expenses shall be borne by Owner.

2.3.13 Labor and Personnel.

(a) Engagement of Labor. Contractor shall provide and manage and transport all Labor and Personnel required in connection with the performance of the Work and of its obligations hereunder. Contractor shall retain only such Labor and Personnel that have experience with the equipment and who are competent to perform their assigned duties in a safe and secure manner, including: (i) Contractor's Project Manager; (ii) lead project engineer and field engineers, cost and schedule engineers. Contractor shall not change Contractor's Project Manager or any other member of Contractor's Key Personnel without the prior written consent of Owner, which consent shall not be unreasonably withheld or delayed. Contractor shall require its Subcontractors to adhere to the same standard with respect to their Labor. Where required by Applicable Law, Contractor shall employ only licensed Personnel in good standing with their respective trades and licensing authorities to perform engineering, design, architectural and other professional services in the performance of the Work. All such professional services shall be performed with the degree of care, safety, skill and responsibility customary among such licensed Personnel provided such performance is in accordance with Applicable Law and Prudent Industry Practices. To the extent required by Applicable Law and Prudent Industry Practices, all Labor shall have received formal documented training in their area of expertise and certification.

(b) Owner Review of Labor. Upon Owner's request, Contractor shall provide Owner with the resumes of all management and supervisory Personnel employed in connection with the Work and Owner may require the replacement of any Personnel, at Contractor's sole expense if, in Owner's reasonable opinion, such Person is (i) endangering life or limb on or near the Project Site or violates or breaches the Real Property Requirements, thereby adversely affecting Owner's relationship with the land owners, (ii) incompetent, or (iii) violating or has violated this Agreement, particularly the Safety Plan and Sections 2.3.13(c) through (e). Rejection of Contractor's Personnel by Owner shall not relieve Contractor of any of its obligations hereunder or be construed as a waiver by Owner of any of its rights under the Agreement.

(c) Alcohol and Drugs. Contractor shall comply with Owner's policies and practices regarding alcohol and drugs and shall not possess, consume, import, sell, give, barter or otherwise dispose of any alcoholic beverages or drugs (excluding drugs for proper medical purposes and then only in accordance with Applicable Law) at the Project Site, or permit or suffer any such possession, consumption, importation, sale, gift, barter or disposal by its Subcontractors, agents or Labor. Subject to requirements of Applicable Law, Contractor shall perform random drug and alcohol testing on Persons employed by its Subcontractors and shall perform a drug and alcohol test on any Person employed by a Subcontractor who Owner or Contractor reasonably suspects is in possession of or under the influence of any dangerous or controlled drug, alcohol or other such substance at any time during such Person's performance of any portion of the Work at the Project Site. Subject to requirements of Applicable Law, Contractor shall perform drug and alcohol testing on its Subcontractors, agents and Labor for purposes of such Person's hiring, treatment or annual physical. Additionally, Contractor shall perform, or cause its Subcontractors and agents to perform, a drug and alcohol test on each of their respective employees prior to any such employee first entering the Project Site to perform any Work. Contractor shall immediately identify and remove from its or its Subcontractors'

employment at the Project Site any Person (whether in the charge of Contractor or any of its Subcontractors) who is in possession of or under the influence of any dangerous or controlled drug, alcohol or other such substance at any time during such Person's performance of any portion of the Work, excluding any Person using a prescription drug under supervision and approval from a medical doctor, or any other Person who does or whose actions may create any unsafe condition or other situation that may cause damage or harm to any Person or property, including any Person using a prescription drug under supervision and approval from a medical doctor. Contractor's Drug and Alcohol Abuse Policy is attached as Exhibit L. This policy does not apply to Owner and its Personnel. Owner shall enforce its own drug and alcohol policy with respect to its Personnel.

(d) Arms and Ammunition. Contractor and its Personnel, shall not possess, give, barter or otherwise dispose of, to any Person or Persons, any arms or ammunition of any kind at the Project Site, or permit or suffer the same as aforesaid and shall at all times assure that the Project Site is kept free from arms and ammunition. No hunting of any kind by Contractor or its Personnel, or other invitees, shall be permitted on the Project Site. Contractor shall immediately identify and remove from its or its Subcontractors' employment at the Project Site any Person that violates this provision.

(e) Disorderly Conduct. Contractor shall be responsible for the conduct and deeds of its Labor and its Subcontractors' Labor relating to the Agreement and the consequences thereof. Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or among such Labor and for the preservation of peace, protection and safety of Persons and property in the area of the Project Site against the same. Contractor shall not interfere with any members of any authorized police, military or security force in the execution of their duties.

(f) Labor Disputes. Contractor shall use reasonable efforts to minimize the risk of labor-related delays or disruption of the progress of the Work. Contractor shall promptly take any and all reasonable steps that may be available in connection with the resolution of violations of collective bargaining agreements or labor jurisdictional disputes, including the filing of appropriate processes with any court or administrative agency having jurisdiction to settle, enjoin or award damages resulting from violations of collective bargaining agreements or labor jurisdictional disputes. Contractor shall advise Owner promptly, in writing, of any actual or threatened (in writing) labor dispute, of which Contractor has knowledge, that might materially affect the performance of the Work by Contractor or by any of its Subcontractors. Notwithstanding the foregoing, the settlement of strikes, walkouts, lockouts or other labor disputes shall be at the discretion of the Party having the difficulty.

2.3.14 Safety and Emergencies.

(a) Safety. Contractor shall initiate and maintain safety precautions and programs to conform with Applicable Laws, Applicable Permits, Exhibit A, or other requirements designed to prevent injury to all Persons (including members of the public and the employees, agents, contractors, consultants and representatives of Owner, Contractor and its Subcontractors, and other contractors and subcontractors) and all public and private property (including structures, sewers and service facilities above and below ground, along, beneath,

above, across or near the Project Site) that are at or near the Project Site that are in any manner affected by the performance of the Work. Such precautions and programs shall include prevention of damage or injury to local flora and fauna. Contractor shall erect and maintain reasonable safeguards for the protection of Labor and the public. Contractor shall exercise reasonable efforts to eliminate or abate all reasonably foreseeable safety hazards created by or otherwise resulting from performance of the Work. Contractor shall, and shall cause all of its Labor, agents, invitees, and Subcontractors to follow the safety plan set forth in Exhibit L (the "Safety Plan") and to follow all other reasonable safety measures and procedures implemented by the Owner at the Project Site.

(b) Compliance with Safety Plan. Contractor shall be responsible for and shall notify Owner as soon as Contractor becomes aware of any injury resulting from a failure of its agents, invitees, Labor, or Subcontractors to abide by the requirements of the Safety Plan set forth in Exhibit L, in each case in connection with performance of the Work.

(c) Emergencies. In the event of any emergency endangering Persons or property during performance of the Work, Contractor shall take such action as may be reasonable and necessary to prevent, avoid or mitigate injury, damage or loss and shall, as soon as practicable, report any such incidents, including Contractor's response thereto, to Owner. Whenever Contractor has not taken reasonable precautions for the safety of the public or the protection of the Work or of structures or property on or adjacent to the Project Site, Owner may, but shall be under no obligation to, upon reasonable advance notice to Contractor and a reasonable opportunity to cure, take such action as is reasonably necessary under the circumstances. The taking of such action by Owner or Owner's failure to do so shall not limit Contractor's obligations or liability hereunder. Provided Contractor fails to timely act, Contractor shall reimburse Owner for any reasonable costs incurred by Owner in taking such actions in the event of an emergency.

2.3.15 Security. Contractor shall take reasonable precautions, consistent with Prudent Industry Practices, to provide for the security and protection: (a) of the equipment, machinery and components comprising the Equipment and the Project through the date of Project Substantial Completion, and (b) for the other property owned or leased by Contractor or any Subcontractor located at the Project Site at areas thereon provided by Owner or stored or warehoused off the Project Site through the date of Final Completion. Contractor shall use the same care to protect any of Owner's and Equipment Provider's property at any time in its possession or under its control while performing the Work as it does with its own property and shall be responsible for damage to such property resulting from Contractor's failure to take such precautions or use such care.

2.3.16 Clean-up. Contractor shall at all times keep the Project Site reasonably free from waste materials, rubbish and Hazardous Materials produced by the Work. As part of the Work, Contractor will arrange and pay for disposal of sewage and wastes generated by Contractor or its Personnel as necessary to enable Contractor to perform the Work. Contractor shall maintain the Project Site in a neat and orderly condition throughout the performance of the Work. Prior to the Final Completion Date or as soon as practicable after the termination of this Agreement by Owner in accordance with the provisions of Article XII, Contractor shall (i) remove all Contractor equipment from the Project Site, (b) tear down and remove all

temporary structures on the Project Site built by it or its Subcontractors and restore such areas to a condition consistent with that of a newly constructed plant (including the re-grading and re-seeding of disturbed areas, which re-seeding may occur after Final Completion if Owner reasonably approves), (c) reclaim, in accordance with the applicable Real Property Requirements, laydown areas, and other construction areas as required by the applicable Real Property Requirements, and (d) remove and dispose of all waste and rubbish generated by Contractor and its Subcontractors from and around the Project Site. Contractor shall provide to Owner all legally required waste disposal manifests, if any, upon request.

2.3.17 Damage to Roads. Contractor shall abide by the maintenance provisions set forth in the Site Control Agreement (Exhibit K) and shall be responsible for (i) all damage it and its Subcontractors cause to state roads and highways (other than township roads) in violation of Applicable Law, (ii) all damage Contractor or its Subcontractors cause to County roads, (iii) all damage caused by it and its Subcontractors to private roads or property of third parties, in each case in connection with performance of the Work.

2.3.18 Fire Prevention. Contractor shall be responsible for providing adequate fire prevention and protection at the Project Site and shall take all reasonable precautions to minimize the risk of fire at the Project Site. Contractor shall provide instruction to the Labor in fire prevention control. Contractor shall provide appropriate fire-fighting and fire protection equipment and systems at the Project Site in a manner consistent with those as would be provided by a prudent contractor constructing a comparable project in comparable terrain and climate to that of the Project. Notwithstanding the foregoing sentence, this Agreement shall not, and does not obligate Contractor's or any of its Subcontractors' employees to fight any fires. In the event of a fire, Contractor's or any of its Subcontractors' employees shall immediately take steps to ensure the safety of themselves and others and shall contact the local fire department to report such fire and to determine the appropriate actions. Contractor shall promptly collect and remove combustible debris and waste material from the Project Site and shall not permit such debris and material to accumulate.

2.3.19 Other Work. As part of the Work (and except as otherwise stated in the Scope of Work, Article V or elsewhere in this Agreement as being the responsibility of Owner or Equipment Provider), Contractor shall provide any other services or items not specifically described in this Agreement if providing such additional work or item is necessary to make the Project operable, free from Defects and capable of performing as specified in this Agreement.

2.4 Prudent Industry Practices for the Work/Compliance. Contractor shall perform the Work in a manner that is (a) in conformance with Prudent Industry Practices and the Quality Assurance Procedures; (b) in compliance with the terms of the Agreement, and all interconnection requirements attached hereto; (c) compliant with all Applicable Laws, Applicable Permits; and (d) in compliance with and not in violation of the terms of the Real Property Requirements, including such that Owner would be in violation of the Real Property Requirements. In no event will references in any provision of this Agreement to one or more of the standards, guidelines, practices, regulations, laws, or Permits contained in this Section 2.4 be interpreted to limit the applicability of all such standards, guidelines, practices, regulations, laws, and Permits to such provision.

2.5 Commencement of Work; Project Schedule; Acceleration.

2.5.1 Access to Project Site. Contractor will commence performance of all off-site Work promptly after the Effective Date and upon receipt of an LNTP, including ordering "long lead time" Equipment. Contractor will not perform any clearing Work on the Project Site until Owner issues to Contractor a Notice to Proceed.

2.5.2 Project Schedule; Monthly Progress Reports.

(a) Within eight (8) weeks after the Effective Date, Contractor shall prepare and submit to Owner for approval a complete "Level 3" working level critical path based in the Initial Project Schedule in sufficient detail acceptable to Owner, including identification of particular work tasks, durations and logical ties between activities (as further defined in the Scope of Work, the "Project Schedule"). Owner's approval of the Project Schedule, which shall not be unreasonably withheld, conditioned or delayed, shall be a condition precedent to Owner's approval of Contractor's initial Request for Payment. Contractor shall perform the Work in accordance with the Project Schedule.

(b) Contractor shall provide Owner with Monthly Progress Reports as further defined in Exhibit A, which shall include progress reports, as compared to the Project Schedule, including the incorporation of delay and acceleration analyses where appropriate. Such Monthly Progress Reports shall be presented electronically and shall address all material elements of the Work. Contractor shall provide Owner with appropriate work and meeting facilities at the Site and shall conduct weekly and monthly project meetings at mutually agreeable locations or by telephone between representatives of Owner, Equipment Provider and Contractor to review the status of the Work. Contractor shall promptly notify Owner in writing at any time that Contractor has reason to believe that there will be a material deviation in the Project Schedule and shall set forth in such notice the corrective action planned by Contractor. Delivery of such notice shall not relieve Contractor of its obligations under Article VI.

2.5.3 Acceleration of Work. If, at any time or from time to time, Contractor fails to achieve or is reasonably likely to fail to achieve a Key Milestone by the date required therefor in the Project Schedule for any reason not otherwise excused under the terms of this Agreement, then, upon written request of Owner, Contractor shall promptly, but in any event within five (5) Business Days of such date, submit a written recovery plan with specific steps, tasks and subcontractor actions necessary to complete all necessary Work by the dates for the remaining Key Milestones. Such recovery plan shall contain a delay analysis, including a statement of the extent to which Contractor claims that the delay is excusable under the terms of the Agreement and Contractor's reasons therefor. The recovery schedule shall also contain sufficient detail to demonstrate the feasibility of achieving Project Substantial Completion by the Guaranteed Substantial Completion Date. Owner shall promptly submit reasonable suggestions to such written recovery plan. To the extent reasonable and feasible, Contractor shall incorporate such suggestions to such recovery plan or shall provide explanation for why such suggestions were not incorporated, which may include alternative Work acceleration proposals. Contractor shall diligently prosecute the Work in accordance with such recovery plan. Neither approval by Owner of such recovery plan nor Contractor's prosecution of the Work in compliance with such recovery plan shall (i) be deemed in any way to have relieved Contractor of its obligations under

the Agreement relating to the failure to timely achieve any Key Milestone by the date required therefor, or (ii) be a basis for a Change Order or any other compensation or an increase in the Contract Price. Contractor shall not be entitled to a Change Order or any other compensation or increase in the Contract Price in connection with the implementation of a recovery plan or any acceleration thereunder.

2.6 Hazardous Materials.

2.6.1 Contractor Duties. Contractor shall, and shall cause its Subcontractors to, comply with all Applicable Laws relating to Hazardous Material. Without limiting the generality of the foregoing: (a) Contractor shall, and shall cause its Subcontractors to, have a release prevention and response plan to contain and clean up any spills or emissions of Hazardous Materials by Contractor or its Personnel (such plan to be made available to Owner upon Owner's request); (b) Contractor shall, and shall cause its Subcontractors to apply for, obtain, comply with, maintain and renew all Applicable Permits required of Contractor by Applicable Laws regarding Hazardous Material that are necessary, customary or advisable for the performance of the Work; (c) Contractor shall, and shall cause its Subcontractors to have an independent Environmental Protection Agency identification number for disposal of Hazardous Material generated by Contractor if and as required under Applicable Laws; (d) Contractor shall conduct its activities under the Agreement, and shall cause each of its Subcontractors to conduct its activities, in a manner designed to prevent pollution of the environment or any other release of any Hazardous Material by Contractor and its Subcontractors in a manner or at a level requiring remediation pursuant to any Applicable Law; (e) neither Contractor nor its Subcontractors shall cause the release or disposal of Hazardous Material at the Project Site, bring Hazardous Material to the Project Site, or transport Hazardous Material from the Project Site, except as required for performance under the Agreement and in accordance with Applicable Law; (f) Contractor shall be responsible for the management of and proper disposal of all Hazardous Material released, brought onto or generated at the Project Site by it or its Subcontractors, if any; (g) if any spillage, discharge, emission, or release should occur through Contractor's actions, Contractor shall immediately notify Owner and take all reasonable steps necessary to: (1) stop and contain the spillage, discharge, emission, or release, (2) make any report(s) of the spillage, discharge, emission, or release as required under Applicable Law, and (3) clean-up the spillage, discharge, emission, or release as required by the applicable Government Authority; (h) Contractor shall cause all such Hazardous Material released, brought onto or generated at the Project Site by it or its Subcontractors, if any, (1) to be transported only by carriers maintaining valid Hazardous Materials transportation permits (as required) and operating in compliance with such permits and laws regarding the transportation of Hazardous Material and only pursuant to manifest and shipping documents identifying only Contractor as the generator of waste or Person who arranged for waste disposal, and (2) to be treated and disposed of only at treatment, storage and disposal facilities maintaining valid permits (as required) regarding Hazardous Material; (i) Contractor shall submit to Owner a list of all Hazardous Material to be brought onto or generated at the Project Site prior to bringing or generating such Hazardous Material onto or at the Project Site; and (j) Contractor shall keep Owner informed as to the status of all Hazardous Material on the Project Site and disposal of all Hazardous Material from the Project Site.

2.6.2 Environmental Releases.

(a) If Contractor or any of its Subcontractors releases any Hazardous Material on, at, or from the Project Site, or becomes aware of any Person who has stored, released or disposed of Hazardous Material on, at, or from the Project Site during the Work, Contractor shall notify Owner in writing within one hour of becoming aware of such circumstance. If Contractor's Work is involved in the area where such release occurred, Contractor shall immediately stop any Work affecting the area.

(b) Contractor shall, at its sole cost and expense, diligently proceed to take all necessary and desirable remedial action to clean up and remediate fully and dispose of, in accordance with Applicable Laws and to Owner's reasonable satisfaction, any contamination caused by (i) any negligent release by Contractor or any of its Subcontractors of any Pre-Existing Hazardous Material (the Parties agree that simply discovering any Pre-Existing Hazardous Material or accidentally disturbing previously unknown Pre-Existing Hazardous Material is not a negligent release of such Pre-Existing Hazardous Material, but that Contractor will act reasonably and prudently with respect to same upon discovery), and (ii) any Hazardous Material that was brought onto or generated at the Project Site by Contractor or any of its Subcontractors, whether on or off the Project Site.

(c) If Contractor discovers any Pre-Existing Hazardous Material that has been stored, released or disposed of at the Project Site, Contractor shall immediately notify Owner in writing. If Contractor's Work involves the area where such a discovery was made, Contractor shall immediately stop any Work affecting the area and Owner shall determine a reasonable course of action. Contractor will not thereafter resume performance of the Work in the affected area except with the prior written permission of Owner. If and when Contractor is instructed to resume performance of the Work (after disposal or other decision by Owner regarding treatment of such Hazardous Substance), Contractor will be entitled to a Change Order as set forth in Section 9.5.1(e). Contractor shall not, and shall cause its Subcontractors to not, take any action that may exacerbate any such contamination.

(d) In addition to Contractor's obligations as set forth above, if Owner desires Contractor to perform all or part of any clean up or remediation that may become necessary as a result of the discovery of any such Pre-Existing Hazardous Material as described in Section 2.6.2(c) above, the clean up and remediation of which is not the responsibility of Contractor as set forth in Section 2.6.2(b)(i) above, it shall request a Change Order pursuant to Section 9.2. Further, if so requested by Owner, Contractor shall cooperate with and assist Owner in making the Project Site available for taking necessary remedial steps to clean-up/remediate any such contamination at Owner's expense as determined in accordance with Article IX; provided, however, that under no circumstances shall Contractor be required to participate in such clean-up/remediation of a Pre-Existing Hazardous Material if such release is not the responsibility of Contractor as set forth in Section 2.6.2(b)(i) above.

2.6.3 Recordkeeping. Contractor shall minimize the use of Hazardous Materials in performance of the Work and shall not utilize, or permit or cause any Subcontractor to utilize, such Hazardous Materials as are prohibited under Applicable Laws from being imported into or used in the United States. Contractor shall maintain an updated file of all safety data sheets for all Hazardous Materials used in connection with performance of the Work or at or near the Project Site or at any construction area related to the Project and shall update such file at least

monthly and make it available on site in accordance with Applicable Law. Contractor shall maintain an accurate record and current inventory of all Hazardous Materials used in performance of the Work on at or near the Project Site or at any construction area related to the Project and the record shall identify quantities, location of storage, use and final disposition of such Hazardous Materials.

2.6.4 Owner's Self-Help Rights. If Contractor fails or refuses to remove from the Project Site (or any areas adjacent thereto or any other areas where Contractor performs the Work) or properly dispose of such Hazardous Materials as required pursuant to Section 2.7, Owner may, after providing Contractor with reasonable notice and opportunity to cure, at its discretion perform such removal or disposal as it may deem to be reasonably necessary or appropriate and charge Contractor with the full cost of performing such work either directly or by offset of such cost from any payment then or thereafter due to Contractor. The taking of any action by Owner in connection with the removal or disposal of such Hazardous Materials shall not relieve Contractor of its obligations under this Agreement and any Applicable Laws or Applicable Permits.

2.7 Owner's Right to Inspect; Correction of Defects.

2.7.1 Right to Inspect. Owner and its representatives shall have the right to inspect the Work and Contractor's records of inspections and quality control/quality assurance and shall have the right to maintain Personnel at the Project Site for such purpose. Owner shall have the right to communicate with any and all Subcontractors in connection with its inspection of the Work. Contractor shall use commercially reasonable efforts to include rights in all Subcontracts to permit Owner and any of their authorized representatives to audit, inspect, test and observe the Equipment at the facilities of any Subcontractor and the manufacturer of Equipment, and, if permitted, Contractor shall ensure reasonable, adequate and safe access to such facilities for such purposes, subject to any reasonable safety rules or restrictions imposed by such Subcontractor. If any portion of the Work should be covered contrary to the timely request of Owner or contrary to requirements specifically expressed in the Agreement, such portion of the Work shall, if requested by Owner, be uncovered for observation and shall be replaced at Contractor's expense. If any other portion of the Work has been covered which Owner has not specifically requested to observe prior to being covered, Owner may request to see such Work and Contractor shall uncover it. If such other portion of the Work is found not to be in accordance with the requirements of this Agreement, the cost of uncovering, replacement and re-covering shall be charged to Contractor. If such other portion of the Work is found to be in accordance with the requirements of this Agreement, Owner shall pay such costs pursuant to an appropriate Change Order in accordance with Article IX. Such inspection of any part of the Work shall in no way relieve Contractor of its obligation to perform the Work in accordance with this Agreement. If Contractor covers any portion of the Work after offering Owner the opportunity to inspect, then if Owner later requests Contractor to uncover such Work then Owner shall pay the costs to uncover unless such Work is found to contain a Defect.

2.7.2 Correction of Defects. Contractor shall, at its own cost and expense, correct or replace any Work that contains a Defect, or is not otherwise in compliance with the terms and requirements of the Agreement. Defective Equipment that has been replaced, if situated on the Project Site, shall be removed by Contractor at Contractor's sole cost and

expense. If Contractor fails within a reasonable period of time, not to exceed ten (10) Business Days after it knows of such Defect or noncompliance or neglects to commence and continue correction of such Defect or noncompliance with diligence and promptness, Owner may upon notice to Contractor, without prejudice to other remedies Owner may have under the Agreement, correct such Defect or noncompliance. In such event, an appropriate Change Order shall be issued deducting from payments then or thereafter due to Contractor the cost of correcting such Defect or noncompliance, including compensation for the costs to enforce this provision (including attorneys' fees) and any consultant's additional services and expenses made necessary by such neglect or failure. If payments then or thereafter due to Contractor are not sufficient to cover such amounts, Contractor shall pay the difference to Owner within ten (10) Business Days from Owner's request.

2.8 Inspection Not Approval. Owner will not be responsible for and will not have control over or charge of construction means, methods, techniques, sequences or procedures, or for safety precautions and programs in connection with the Work, and Owner will not be responsible for Contractor's failure to carry out the Work in accordance with this Agreement. Owner will not be responsible for or have control or charge over the acts or omissions of Contractor, any Subcontractor, or any of their agents or employees. No inspection made, failure to inspect, acceptance of Work, payment of money or approval given by Owner shall relieve Contractor of its obligations for the proper performance of the Work in accordance with the terms hereof. Owner may reject any Work with Defects or which is not in accordance with the requirements of the Agreement, regardless of the stage of completion, the time or place of discovery of error, and whether Owner previously accepted any or all of such Work through oversight or otherwise, except to the extent such discovery occurs after expiration of the Warranty Period. No approval given by Owner, in and of itself, shall be considered as an assumption of risk or liability by any such Person. Any such approval shall mean that the Person giving the approval has no objection to the adoption or use by Contractor of the matter approved at Contractor's own risk and responsibility. Contractor shall have no claim relating to any such matter approved, including any claims relating to the failure or inefficiency of any method approved.

2.9 Liens. Provided that Owner has paid Contractor in accordance with the requirements of this Agreement, Contractor shall, at Contractor's sole expense, discharge and cause to be released, whether by payment or posting of an appropriate surety bond in accordance with Applicable Law, within ten (10) days after receipt of a written demand from Owner, any Lien in respect to the Work, the Equipment, the Project Site, or any fixtures or personal property included in the Work (whether or not any such Lien is valid or enforceable) created by, through or under, or as a result of any act or omission (or alleged act or omission) of, Contractor or any Subcontractor, or other Person providing services or materials within the scope of Contractor's Work. Upon the failure of Contractor to promptly discharge or cause to be released any Lien as required by this Section 2.9, within ten (10) days after notice to Contractor, Owner may, but shall not be obligated to, pay, discharge or obtain a surety bond for such Lien and, upon such payment, discharge or posting of surety bond therefore, shall be entitled to immediately recover from Contractor the amount thereof together with all expenses incurred by Owner in connection with such payment, discharge or posting, or set off all such amounts against any sums owed by Owner to Contractor. Contractor shall notify Owner of the filing of any Lien against the Project, the Equipment, the Project Site, or any fixtures or personal property included in the Work

promptly upon learning of the existence or filing of such Lien. Acceptance by Contractor of the final payment shall constitute a release by Contractor of Owner, Affiliates and every officer and agent thereof from all Liens (whether statutory or otherwise and including mechanics' or suppliers' Liens), claims and liability hereunder with respect to any Work performed or furnished in connection with this Agreement, or for any act or omission of Owner or of any Person relating to or affecting this Agreement, except claims for which Contractor has delivered a dispute notice to Owner. No payment by Owner shall be deemed a waiver by Owner of any obligation of Contractor under this Agreement.

2.10 Cooperation.

2.10.1 Contractor shall be responsible for coordinating work on the Project Site. Owner shall use commercially reasonable efforts to cause all Other Owner Contractors and Equipment Provider to comply with the reasonable coordination requirements imposed by Contractor, which coordination shall be intended to optimize completion of construction of the Project in a timely manner.

2.10.2 Contractor shall cooperate with Owner in connection with Owner's efforts to obtain the approvals, certificates, financing and Owner Permits for the Project.

2.10.3 Contractor acknowledges that work may be performed by others at the Project Site during the execution of Work. Contractor further acknowledges that Owner, through itself or through its employees, Subcontractors or agents, may continue to work and perform activities in connection therewith at and around the Project Site during the execution of the Work. Contractor shall cooperate and cause its Subcontractors, and Owner shall use commercially reasonable efforts to cause the Other Owner Contractors to cooperate with Contractor, to assure that no Party unreasonably hinders or increases, or makes more difficult than necessary the work being done by the other Parties. Contractor shall perform the Work in full cooperation with such others (provided the Other Owner Contractors reasonably cooperate with Contractor) and to permit, without charge, reasonable access to, and use of, the Project Site, by others or by Owner, when such access or use is necessary for the performance and completion of the work of others.

2.10.4 All material and labor shall be furnished, and the Work performed, will be properly coordinated and completed in accordance with the applicable schedules and the times of completion required by the Agreement with priority given in all instances to activities necessary to achieve Key Milestones in accordance with the Project Schedule, subject to Contractor's right to a Change Order in the event of a Force Majeure Event or Owner-Caused Delay.

2.10.5 Contractor shall use reasonable efforts, and cause its Subcontractors to use their reasonable efforts, to assist Owner in creating, assessing and carrying out programs which shall, during all phases of the Work, minimize the impacts upon the Project Site caused by the Work. To the extent they do not materially adversely affect costs or the achievement of Key Milestones on or prior to the scheduled completion dates for such Key Milestones, as set forth in the Project Schedule, such programs shall include: (i) minimizing the impacts of noise and dust at and around the Project Site; and (ii) using local Labor and other resources whenever possible, to the extent such Labor is qualified and cost competitive.

2.11 Intellectual Property Rights. Contractor shall obtain and, to the extent described below, maintain all trade secrets, patents, copyrights, trademarks, proprietary rights or information, licenses or other intellectual property rights (collectively, the "Intellectual Property Rights") necessary for performance of the Work and the operation and maintenance of the Project. Contractor hereby grants to Owner an irrevocable, non-exclusive, perpetual, royalty-free license under all Intellectual Property Rights whether now existing or developed for the Work, now or hereafter owned, licensed to or controlled by Contractor or any of its Affiliates, to use the same to the extent necessary for the ownership, completion, operation, maintenance, repair, rebuilding, alteration and expansion of the Work (provided such alteration or expansion is within the Scope of Work for this Project) and all subsystems and components thereof. To the extent that the license granted to Owner above is predicated upon Intellectual Property Rights held by Contractor, Contractor will maintain those Intellectual Property Rights throughout the life of the Project.

2.12 Credit Support.

2.12.1 Within thirty (30) Days following the Effective Date, but in any case no later than the date on which Notice to Proceed is issued and as a condition on Owner's obligation to make any payment hereunder, Contractor shall furnish to Owner the following forms of credit support to secure its obligations hereunder:

(a) a Letter of Credit with a total drawable amount ("face amount") equal to _____ Dollars ($_____) ***[$200/kW of nameplate capacity]***;

(b) a Payment and Performance Bond with a penal sum not less than twenty-five percent (25%) of the Contract Price in substantially in the form set forth in Exhibit P-3 (the "Payment and Performance Bond"); and

(c) a guaranty from Contractor's ultimate parent company ("Guarantor") with a limitation of liability of not less than the Contract Price (the "Parent Guaranty") substantially in the form set forth in Exhibit P-4.

The Payment and Performance Bond may be issued by one or more sureties, provided that each one is jointly and severally liable under the Payment and Performance Bond. Each such surety must be an admitted insurer in the State of Oregon and be duly licensed or authorized in Oregon to issue bonds for the limits so required. If a surety on the Payment and Performance Bond is declared bankrupt or becomes insolvent or its right to do business is terminated in the State of Oregon, Contractor shall within seven (7) days thereafter substitute another surety (and new Payment and Performance Bond, if requested by Owner), which must be acceptable to Owner and meet the requirements of this Section 2.12. The Parent Guaranty shall remain in place until the expiration of the Warranty Period. Contractor shall not be entitled to any increase in the Contract Price for the provision of the Letter of Credit, the Payment and Performance Bond or the Parent Guaranty.

2.13 Financial Reports. If Guarantor or Contractor is not legally required to file quarterly and annual financial reports with the Securities and Exchange Commission, then it shall furnish to Owner:

2.13.1 as soon as available, but in any event within 45 days after the end of each calendar quarter, a consolidated and consolidating balance sheet and income statement covering its operations during such period, in a form reasonably acceptable to Owner and certified by its chief executive officer, chief financial officer, or treasurer; and

2.13.2 within 120 days after the end of each fiscal year, audited financial statements, together with an opinion that is unqualified on such financial statements of an independent certified public accounting firm of national standing.

All such financial statements shall be complete and correct in all material respects, shall include accompanying notes and schedules, and shall be prepared in reasonable detail and in accordance with generally accepted accounting principles applied consistently throughout the periods reflected therein and with prior periods.

## ARTICLE III

## SUBCONTRACTORS

3.1 Subcontractors. Owner acknowledges that Contractor intends to have portions of the Work accomplished by Subcontractors qualified to perform such Work pursuant to written subcontracts between Contractor and such Subcontractors. Exhibit I-1 sets forth a list of approved Major Subcontractors. Owner agrees to Contractor's use and engagement of Subcontractors; provided Contractor may not enter into any Major Subcontract with any Person not listed in Exhibit I-1 or approved by Owner in writing (which approval shall not be unreasonably conditioned, withheld or delayed). Except as otherwise expressly provided in the Agreement, Contractor shall be solely responsible for engaging, managing, supervising and paying all Subcontractors and Persons directly or indirectly employed by them; provided, however, that Owner shall have the right to communicate with Subcontractors and their personnel in connection with the Work and Owner's rights and obligations under this Agreement. Contractor shall require that all Work performed and all Equipment provided by Subcontractors be received, inspected and otherwise furnished in accordance with the Agreement. Contractor shall be solely liable for all acts, omissions, liabilities and Work (including Defects therein) of its Subcontractors and whenever this Agreement refers to the negligence, fault or omission of Contractor, it shall include the negligence, fault or omission of Contractor's employees, Subcontractors and their agents and employees, and other persons performing portions of the Work under a contract with Contractor.

3.2 Subcontracts. All contracts with Subcontractors shall be consistent with the terms and provisions of the Agreement. At a minimum, all subcontracts shall require the Subcontractors to comply with Applicable Laws, and shall provide that Owner has the right of inspection and communication with Subcontractors as provided hereunder and require such Subcontractors to (a) be subject to the Labor obligations hereunder as well as the safety and security provisions of the Agreement, (b) provide guarantees and warranties with respect to its portion of the Work and the Equipment and (c) obtain, maintain and keep in force throughout the time during which they are engaged by Contractor such insurance coverages as are required of Contractor under this Agreement. All subcontracts shall preserve and protect the rights of Owner, shall not prejudice such rights and shall require each Subcontractor to use reasonable

efforts to enter into similar agreements with other Subcontractors. All subcontracts shall require payment to Subcontractors within no less than thirty (30) calendar days of submission of a valid invoice and associated lien waivers for work performed or materials or equipment supplied in accordance with the terms of the subcontract. Contractor shall require and shall cause all Subcontractors to perform their portions of the Work in accordance with the requirements of this Agreement. Contractor shall ensure that Contractor's rights and obligations under each Subcontract may be, without requiring the prior consent of the relevant Subcontractor, in whole or in part, assigned and delegated by Contractor to Owner. Each Subcontract shall provide that upon notification to the Subcontractor from Owner, that: (a) the Agreement has been terminated; (b) Contractor's right to proceed with the Work has been terminated; and (c) Owner will thereafter be assuming Contractor's obligations under such Subcontract, then such Subcontractor shall continue to perform its responsibilities under such Subcontract for the benefit of Owner and shall recognize Owner as being vested with all the rights and responsibilities of Contractor under such Subcontract (other than obligations, including payment obligations, arising or relating to prior to the date of the notice, which shall remain the responsibility of the Contractor). Notwithstanding the foregoing, it is specifically understood and agreed (and each Subcontract shall clarify) that no such assignment shall release Contractor from any liability hereunder, and no Subcontractor shall have any right to look to Owner for the performance of Contractor's obligations under any Subcontract unless and until such Subcontractor has received such notice from Owner. Each Major Subcontract shall require the Subcontractor to execute an acknowledgment of, and agreement to, the provisions of this Section 3.2. Contractor will deliver to Owner a copy of each such executed acknowledgment and agreement within forty-eight (48) hours after each Subcontractor's execution of its Subcontract.

3.3 Owner as Third Party Beneficiary. No Subcontractor is intended to be nor shall it be deemed a third party beneficiary of this Agreement. Nothing contained herein shall obligate Owner to pay any Subcontractor and Contractor shall be solely responsible for paying each Subcontractor in accordance with the applicable Subcontract or purchase order between Contractor and the Subcontractor; provided, however, each agreement between Contractor and a Subcontractor with respect to the Work shall name Owner as an intended third party beneficiary.

3.4 Subcontractor Payments. Contractor shall pay all Subcontractors in accordance with the requirements of the applicable subcontracts, provided that in all cases, Contractor shall pay Subcontractors within thirty (30) days after Subcontractor has completed its work on the Project. On a no less than monthly basis, Contractor shall provide Owner with all reasonably requested documentation to evidence its compliance with the preceding sentence.

3.5 Subcontractor Warranties. Without in any way derogating Contractor's representations and warranties and other testing requirements and guarantees set forth herein with respect to all of the Work, Contractor will require all Subcontractors to provide product and service warranties at a minimum equal to the Warranties in Article VII. Contractor shall use reasonable efforts to obtain from all Subcontractors any representations, warranties, guarantees, and obligations offered by such Subcontractors and to negotiate the longest reasonably practicable warranty periods at no additional cost with respect to design, materials, workmanship, Equipment, tools, supplies, and other items furnished by such Subcontractors. Contractor shall assign all representations, warranties, guarantees, and obligations of all Subcontractors at the request and direction of Owner, and without recourse to Contractor, to

Owner upon default by Contractor or termination or expiration of this Agreement; provided, however, that, notwithstanding such assignment, Contractor shall be entitled to enforce each such representation, warranty, guaranty, and obligation so long as Contractor has any liability under this Agreement. To the extent assignable, Contractor hereby assigns to Owner, effective as of the end of the Warranty Period for the Project, all representations, warranties, guaranties and obligations of all Subcontractors.

## ARTICLE IV

## CONTRACT PRICE

4.1 Contract Price. As full consideration to Contractor for the complete performance of the Work and Contractor's other covenants in this Agreement, Owner will, subject to the provisions of this Article IV and the Schedule of Values attached hereto as Exhibit B-1, pay Contractor [ _____] Dollars ($_____ ) (the "Contract Price"). The Contract Price may be adjusted only pursuant to a Change Order issued in accordance with the provisions of Article IX. Subject to the terms and conditions of this Article IV, the Contract Price shall be paid by Owner to Contractor, in accordance with the requirements set forth in the Agreement, by way of the milestone payments set forth in the Payment Schedule attached hereto as Exhibit B-2.

4.2 Taxes.

4.2.1 Contractor's Taxes.

(a) Contractor shall be responsible for all taxes, transportation fees, freight, packing costs, custom duties, personnel fees and all other costs associated with the performance of the Work and any other of its duties and responsibilities under this Agreement, unless otherwise stated in this Agreement (collectively "Contractor's Taxes"). The Parties agree that the Contract Price, as stated in Section 4.1, includes all Contractor's Taxes, excluding materials that are tax exempt under Applicable Law.

(b) To the extent Owner indicates to Contractor that it will obtain an exemption which is thereby factored into the original Contract Price and Contractor complies with Owner's reasonable instructions for implementing such exemption for purposes of avoiding payment of sales and use taxes to Subcontractors or Suppliers for goods and services subject to such exemption, then Owner shall reimburse Contractor for the amount of any sales or use taxes that Contractor is required to pay, to the extent excluded from the original Contract Price, notwithstanding the applicability of such exemption; provided, however, Contractor shall procure and provide to Owner such documents evidencing payment of such taxes as Owner may be reasonably required to enable Owner to obtain a refund of such paid taxes.

(c) At any time and from time to time upon Owner's reasonable request, Contractor will allow Owner and its designees the opportunity to review all purchases by Contractor and its Subcontractors (and will in this regard provide all relevant information regarding the same (including separate break-out pricing for goods and services, if reasonably

available)) for the purpose of determining whether such exemptions or rebates apply and have been or should have been granted.

(i) If Owner directs Contractor to seek an exemption or rebate and Contractor fails to seek such exemption or rebate for an item, Owner will be relieved of its obligation under Section 4.2.2(a) to reimburse Contractor for the taxes on such item.

(ii) If Contractor seeks exemption or rebate on an item in accordance with the foregoing, but the same is not granted, Owner shall reimburse Contractor for the disallowed amount, and Contractor will assign to Owner its right to seek a refund of, or rebate in connection with, the amount in question and will reasonably cooperate with Owner to seek such refund or rebate. If such assignment is not allowed under Applicable Law, then Contractor will, at Owner's direction and expense, seek such refund and, if received, pay over such refund to Owner, and all costs of seeking a refund or appealing the denial of an exemption, refund or rebate shall be borne by Owner.

(iii) Any rebates received by Contractor or its Subcontractors in connection with any Contractor's Taxes reimbursed by Owner under Section 4.2.2 from the purchase of any materials, supplies or equipment in connection with the Work shall be immediately paid over to Owner.

(d) Contractor shall promptly provide Owner with notice of any audits, assessments or challenges by any Governmental Authority with respect to Contractor's Taxes, which are to be reimbursed by Owner. In the event of any such audit, assessment or challenge, Owner shall have the right to receive copies of all correspondence and documents relating thereto, to attend and participate in all meetings with the Governmental Authority and to participate in and control all mediation, and litigation related thereto, provided the cost thereof is borne by Owner and Owner indemnifies, defends and holds Contractor harmless with respect thereto.

(e) To the extent Owner is obligated under Applicable Laws to pay any of Contractor's Taxes, Contractor shall: (i) furnish to Owner all information and reports required to be furnished to the appropriate taxing authorities in connection with all such Contractor's Taxes; and (ii) reimburse Owner for the full amount of such Contractor's Taxes paid by Owner that are not otherwise required to be reimbursed by Owner to Contractor under Section 4.2.2. Contractor will have no responsibility for property taxes assessed on the Work or the Project Site.

4.2.2 Owner Taxes.

(a) If Contractor is assessed any taxes, for tangible personal property and services purchased for the purpose of and in conjunction with constructing of the Project despite having complied with the requirements of Section 4.2.1, Contractor will invoice Owner for reimbursement of such assessment as part of each applicable Request for Payment, and shall include therewith all documentation necessary to evidence Contractor's and Subcontractor's payment of such taxes. For the avoidance of doubt, Owner will not be responsible: (i) to reimburse Contractor for those Contractor's Taxes as described in Section 4.2.1(a); or (ii) for any

penalties or interest related to non-payment or late payment of any required Contractor's Taxes, unless such non-payment or late payment is due to or caused by the instruction of Owner to Contractor, as provided in Section 4.2.1(c)(ii).

(b) Owner shall administer and pay all sales, use, gross receipts, income, value-added and withholding taxes and duties, and any other similar taxes or contributions (including penalties and interest related to such taxes), imposed by any taxing authority: (i) that are measured by Owner's sale of electricity from the Project; and (ii) upon services or labor provided by Owner or any Other Owner Contractors in connection with the Project (collectively "Owner's Taxes"). Owner shall furnish to the appropriate taxing authorities all required information and reports in connection with all such Owner's Taxes.

(c) To the extent Contractor is legally obligated to pay any of Owner's Taxes, Owner shall: (i) furnish to Contractor all information and reports required to be furnished to the appropriate taxing authorities in connection with all such Owner's Taxes; and (ii) reimburse Contractor for the full amount of such Owner's Taxes paid by Contractor.

4.3 Requests for Payment. Contractor shall, on or before then tenth ($10^{th}$) Business Day of each calendar month, prepare and submit to Owner an application for payment substantially in the form of Exhibit B-3 (each, a "Request for Payment") for the milestone(s) achieved during the prior month, in accordance with the Payment Schedule.

4.4 Retainage.

4.4.1 Retainage. Owner shall withhold, as retainage (the "Retainage") an amount equal to ten percent (10%) of all payments made to Contractor under this Agreement.

4.4.2 Use of Retainage. The Retainage shall be held by Owner as security for the performance of Contractor's obligations hereunder and any interest thereon shall accrue for the account of Owner and not Contractor. The Parties acknowledge that because the Retainage shall constitute security, Owner may utilize the same to, among other things, cure any Contractor Event of Default, offset Delay Liquidated Damages, pay unpaid Contractor suppliers, remove Liens filed by Subcontractors and cover any expenses associated therewith, or offset against any other amounts payable by Contractor to Owner under this Agreement.

4.4.3 Release of Retainage. Within fifteen (15) days after the Project Substantial Completion Date, subject to Section 4.5 Owner shall release to Contactor all cash Retainage, except for a cash amount equal to two hundred percent (200%) of the projected costs to complete any remaining items on the Punch Lists, as such cost is reasonably estimated by Owner. Within fifteen (15) days after the Final Completion Date, Owner shall release the remaining cash Retainage (less any amount utilized by Owner to perform any Punch List items).

4.5 Conditions of Payment. PGE's obligation to may any payment hereunder is conditioned upon the following:

4.5.1 Contractor shall have submitted a Request for Payment to Owner in the form set forth as Exhibit B-3, together with all required documents referenced therein, including, without limitation the following:

(a) written waivers and releases in the form of Exhibit O-1, Exhibit O-2, Exhibit O-3 and Exhibit O-4 (as applicable), duly executed by Contractor and all Major Subcontractors; and

(b) a written certification of an officer of Contractor that (i) the requirements of Sections 4.5.2 through 4.5.5 have been satisfied and (ii) there are no known mechanics' or materialmen's liens or other such claims or encumbrances outstanding from Subcontractors at the date of the Request for Payment, all due and payable bills with respect to the Work have been paid to date or are included in the amount requested in the Request for Payment, and, except for such bills not paid but so included, there is no known basis for the filing of any mechanics' or materialmen's liens on any portion of the Project or the Work, and releases from all Subcontractors have been obtained in such form as to constitute an effective release of lien (corresponding to payments received by them) under the laws of the State of Oregon.

4.5.2 Contractor shall have completed the Work for which payment is sought and have submitted evidence reasonably acceptable to Owner that demonstrates the completion of such Work.

4.5.3 The representations and warranties made by Contractor in this Agreement shall be true and accurate in all respects, both before and after giving effect to the making of the requested payment.

4.5.4 All Contractor Permits required by Applicable Law and this Agreement shall have been obtained and shall be in full force and effect on the requested payment date.

4.5.5 No uncured Contractor Event of Default shall then exist and no material breach, violation or default shall have occurred and be continuing under the Parent Guaranty.

Within forty five (45) Days after its receipt of a Request for Payment, provided Contractor has satisfied the foregoing conditions, Owner shall pay to Contractor the amount that remains after the deduction from the amount requested in the applicable Request for Payment of the following amounts: (a) any portion thereof that Owner in good faith disputes as not being due and owing, (b) any overpayment made by Owner for any previous period, (c) any Delay Liquidated Damages payable by Contractor, (d) any amounts withheld pursuant to Sections 4.6 and 4.8 and (e) any costs incurred by Owner in enforcing any provision hereof (including attorneys' and other consultants' fees) regardless of whether such provisions expressly provide for withholding or set-off. Contractor may only submit one (1) Request for Payment per calendar month.

4.6 Deductions from Payments. Notwithstanding any other provision to the contrary contained herein, Owner may withhold and shall have no obligation to make payments to Contractor hereunder and Owner may decide not to certify payment or may nullify the whole or a part of a certification for payment made pursuant to a previous Request for Payment to such extent as may be reasonably necessary to protect Owner from loss because of (a) Defects in the Work not timely remedied; (b) third-party claims filed against Owner, (c) Liens filed (that have not been bonded off as described in Section 2.9 or are not covered by insurance maintained hereunder); (d) failure of Contractor to make undisputed payments when due to Subcontractors;

(e) damage to Owner or another contractor, including damage to the property of Owner or any of its Affiliates, to the extent the costs of such damages are not covered by insurance maintained hereunder; (f) damages caused by Contractor or its Personnel; (g) Contractor's failure to deliver a recovery plan as set forth in Section 2.5.3 or the failure of Contractor to diligently proceed with the recovery plan; or (h) Contractor's failure to provide information requested by Owner to ensure conformance of the Work to the requirements of this Agreement and Applicable Law or to measure the progress of the Work, as necessary to conform Contractor's entitlement to payment. Contractor shall not have any rights of termination or suspension hereunder as a result of Owner's exercise or attempted exercise of its rights under this Section 4.6. Owner shall release payments withheld pursuant to this Section 4.6 within thirty (30) days from the date when Contractor cures all such events or breaches to the reasonable satisfaction of Owner. If there is any dispute about any amount invoiced by Contractor, the amount not in dispute shall be promptly paid.

4.7 Effect of Payment. Payment of the Contract Price shall not constitute Owner's approval of any portion of the Project or the Work which has been determined not to be, or subsequently is determined not to have been, performed in accordance with the requirements of this Agreement.

4.8 Set off. Owner may deduct and set off against any part of the balance due or to become due to Contractor under this Agreement or against any Retainage (a) any Delay Liquidated Damages due or accrued but not paid from Contractor to Owner hereunder that are not then the subject of dispute resolution under Section 14.2, or (b) any other amounts that are due from Contractor to Owner under or in connection with this Agreement.

4.9 No Payment if Default. Notwithstanding any other provision to the contrary contained herein, Owner shall have no obligation to make any payment to Contractor at any time when a Contractor Event of Default has occurred and is continuing.

4.10 Interest. Any sums not timely paid shall accrue interest at Prime Rate plus two percent (2%) from the date due until paid.

## ARTICLE V

## OWNER RESPONSIBILITIES

In addition to Owner's other duties and responsibilities under and pursuant to this Agreement, Owner shall have the following general obligations and responsibilities:

5.1 Project Site Access. As required by Project Schedule, Owner shall provide access to the Project Site to Contractor, Subcontractors and their Personnel as necessary to perform the Work.

5.2 Permits. Owner shall, with Contractor's reasonable assistance, timely obtain and maintain, at its own cost and expense, all Owner Permits, copies of which shall be delivered to Contractor upon its request. In addition, Owner shall execute such applications as Contractor may reasonably request in connection with obtaining any of Contractor Permits.

## ARTICLE VI

## STAGES OF COMPLETION OF THE WORK

6.1 Work Completion. Contractor shall complete the Work in strict compliance with the Project Schedule and shall certify completion of such portions of the work in accordance with the process required in Exhibit Q (Form of Work Completion Certificates).

6.1.1 Commencement of Construction Liquidated Damages. Owner and Contractor acknowledge and agree that any failure of Contractor to Commence Construction (as such term is defined in the US Tax Code) to occur on or before _____will directly cause substantial damage to Owner, which damage cannot be ascertained with reasonable certainty. Thus, if such failure occurs, Contractor shall pay to Owner, as liquidated and agreed damages and not as a penalty, the following amounts (collectively, "Commencement of Construction Liquidated Damages"). ***[To be discussed depending on technology and Bidder's tax credit assumptions.]***

6.1.2 Substantial Completion Delay Liquidated Damages. Owner and Contractor acknowledge and agree that any failure of Contractor to cause Project Substantial Completion to occur by the applicable Guaranteed Substantial Completion Date will directly cause substantial damage to Owner, which damage cannot be ascertained with reasonable certainty. Thus, if such failure occurs, Contractor shall pay to Owner, as liquidated and agreed damages and not as a penalty, the following amounts (collectively, "Substantial Completion Liquidated Damages"):

| **Days that Project Substantial Completion is Delayed Beyond Guaranteed Substantial Completion Date** | **Substantial Completion Liquidated Damages** |
|---|---|
| Day 1 to Day ___ | $_____ per Day |
| Day ___ and beyond. | $_____ per Day |

6.1.3 Contractor shall not be relieved from the obligation to meet the Guaranteed Substantial Completion Dates except to the extent any such date is extended pursuant to a Change Order or a written notice from Owner.

6.2 Project Mechanical Completion. *[Definition to be determined by Bidder's technology, Certificate of Mechanical Completion and Mechanical Completion Checklist in Exhibits.]*

6.3 Project Substantial Completion.

6.3.1 Conditions of Project Substantial Completion. "Project Substantial Completion" shall be achieved when each of the following conditions has been satisfied:

(a) all Equipment comprising the Project has been installed as required;

(b) the Project has been connected to and synchronized with the Grid, and is capable of operating as a fully-integrated electricity generating plant that safely and continuously generates electric power in accordance with the requirements of all Applicable Laws and this Agreement;

(c) Contractor and Owner have agreed upon the Final Punch List for all Work, as described in Section 6.4.1;

(d) Contractor has fully completed all Work (including all Work on or comprising all remaining Project for the Project), except those items on the agreed upon the Final Punch List;

(e) any Defects found have been corrected;

(f) Contractor (i) has demonstrated through Performance Testing in accordance with Exhibit C-3 that the Project has achieved the Performance Guarantee in accordance with Exhibit C-4, or (ii) has demonstrated through Performance Testing results in accordance with Exhibit C-3 that the Project has not achieved the Performance Guarantee and that Contractor has paid all applicable Performance Liquidated Damages accordance with Exhibit C-4.

(g) Contractor has provided Owner with copies of all Contractor Permits;

(h) all Spare Parts requested by Owner under Section 2.3.10 have been delivered by Contractor to the Project Site in accordance with Section 2.3.10; provided that any Spare Parts requested by Owner within two (2) weeks prior to the date of submittal of the Project Substantial Completion Certificate which have not been delivered by such date will be added to the Final Punch List;

(i) Contractor has paid all Delay Liquidated Damages due under this Agreement, if any;

(j) Contractor has delivered to Owner copies of all test reports and electrical schematics related to the Work;

(k) Contractor has delivered draft copies of the Operating Manual and Job Books in accordance with Sections 2.3.11(a) and (b);

(l) Contractor has delivered to Owner all interim progress payment or final, as the case may be, waivers of mechanic's and materialman's Liens from all Subcontractors for Work completed through such date; and

(m) Owner has confirmed or is deemed to have confirmed in writing that the conditions set forth hereinabove have occurred, pursuant to Section 6.3.2.

6.3.2 Confirmation of Project Substantial Completion. When Contractor believes it has satisfied all of the requirements for Project Substantial Completion, Contractor shall notify Owner in writing. Within five (5) Business Days of receipt of such notice, Owner shall notify Contractor in writing whether Owner agrees that Contractor has fulfilled the requirements of Project Substantial Completion. If Owner believes Contractor has not fulfilled such requirements, Owner shall specify in such notice to Contractor in reasonable detail the reasons that such requirements have not been met. Contractor shall promptly act to correct such deficiencies so as to achieve Project Substantial Completion as soon as practicable. Following any such remedial action, Contractor shall deliver to Owner a new notice and the provisions of this Section 6.3.2 shall apply with respect to such new notice in the same manner as they applied to the original notice. If Owner fails to respond within seven (7) Business Days to the Project Substantial Completion Certificate provided by Contractor, Project Substantial Completion shall be deemed to have been achieved; provided, however, such deemed Project Substantial Completion shall not relieve Contractor from any of its obligations hereunder, including Contractor's obligations to achieve Project Substantial Completion. For all purposes of this Agreement, Project Substantial Completion Date shall be the date the Project Substantial Certificate is ultimately accepted by Owner or, if applicable, deemed accepted by Owner.

6.4 Punch List for Project.

6.4.1 Development of Punch List. Prior to submittal of the initial Project Substantial Completion Certificate, Contractor will prepare and deliver to Owner a written list setting forth all of the items that remain to be performed in order to complete the Work, provided such items of Work on such list shall only be items that are (i) minor in nature, (ii) not related to the functionality, utility, operation or restoration of Work, (iii) not related to the compliance of any such Work with any Applicable Laws or Applicable Permits, and (iv) not related to the correction of Defects. Such list shall also state the proposed time limits within which Contractor will complete each of such remaining Work items. Upon its receipt of such list, Owner will reasonably review the same and notify Contractor of any proposed revisions thereto. Owner's Project Manager and Contractor's Project Manager will then meet and consult in good faith to agree upon the definitive, final version of such list (including the approved time limits within which Contractor will perform such remaining Work items) (such final list, as agreed to by Owner, the "Final Punch List").

6.4.2 Completion of Punch List Items. Once any Punch List hereunder is agreed upon, Contractor will promptly begin the items thereon. Contractor's Work on such Punch Lists shall be performed in a manner that does not unreasonably interfere with the commercial operation of the Project. Owner will provide Contractor with reasonable access to the Project Site so that Contractor may perform the Work on the Punch Lists.

6.5 Final Completion.

6.5.1 Conditions of Final Completion. "Final Completion" will be achieved when each of the following conditions has been met:

(a) Project Substantial Completion has occurred;

(b) Contractor has completed performance of all of the Work, including all Punch List items, except for those items that Owner and Contractor agree are to be completed by Owner (and Contractor has paid all amounts due Owner in connection therewith);

(c) Owner has received a final list and summary of the work performed by all Subcontractors and verification of the payment thereof;

(d) Contractor has provided to Owner all Lien releases as required under Section 4.5 (provided that Contractor's Final Lien Waiver and Release, in substantially the form of Exhibit O-3 attached hereto from Contractor and Subcontractor's Final Lien Waiver and Release in the form of Exhibit O-4 attached hereto from each Major Subcontractor, shall be given concurrently with Final Completion and payment of amounts due by Owner in connection therewith);

(e) all documentation, including data points and redlines, as necessary to accurately reflect the Project as constructed in the As-Built Drawings shall have been delivered to, and accepted by, Owner;

(f) all sets of the final Operating Manuals and final Job Books have been delivered to Owner as required under Section 2.3.11; and

(g) Owner has confirmed or is deemed to have confirmed in writing that the conditions set forth hereinabove have occurred, pursuant to Section 6.5.2.

6.5.2 Confirmation of Final Completion. When Contractor believes that it has satisfied all of the requirements for Final Completion, Contractor shall notify Owner in writing. Within five (5) Business Days of receipt of such notice, Owner shall notify Contractor in writing whether Owner agrees Contractor has fulfilled the requirements of Final Completion. If Owner believes Contractor has not fulfilled such requirements, Owner shall specify in such notice to Contractor in reasonable detail the reasons that such requirements have not been met. Contractor shall promptly act to correct such deficiencies so as to achieve Final Completion as soon as practicable. Following any such remedial action, Contractor shall deliver to Owner a new notice and the provisions of this Section 6.5.2 shall apply with respect to such new notice in the same manner as they applied to the original notice. If Owner fails to respond within five (5) Business Days to the Final Completion Certificate provided by Contractor, Contractor shall provide a second Final Completion Certificate, which will include a reference to the previously provided certificate and a statement to the effect that failure to respond to such second certificate shall result in Final Completion being deemed to have been achieved. If Owner fails to respond to the second Final Completion Certificate within seven (7) Business Days following receipt of such second certificate, Final Completion shall be deemed to have been achieved; provided, however, such deemed Final Completion shall not relieve Contractor from any of its obligations hereunder, including Contractor's obligations to achieve Final Completion. For all purposes of this Agreement, the date of achievement of Final Completion shall be the date the on which the relevant completion notice accepted by Owner or, if applicable, deemed accepted by Owner.

6.6 Reasonable Amount; Exclusive Remedy. The Parties agree that the sum of the amounts fixed as Construction Commencement Liquidated Damages and Substantial Completion

Liquidated Damages ("Delay Liquidated Damages") are fair and reasonable, considering the damages that Owner would sustain in the described event, and that these amounts are agreed upon and fixed as liquidated damages because of the difficulty of ascertaining the exact amount of damages that would be sustained. Except as set forth in Article XII, collection of Delay Liquidated Damages shall constitute Owner's exclusive remedy and Contractor's exclusive liability for Contractor's failure to cause, as applicable, Project Substantial Completion to occur by the Guaranteed Substantial Completion Date, as such date may be extended by any executed Change Order. The foregoing sentence shall not relieve Contractor from its obligations (nor limit Owner's ability to seek other available remedies in connection with Contractor's failure to comply with its obligations) to perform the Work in accordance with this Agreement or from its Warranty or other obligations under this Agreement.

6.6.1 Limitation of Liability for Delay Liquidated Damages. Contractor's aggregate liability for Delay Liquidated Damages shall not exceed an amount equal to _____percent (___ %) of the Contract Price.

6.6.2 Offset Rights; Security for Obligations. Owner shall have the right to offset any amounts owing to Owner under this Article VI against payments or other amounts owing to Contractor and to exercise its rights against any security provided by or for the benefit of Contractor, in such order as Owner may elect in its sole discretion.

## ARTICLE VII

## WARRANTIES

7.1 Warranty Provisions.

7.1.1 Warranty. As the "Warranty," Contractor warrants to Owner that: (a) all Equipment and Spare Parts shall be new, unused and undamaged when installed, (b) all such Equipment, Spare Parts and all Work shall (i) be free from Defects, (ii) conform to all applicable requirements of all Applicable Laws, Applicable Standards and the Agreement and (iii) be in strict compliance with the Scope of Work; (c) the services comprising the Work will be performed with Contractor's best skill and judgment in a good and workmanlike manner; (d) the Work will conform to, and be performed in accordance with, all Applicable Laws, Prudent Industry Practices, and the other terms and requirements of the Agreement; and (e) none of the Work and other services rendered by or through Contractor hereunder, nor the use of the Work by Owner, nor any license granted hereunder, infringes, violates or constitutes a misappropriation of any Intellectual Property Rights.

7.1.2 Warranty Period; Extensions. The Warranty shall commence on the Project Substantial Completion Date and shall continue for a period of ____ (__) years after Project Substantial Completion Date (the "Warranty Period"); *provided*, *however*, that if any component of the Work is repaired or replaced pursuant to the Warranty Service, then the Warranty Period with respect to such component shall be continued for a period that is the longer of (a) the remainder of the original Warranty Period, or (b) one (1) year from the date of completion of the repair or replacement or re-performance thereupon, *provided*, *further*, that if fifteen percent (15%) or more of any type of component of the Work requires repair or

replacement within the Warranty Period, then the Warranty Period for that type of component shall be automatically extended for all such components of that type for an additional one (1) year from the later of (i) the date of expiration of the Warranty Period or (ii) the date of the completion of Warranty Service to correct the failure that caused the percentage of failures to reach fifteen percent (15%). At expiration of the Warranty Period, any unexpired warranties relating to the Work shall be assigned to Owner (and Contractor will promptly execute such documents as may be necessary to cause such assignment to occur).

7.1.3 Correction of Deficiencies. If the Work or Equipment or Spare Part is in breach of any Warranty set forth in this Section 7.1, Contractor shall promptly cure such breach as promptly as practicable upon being given written notice thereof ("Warranty Service"). Owner shall provide Contractor with reasonable access to the Project in order to perform its obligation under this Article VII and the Parties shall schedule such work as necessary so as to minimize disruptions to the operation of the Project. Owner shall have the right to operate and otherwise use the Equipment until such time as Owner deems prudent to suspend such operation or use in order to accommodate Contractor's Warranty Services. If Equipment has been placed in service, Contractor shall perform such Warranty Service as soon as Owner deems it prudent to remove the same from service for any Warranty Service by Contractor; provided that the Warranty Period will continue until Contractor has completed such Warranty Service. Neither payment by Owner, nor any other provision of this Agreement, nor partial or entire use or possession of the Work by Owner shall relieve Contractor of liability with respect to the Warranty contained in this Article VII. Contractor shall bear all costs and expenses directly associated with the Warranty Services, including, all costs of services and equipment and of any necessary disassembly, removal, replacement, transportation, reassembly, reinstallation, and retesting, as well as reworking, repair or replacement of such Work, and reassembly of structures, electrical work, machinery, Equipment, or any other obstruction as necessary to give access to the non-conforming item for correction, and for removal, repair or replacement of any damage to other work or property that arises from the breach of Warranty and any applicable insurance deductibles. Upon completion of Warranty Service, all Equipment shall be returned or restored to its proper condition (subject to normal wear and tear), including but not limited to fit alignment, adjustment, operability and finish. If Contractor is obligated to repair, replace or renew any Equipment, item or portion of the Work hereunder, Contractor will undertake a technical analysis of the problem and correct the "root cause" unless Contractor can demonstrate to Owner's reasonable satisfaction that there is no material risk of the reoccurrence of such problem. Contractor's obligations under this Section 7.1 shall not be impaired or otherwise adversely affected by any actual or possible legal obligation or duty of any vendor or Subcontractor to Contractor or Owner. No correction or cure shall be considered complete until Owner has reviewed and accepted such remedial work. So long as Contractor has been notified of a breach of Warranty prior to the end of the Warranty Period, the obligation of Contractor to provide Warranty Service to correct such noncompliance, Defect or breach of Warranty shall survive the expiration of the Warranty Period.

7.1.4 Conformance of Warranty Service to Warranty. Contractor warrants that all materials incorporated into the Work as part of repairs to and replacements of the Work by Contractor or any Subcontractor, and repairs to and replacements of the Work pursuant to the Warranty Service shall conform to the requirements of this Agreement and the Warranty. Contractor shall perform, at its cost and expense, such tests as Owner may reasonably request to

verify that any correction, repair, replacement or re-performance of the Work pursuant to the Warranty Service complies with the requirements of the Warranty.

7.2 Delay. Contractor shall perform the Warranty Service as promptly as reasonably possible after being notified of the noncompliance by Owner, and in any event shall commence performance of the Warranty Service no later than two (2) Business Days after such notice. If, after notification of a Defect or breach of Warranty, Contractor delays past such date in commencing, or shall fail to continue performing or completing, Warranty Service with respect to such Defect or breach of Warranty, Owner may correct such breach of Warranty so that the Work and Equipment comply with the Warranty after giving Contractor three (3) Business Days written notice, and Contractor shall be liable for all reasonable direct costs, charges and expenses incurred by Owner in connection with the same and shall pay the same to Owner upon receipt of invoices with supporting documentation from Owner. Such correction of a breach of Warranty condition shall be deemed to be Warranty Service performed by Contractor and the Warranty Period for such corrected Work shall be extended in accordance with Section 7.1.2. No correction of a Defect or breach of Warranty pursuant to this Section 7.2 shall void the Warranty.

7.3 Subcontractor Warranties. Contractor shall be responsible for enforcing the warranties of all Subcontractors through the Warranty Period unless Owner requests that any such warranties be assigned to it at an earlier date. At the end of the Warranty Period, Contractor will assign to Owner its rights under any and all such Subcontractor warranties that continue past the end of the Warranty Period, including the Major Equipment Warranties. Contractor will secure such assignment from each Subcontractor, and Contractor will deliver to Owner copies of all Subcontracts providing for warranties enforceable by Owner. Contractor will not, and Contractor will ensure that Contractor's Personnel do not, take any action which could release, void, impair or waive any Subcontractor warranties. Contractor shall provide reasonable assistance to Owner without cost to Contractor in connection with the enforcement by Owner of any Subcontractor warranty after such assignment provided those warranties are in are excess of those set forth in Section 7.1.

7.4 Major Equipment Warranties. The following components of the Project have Equipment warranties from manufacturers or suppliers (the "Major Equipment Warranties"):

7.4.1 [_____], Appendix D-1;

7.4.2 [_____], Appendix D-2;

7.4.3 [_____], Appendix D-3;

7.4.4 [_____], Appendix D-4; and

7.4.5 [_____], Appendix D-5.

7.5 Proprietary Rights. Without limiting any of the provisions of the Agreement and notwithstanding any provision herein to the contrary, if Owner or Contractor is prevented from completing the Work (or any part thereof) in accordance with the Agreement or from the use, operation, repair, maintenance, alteration, expansion, rebuilding or enjoyment of the Work

(or any part thereof) as a result of a claim, action or proceeding by any Person for unauthorized disclosure, infringement or use of Intellectual Property Rights arising from Contractor's performance (or that of its Subcontractors) under the Agreement or any Intellectual Property Right or Contractor Deliverable transferred or licensed to Owner hereunder, Contractor shall promptly, but in no event later than thirty (30) days from the date of any action or proceeding, take all actions necessary to remove such impediment, including (a) secure termination of the injunction and procure for Owner or its assigns, as applicable, the right to use such materials, Equipment or Contractor Deliverable in connection with the completion, repair, operation, maintenance, alteration, rebuilding or expansion of the Work without obligation or liability; or (b) replace such materials, Equipment, or Contractor Deliverable, with a non-infringing equivalent, or modify same to become non-infringing, all at Contractor's sole expense, but subject to all the requirements of the Agreement.

7.6 NO IMPLIED WARRANTIES. THE WARRANTIES SET FORTH IN THIS AGREEMENT ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED. THERE ARE NO OTHER WARRANTIES, AGREEMENTS, ORAL OR WRITTEN, OR UNDERSTANDINGS WHICH EXTEND BEYOND THOSE SET FORTH IN THIS AGREEMENT WITH RESPECT TO THE WARRANTED WORK, MATERIALS AND EQUIPMENT. The foregoing sentence is not intended to disclaim any other obligations of Contractor set forth herein.

7.7 Survival of Warranties. The provisions of this Article VII shall survive the expiration or termination of this Agreement.

## ARTICLE VIII

## FORCE MAJEURE; OWNER-CAUSED DELAYS

8.1 Force Majeure.

8.1.1 Notice. If a Party believes that an event constituting a Force Majeure Event has occurred that has or will prevent or delay the performance of its obligations under this Contract, then such Party shall give the other Party written or electronic notice within ten (10) days after the Party became aware of such event (the "Force Majeure Notice"). The Force Majeure Notice need only be given to the other Party's on-site manager or supervisor (Owner's Project Manager), but shall be in writing or via email. Within thirty (30) Days after the Force Majeure Notice, the Party claiming a Force Majeure Event shall, to the extent practicable; (i) specify the length of the delay occasioned by, and additional costs incurred by reason of such Force Majeure Event; (ii) describe the particulars of the cause and nature of the Force Majeure Event; and (iii) provide evidence of the occurrence of such Force Majeure Event. At all times after the Force Majeure Notice, the affected Party shall continue to furnish timely regular reports with respect thereto during the continuation of the Force Majeure Event.

8.1.2 Excuse of Non-Performance. So long as the conditions set forth in this Section 8.1.2 are satisfied, except with regard to payment obligations, neither Party shall be responsible or liable for or deemed in breach of this Agreement because of any failure or delay in complying with its obligations under or pursuant to the Agreement to the extent that such failure

has been caused, or contributed to, by one or more Force Majeure Events or its effects or by any combination thereof; provided that in such event:

(a) any liability of either Party which arose before the occurrence of the Force Majeure Event causing the suspension of performance shall not be excused as a result of the occurrence;

(b) the affected Party shall continually exercise all commercially reasonable efforts to alleviate and mitigate the cause and effect of such Force Majeure Event, remedy its inability to perform, and limit damages to the other Party;

(c) the affected Party shall use all reasonable efforts to continue to perform its obligations hereunder and to correct or cure the event or condition excusing performance; and

(d) when the affected Party is able to resume performance of the affected obligations under the Agreement, that Party shall give the other Party written notice to that effect, and the affected Party promptly shall resume performance under the Agreement, provided that in the event that a Force Majeure Event causes a prolonged delay to the Project, Owner may elect to terminate this Agreement pursuant to Section 12.3.

8.1.3 Change Order Rights. If Contractor desires a Change Order for a Force Majeure Event, Contractor shall comply with the Force Majeure Notice requirements contained in Section 8.1.1. If Contractor does so, it will be entitled to a Change Order to the extent so provided in Section 9.5.1(a). If Contractor fails to comply with such notice requirements, then Contractor will be deemed to have waived its right to receive a Change Order for the subject Force Majeure Event.

8.1.4 Burden of Proof. The burden of proof as to whether a Force Majeure Event has occurred and whether the Force Majeure Event excuses a Party from performance under this Section 8.1 shall be upon the Party claiming such Force Majeure Event.

8.2 Owner-Caused Delay.

8.2.1 Without limiting the definition of Owner-Caused-Delays, notwithstanding anything in this Agreement to the contrary, in any case where this Agreement states that Owner "shall cause" the Other Owner Contractors to take or not to take a certain action, the Parties agree that if the Owner fails to meet that obligation, such failure shall exclusively constitute an Owner-Caused Delay and shall not constitute an Owner Event of Default, and Contractor's sole and exclusive remedies as a result thereof will be as set forth in this Section 8.2 and Section 9.5.1(c).

8.2.2 Notice. If Contractor believes an Owner-Caused Delay has occurred, then Contractor shall give Owner's Project Manager written or electronic notice describing the alleged Owner-Caused Delay within ten (10) days following the date on which Contractor became aware of the occurrence of an event Contractor believes is or may be an Owner-Caused Delay and Contractor's notice shall describe the details of the Owner-Caused Delay and any effects on Contractor's performance of its obligations under this Agreement.

8.2.3 Excuse of Non-Performance. So long as the conditions set forth in this Section 8.2 are satisfied, Contractor shall not be responsible or liable for or deemed in breach of the Agreement because of any failure or delay in completing the Work in accordance with the Project Schedule or achieving any Key Milestone to the extent that such failure has been caused by one or more Owner-Caused Delays, provided that: (a) such suspension of performance and extension of time shall be of no greater scope and of no longer duration than is required by the effects of the Owner-Caused Delay; (b) Contractor provides timely notice of the Owner-Caused Delay, and (c) Contractor provides all assistance reasonably requested by Owner, at Owner's cost, for the elimination or mitigation of the Owner-Caused Delay.

8.2.4 Change Order Rights. If Contractor desires a Change Order for an Owner-Caused Delay, Contractor shall comply with the notice requirements contained in Section 8.2.2. If Contractor does so, it will be entitled to a Change Order to the extent so provided in Section 9.5.1(c). If Contractor fails to comply with such notification requirements, Contractor will be deemed to have waived its right to receive a Change Order for the subject Owner-Caused Delay.

8.3 No Effect on Obligation to Pay Delay Liquidated Damages. Adjustments to the Project Schedule (including the Guaranteed Substantial Completion Date) may occur as a result of any of the events described in this Article VIII. Unless dates for performance are adjusted by an executed Change Order, the obligation to pay Delay Liquidated Damages on the Guaranteed Substantial Completion Date shall not be affected.

## ARTICLE IX

## CHANGES

9.1 Changes. Except to the extent expressly provided in this Article IX, there shall be no change to the Work, the Contract Price or the Project Schedule except to the extent provided in a written instrument signed by Owner and Contractor in substantially the form attached to this Agreement as Exhibit M (a "Change Order") stating their mutual agreement upon all of the following: (a) a change in the Work, if any; (b) the amount of the adjustment in the Contract Price, if any; and (c) the extent of the adjustment in the Project Schedule, if any (any of the foregoing, a "Change").

9.2 Changes at Owner's Request. Owner may, from time to time, without invalidating this Agreement, order or approve by notification in writing to Contractor (a) Changes in all or a portion of the Work or (b) acceleration of the Work, including to recover from delays caused by an Owner-Caused Delay, a Force Majeure Event or suspension of the Work by Owner in accordance with Section 12.6. Contractor shall review and consider any request from Owner for such a Change and shall make a written response thereto within seven (7) days after receiving such request. If giving effect to any Change so requested by Owner will increase or decrease its cost of performing the Work, shorten or lengthen the time needed for completion of the Work, require modification of its warranties in Article VII or require a modification of any other provisions of the Agreement, the Parties shall agree to issue Change Order adjusting the Contract Price upwards or downwards and the Project Schedule accordingly (including any amendments to the Agreement). Each Change Order shall constitute a

final settlement of all items covered therein, including any compensation for impact on, or delay or acceleration in, performing the Work.

9.3 No Unapproved Changes. Contractor shall not perform any Changes to the Work until Owner has approved in writing the proposed adjustments or has expressly authorized Contractor in writing to perform the Change prior to such approval. If Owner does not approve the proposed adjustments and Contractor and Owner are unable mutually to agree upon alternative adjustments, Owner may by written notice to Contractor cancel the Change. Upon receiving from Owner a written approval or written authorization to perform, Contractor shall diligently perform the Change in accordance with and subject to all of the terms of this Agreement. Contractor shall not suspend, in whole or in part, performance of this Agreement during any Dispute over any Change Order unless directed to do so by Owner, and if directed to proceed with a Change or disputed item pending review and agreement upon adjustments, Contractor shall (without waiving any rights with respect to such Change or disputed item) do so.

9.4 Changes Initiated by Contractor. Promptly after Contractor becomes aware of any circumstances which Contractor has reason to believe may necessitate a Change, Contractor will issue to Owner a "Change Order Request". All Change Order Requests shall include documentation sufficient to enable Owner to determine: (a) the factors necessitating the possibility of a Change; (b) the impact which the Change is likely to have on the Contract Price; (c) the impact which the Change is likely to have on the timely achievement of the activities set forth in the Project Schedule (including the Guaranteed Substantial Completion Dates); and (d) such other information which Owner may request in connection with such Change. Owner may, but except as provided in Section 9.5 below, shall not be obligated to, issue a Change Order pursuant to a Change Order Request.

9.5 Required Change Orders.

9.5.1 Provided that Contractor has notified Owner as required and has used all reasonable efforts to avoid and mitigate any potential delays to the Project Schedule or increased Direct Costs resulting from such events, Contractor will, to the extent described in Sections 9.5.2 and 9.5.3, be entitled to receive Change Orders as and for the events described in this Section 9.5.1.

(a) Change Order Due to Force Majeure Event. Subject to Sections 8.1, and 9.5.1, if and to the extent that a Force Majeure Event causes Contractor to suffer a delay in its performance of the Work, Owner will issue a Change Order extending the Project Schedule to the extent required under Section 9.5.2. Subject to Sections 9.5.1, 8.1, and 13.3, in the event one or more Force Majeure Events occurring at the Project Site, directly cause delays in the Work exceeding thirty (30) days in the aggregate, Owner will, via Change Order, increase the Contract Price to the extent required under Section 9.5.3. Such Change Orders shall be Contractor's sole and exclusive remedy for any increased costs associated with delays caused by any Force Majeure Events, and Contractor will not be entitled to any additional payment, damages and costs or other compensation in connection with any such delays.

(b) Change Order Due to Suspension of Work by Owner. Subject to Section 9.5.1, if after the Effective Date Owner suspends the Work pursuant to the provisions of

Section 12.6, then: (A) Owner shall issue a Change Order extending the Project Schedule to the extent required under Section 9.5.2; and (B) to the extent that such suspension increases Contractor's Direct Costs in performing the Work, Owner will, via Change Order, increase the Contract Price to the extent required under Section 9.5.3. Such Change Order shall be Contractor's sole and exclusive remedy for any increased costs and delays resulting from such suspension of Work by Owner, and Contractor will not be entitled to any additional payment, damages or other compensation in connection with any such delays.

(c) Change Order Due to Owner-Caused Delay. Subject to Section 9.5.1 and Section 8.2, (i) if and to the extent that an Owner-Caused Delay causes Contractor to suffer a delay in the performance of the Work, Owner will issue a Change Order extending the Project Schedule to the extent required under Section 9.5.2, and (ii) if and to the extent that such Owner-Caused Delay increases Contractor's Direct Costs in performing the Work, Owner will, via Change Order, increase the Contract Price to the extent required under Section 9.5.3. Such Change Order(s) shall be Contractor's sole and exclusive remedy for any delays and increased costs resulting from an Owner-Caused Delay, and Contractor will not be entitled to any payment, damages or other compensation in connection with any such delays or increased costs.

(d) Change Order Due to Unforeseen Subsurface Condition. Subject to Section 9.5.1 and Section 2.3.1(b), (i) if and to the extent that an Unforeseen Subsurface Condition causes Contractor to suffer a delay in the performance of the Work, Owner will issue a Change Order extending the Project Schedule to the extent required under Section 9.5.2, and (ii) if and to the extent that such Unforeseen Subsurface Condition increases Contractor's Direct Costs in performing the Work, Owner shall, via Change Order, increase the Contract Price to the extent required under Section 9.5.3. Such Change Order(s) shall be Contractor's sole and exclusive remedy for any delays and increased costs resulting from an Unforeseen Subsurface Condition, and Contractor will not be entitled to any payment, damages or other compensation in connection with any such delays or increased costs.

(e) Change Order Due to Pre-Existing Hazardous Materials. Subject to Section 9.5.1, if and to the extent that Contractor discovers any Pre-Existing Hazardous Material that has been stored, released or disposed of at the Project Site, and, as required under Section 2.6, Contractor stops performance of the Work in that area, then, once such Work is re-commenced, Owner will issue a Change Order extending the Project Schedule to the extent required under Section 9.5.2. Subject to Section 9.5.1, if and to the extent that such cessation of Work increases Contractor's Direct Costs in performing the Work, Owner shall, via Change Order, increase the Contract Price to the extent required under Section 9.5.3. Such Change Order(s) shall be Contractor's sole and exclusive remedy for any delays and increased costs resulting from any such cessation of the Work, and Contractor will not be entitled to any payment, damages or other compensation in connection with any such delays or increased costs.

9.5.2 Changes Involving Schedule Extensions. To the extent that Contractor demonstrates that an event for which it is entitled to a Change as described in Section 9.5.1 is the sole cause of critical path delay to Contractor's ability to perform the Work despite Contractor's use of reasonable efforts to mitigate and avoid any such delay, Owner shall issue a Change Order to extend the dates in the Project Schedule as necessary to accommodate such delay. Contractor's demonstration of the impact on the critical path of the Work must be made on a

basis that analyzes the actual impacts of the given event on the then-current schedule for completion of the Work. In no event will Contractor be entitled to an extension of time under this Section 9.5.2 to the extent that the performance of the Work for which the extension is sought would have been suspended, delayed or interrupted by the concurrent fault, actions or omissions of Contractor.

9.5.3 Changes to the Contract Price.

(a) Except as set forth in Section 9.5.3(b), with respect to any Change Order required to be issued to increase the Contract Price as a result of an event described in Section 9.5.1, unless the Parties agree otherwise in writing, such Change Order will, on a retrospective basis, increase the Contract Price by an amount equal to the Direct Costs incurred by Contractor solely in connection with such event, plus a mark-up. The mark-up is not to exceed _____ percent (__%) in the aggregate, including all Subcontractor and Contractor mark-ups solely in connection with such Change.

(b) In no event will Contractor be entitled to payment for Direct Costs hereunder to the extent that such costs would have occurred notwithstanding such event, due to the concurrent fault, actions or omissions of Contractor or its Subcontractors.

(c) For purposes hereof, "Direct Costs" shall mean only the actual, documented costs that are directly incurred by Contractor as a result of the event giving rise to the Change Order for the following items: (i) compensation for labor utilized and in the direct employ of Contractor at the Project Site, at the rates as set forth in Exhibit B-4; (ii) cost of materials and permanent equipment; (iii) payments properly made by Contractor to Subcontractors; (iv) rental charges of necessary machinery and equipment (but excluding hand tools) used at the Project Site; (v) Permit fees; (vi) compensation of engineers or other design professionals employed directly by Contractor; and (vii) reasonable costs of mobilization and demobilization. Notwithstanding the foregoing, "Direct Costs" shall not include (t) salaries or other compensation (including costs of contributions, assessments, fringe benefits or taxes based on salaries or compensation) of Contractor's Personnel at Contractor's principal office and branch offices (except as provided in the previous sentence); (u) expenses of Contractor's principal and branch offices; (v) Contractor's profit, overhead or general expenses of any kind; (w) any replacement, repair or other costs or liabilities arising from any loss of or damage to any equipment, tools or other property owned or used by Contractor or its Subcontractors; (x) costs to correct or reperform any components of such Work as a result of the acts or omissions of Contractor or its Personnel; (y) any fines or penalties assessed against Contractor or its Personnel in connection with such Work that were assessed due to the fault of Contractor or its Personnel; (z) any Builder's All Risk deductibles; or (aa) any costs or expenses other than those specifically set forth above as Direct Costs.

9.5.4 Taxes. The Parties acknowledge that the provisions of Section 4.2 will apply to any additional Work covered by any Change Order.

9.5.5 Offsets. If Owner so requests, Contractor will in good faith work with Owner to enable a reduction in any required schedule extension hereunder via a Change Order directing and paying for achievable acceleration.

## ARTICLE X

## INDEMNIFICATION

10.1 Indemnities.

10.1.1 Contractor's General Indemnity. Contractor shall defend, indemnify, reimburse and hold harmless, Owner, the financing parties and each of their subsidiaries and Affiliates, and the directors, officers, agents, employees, successors and assigns of each of them, and the owners of the real property comprising the Project Site (each of the foregoing, an "Owner Indemnified Party") from and against any and all losses, costs, damages, injuries, liabilities, claims, demands, penalties, assessments, interest and causes of action, expenses, including reasonable attorney's fees, incurred by or asserted against any Owner Indemnified Party as a result of any and all of the following:

(a) any bodily injury, death or damage to property caused by any negligent act or omission (including strict liability) or willful misconduct relating to or arising out of the performance of the Work or any curative action under any warranty related to the Work, following performance of the Work by Contractor or any Affiliate thereof, any Subcontractor, or anyone directly or indirectly employed by any of them, or anyone for whose acts such Person may be liable;

(b) any claims resulting from bodily injury, death or property damage arising out of Defects or breach of Warranty;

(c) claims by any Government Authority for any Contractor's Taxes;

(d) any pollution or contamination that may originate from sources in Contractor's or its Subcontractors' possession, use and control or caused by the negligence of Contractor, any Subcontractor or anyone directly or indirectly employed by any of them, or anyone for whose acts such Person may be liable (including as a result of the negligent release of Pre-Existing Hazardous Materials, the negligent exacerbation of Pre-Existing Hazardous Materials or negligent rendering of removal or remediation of Pre-Existing Hazardous Material more costly), including from Hazardous Material, industrial hazards, bilge and garbage;

(e) any Lien on the Work, Equipment, the Project, the Project Site, or any fixtures or personal property included in the Work (whether or not any such Lien is valid or enforceable) to the extent Owner has paid all amounts due relating to the Work that is the subject of such Lien, created by, through or under, or as a result of any act or omission (or alleged act or omission) of, Contractor or any Subcontractor or other Person providing services, equipment or materials in connection with the Work;

(f) any claim, action or proceeding by any Person for unauthorized disclosure, infringement or use of any Intellectual Property Right arising from or related to (i) Contractor's performance (or that of its Affiliates, Subcontractors) under the Agreement, (ii) the design, construction, use, operation or ownership of the Work (including the Equipment, Contractor Deliverables or any portion of any of them), or (iii) Owner's use of any license granted hereunder. Without limiting Contractor's other obligations under this Agreement, if

Owner is enjoined from completing the Project or any part thereof, or from the use, operation or enjoyment of the Project or any part thereof, as a result of such claim or legal action or any litigation based thereon, Contractor shall, in addition to its indemnification obligations hereunder, promptly use commercially reasonable efforts to have such injunction removed at no cost to Owner. Contractor shall timely notify Owner in writing of any claims which Contractor may receive alleging infringement of patents or other proprietary rights that may affect Contractor's performance of the Work, provided that in the event that such efforts are not effective within a period of sixty (60) days after the imposition of such injunction, Owner may take such steps as may be necessary to remove the injunction, including obtaining any necessary license, at Contractor's sole expense;

(g) any cancellation or invalidation of any insurance policy or part thereof procured under Article XI as a result of Contractor's failure to comply with any of the requirements set forth in such policy or any other act by Contractor or any Subcontractor (but only to the extent Contractor knows the requirements and they are attached hereto);

(h) any failure of Contractor to comply with, or failure of the Work to comply with, or be capable of operating in compliance with, Applicable Laws, the conditions or provisions of Applicable Permits, Prudent Industry Practices, any applicable Real Property Requirements; or

(i) any claims with respect to employer's liability or worker's compensation filed by any employee of Contractor or any of its Subcontractors, except to the extent caused by the negligent acts or omissions of Owner, Equipment Provider or Other Owner Contractors.

10.1.2 Owner's Indemnity. Owner shall defend, indemnify and hold harmless, Contractor and its directors, officers, agents, employees, successors and assigns from and against any and all losses, costs, damages, injuries, liabilities, claims, demands, penalties, assessments, interest and causes of action, expenses, including reasonable attorney's fees, incurred by or asserted against any such Person (a) as a result of the injury or death of any Person, including employees of Owner, Contractor or any Person employed by any of them for whose acts any of them may be liable, but only to the extent caused by Owner's negligent acts or omissions, (b) as a result of any loss of or damage to property, but only to the extent caused by from Owner's negligent acts or omissions, (c) any claims by any Governmental Authority for any Owner Taxes or for any claims directly arising from following Owner's direction to seek exemptions or rebates for certain taxes as described in Section 4.2.1(b); or (d) as a result of any release of a Pre-Existing Hazardous Material, except to the extent Contractor has an indemnification obligation with respect thereto pursuant to Section 10.1.1.

10.2 Indemnification Procedure.

10.2.1 Notice of Proceedings. The Person claiming to be indemnified under the terms of this Article X (the "Indemnified Person") shall give the Party from which indemnification is sought (the "Indemnifying Party") written notice of commencement of any legal action or of any claims against such Indemnified Person in respect of which indemnification will be sought, together with a copy of such claim, process or other legal

pleading. Failure of the Indemnified Person to give such notice will not reduce or relieve the Indemnifying Party of liability hereunder unless and to the extent that the Indemnifying Party was precluded from defending such claim, action, suit or proceeding as a result of the failure of the Indemnified Person to give such notice. In any event, the failure to so notify shall not relieve the Indemnifying Party from any liability that it may have to the Indemnified Person otherwise than under this Article X.

10.2.2 Conduct of Proceedings. Each Party and each other Indemnified Person shall have the right, but not the obligation, to contest, defend and litigate any claim, action, suit or proceeding by any third party alleged or asserted against it arising out of any matter in respect of which it is entitled to be indemnified hereunder and the reasonable costs and expenses thereof (including reasonable attorneys' fees and expert witness fees) shall be subject to the said indemnity; provided that the Indemnifying Party shall be entitled, at its option, to assume and control the defense of such claim, action, suit or proceeding at its expense upon its giving written notice thereof to the Indemnified Person, and such Indemnifying Party shall conduct with due diligence and in good faith the defense of any claim against such party, whether or not the Indemnifying Party shall be joined therein, and the Indemnified Person shall cooperate with the Indemnifying Party in such defense. The Indemnified Person may elect to participate through separate counsel in the defense of any such claim, but the fees and expenses of such counsel shall be at the expense of such Indemnified Person unless (a) there exists a material conflict of interest between the Indemnifying Party and such Indemnified Person in the conduct of the defense of such claim or (b) the Indemnifying Party did not employ counsel to assume the defense of such claim within a reasonable time after notice of the commencement thereof or (c) the Indemnified Person reasonably concludes and specifically notifies the Indemnifying Party that there may be specific defenses available to it which are different from or additional to those available to the Indemnifying Party. In each of such cases the Indemnifying Party shall not have the right to control the defense or settlement of such claim and the reasonable fees and expenses of counsel engaged by the Indemnified Person shall be at the expense of the Indemnifying Party. Indemnifying Party shall give prompt written notice to Indemnified Person of any proposed settlement of an indemnified claim. Indemnifying Party may not, without Indemnified Person's prior written consent, settle or compromise any claim or consent to the entry of any judgment regarding which indemnification is being sought hereunder unless such settlement, compromise or consent (i) includes an unconditional release of Indemnified Person from all liability arising out of such claim, (ii) does not contain any admission or statement suggesting any wrongdoing or liability on behalf of Indemnified Person, and (iii) does not contain any equitable order, judgment or term (other than the fact of payment or the amount of such payment) that in any manner affects, restrains or interferes with the business of Indemnified Person or any of its Affiliates.

10.2.3 Contributory Negligence. If the joint, concurring, comparative or contributory fault or negligence of the Parties gives rise to damages for which the Parties are entitled to indemnification under this Article X, then such damages shall be allocated between the Parties in proportion to their respective degrees of fault or negligence contributing to such damages.

10.2.4 Survival of Indemnities. The indemnities set forth in this Article X shall survive the termination or expiration of this Agreement.

## ARTICLE XI

## INSURANCE

From the first to occur of the LNTP Date or the Notice to Proceed Date through and including the Final Completion Date, except as otherwise specified, Owner and Contractor shall procure and maintain, or cause to be procured and maintained, the insurance coverages set forth in Exhibit P-1 and identified therein as Owner's or Contractor's responsibility with one or more duly licensed insurance carrier(s).

## ARTICLE XII

## DEFAULT, TERMINATION AND SUSPENSION

12.1 Contractor Default.

12.1.1 Contractor Events of Default. The occurrence of any one or more of the following events shall constitute an event of default by Contractor hereunder ("Contractor Event of Default"):

(a) any of the following (each a "Bankruptcy or Insolvency Event") occurs (i) Contractor [or Guarantor] consents to the appointment of or taking possession by, a receiver, a trustee, custodian, or liquidator of itself or of a substantial part of its assets, or fails or admits in writing its inability to pay its debts as they become due, or makes a general assignment for the benefit of creditors; (ii) Contractor [or Guarantor] files a voluntary petition in bankruptcy or a voluntary petition or an answer seeking reorganization in a proceeding under any applicable bankruptcy or insolvency laws of any jurisdiction, whether now or hereafter in effect, or files an answer admitting the material allegations of a petition filed against it in any such proceeding, or seeks relief by voluntary petition, answer or consent, under the provisions of any now existing or future bankruptcy, insolvency or other similar law of any jurisdiction, whether now or hereafter in effect, providing for the liquidation, reorganization, or winding up of corporations, or providing for an agreement, composition, extension, or adjustment with creditors; (iii) a substantial part of Contractor's [or Guarantor's] assets is subject to the appointment of a receiver, trustee, liquidator, or custodian by court order and such order shall remain in effect for more than thirty (30) days; or (iv) Contractor [or Guarantor] is adjudged bankrupt or insolvent, has any property sequestered by court order and such order shall remain in effect for more than thirty (30) days, or has filed against it a petition under any bankruptcy, reorganization, arrangement, insolvency, readjustment of debt, dissolution or liquidation law of any jurisdiction, whether now or hereafter in effect, and such petition shall not be dismissed within sixty (60) days of such filing;

(b) Contractor fails, for any reason, (i) to pay when due Delay Liquidated Damages as required herein or (ii) to make any other payment or payments required to be made to Owner under the Agreement within ten (10) Business Days after receipt of written notice from Owner of Contractor's failure to make such other payment or payments (except to the extent Contractor disputes such other payment or payments in good faith and in accordance with the terms of this Agreement);

(c) Contractor fails to comply with any material provision of any Applicable Law, Applicable Permit, or applicable Real Property Requirement, the effects of which have not been cured to Owner's reasonable satisfaction within ten (10) Business Days after notice from Owner, provided, if such failure to comply is not capable of being cured within ten (10) Business Days, Contractor shall not be in default so long as Contractor commences to cure within ten (10) Business Days and thereafter diligently proceeds to cure such breach in a manner reasonable satisfactory to Owner;

(d) either of the following occurs: (i) Contractor fails to make payments when due to Subcontractor for services, materials or equipment beyond applicable notice and cure periods, unless such payments are reasonably disputed by Contractor and any Liens relating to such disputed payments are satisfied or bonded off by Contractor; or (ii) Contractor suspends performance of a material portion of the Work resulting in the Work not progressing substantially in accordance with the Project Schedule (other than as permitted under Article VIII or pursuant to a Change Order); and in each instance as described in each of sub-clauses (i) and (ii) of this Section 12.1.1(d), the impacts of such condition remain un-remedied for five calendar days following written notice thereof to Contractor;

(e) any material breach by Contractor of any representation or warranty contained in Article XV, the impacts of which have not been cured to Owner's reasonable satisfaction within ten (10) Business Days after notice from Owner;

(f) Contractor fails to: (i) provide a written recovery plan within the time provided for in Section 2.5.3 and satisfying the requirements of Section 2.5.3; or (ii) implement the recovery plan in a diligent and timely manner and, in any case, within the schedule provided for in such recovery plan.

(g) Contractor reaches the limitations of Delay Liquidated Damages set forth in Section 6.6.1 before Contractor achieves all of the Key Milestones;

(h) the transfer by Contractor of (i) all or a substantial portion of the rights or obligations of Contractor hereunder, except for an assignment permitted hereunder, or (ii) all or a substantial portion of the assets or obligations of Contractor;

(i) any failure by Contractor to maintain the insurance coverages required of it in accordance with Article XI, the impacts of which have not been cured to Owner's reasonable satisfaction within ten (10) Business Days after notice from Owner;

(j) Contractor fails to provide or maintain in effect each Letter of Credit, [the Payment and Performance Bond] or the Parent Guaranty as required under Section 2.12; or

(k) Contractor is in breach of any provision of this Agreement or has failed to perform its obligations under the Agreement (other than those breaches specified in this Section 12.1.1 (a) through (l)) and (i) such breach is not cured by Contractor within fifteen (15) days after notice thereof from Owner, or (ii) if such breach is not capable of being cured within such fifteen (15) day period, Contractor (A) fails to commence to cure such breach within such

fifteen (15) day period, or (B) fails to thereafter diligently proceed to cure such breach in a manner reasonably satisfactory to Owner in its sole discretion.

12.1.2 Termination for Cause. Upon the occurrence and during the continuation of any Contractor Event of Default hereunder, Owner, in addition to its right to pursue any other remedy given under this Agreement or now or hereafter existing at law or in equity or otherwise, shall have the right to terminate this Agreement by written notice to Contractor (a "Termination for Cause"). A Termination for Cause shall be effective upon delivery of Owner's notice with respect thereto. In the event of a termination by Owner under this Article XII, Owner shall have the right to take possession of and use all Contractor Deliverables and all of the equipment owned by Contractor or an Affiliate and located at the Project Site on the date of such termination for the purpose of completing the Work (provided that Owner will bear the risk of loss or damage to the same thereafter, until turnover back to Contractor or the Affiliate) and may employ any other Person to complete the Work by whatever method that Owner may deem necessary. In addition, Owner may make such expenditures as in Owner's sole judgment will accomplish the timely completion of the Work in accordance with the terms hereof. Owner shall, within a reasonable period of time after the Work is finally completed by the work of one or more replacement contractors, determine the total cost to Owner for completing the Work in accordance with the Scope of Work, and the other requirements of this Agreement, including all sums previously paid or then owed to Contractor pursuant to this Agreement. In contracting with such replacement contractors, Owner shall, to the extent practicable, cause the Work to be completed in accordance with the Agreement and shall employ reasonable efforts to mitigate the costs incurred in connection with completion of the Work. If the Contract Price is less than the sum of (i) all costs and expenses incurred by Owner to engage a substitute contractor to complete (or cure deficiencies in) the Work, including overhead and legal, engineering and other professional expenses, (ii) all other costs, expenses and damages suffered by Owner as a result of a default or breach by Contractor of the requirements of this Agreement and the termination of the of the Agreement as a result thereof, and (iii) all amounts previously paid to Contractor pursuant to this Agreement, Contractor shall pay to Owner on demand the amount of such difference. Any amount owed by Owner to Contractor for the completion of the Work shall be retained by Owner until after completion of the Work and applied by Owner to pay any amounts and damages owed by Contractor pursuant to this Section 12.1.2 or otherwise. Any excess of the amount retained over the amount due under this Section 12.1.2 shall be remitted to Contractor within sixty (60) days after the Final Completion Date.

12.1.3 Other Owner Remedies. Upon the occurrence and during the continuance of a Contractor Event of Default but prior to termination of this Agreement by Owner, Owner may, without prejudice to any of its other rights or remedies, (a) seek performance by any guarantor or surety of Contractor's obligations hereunder, (b) seek equitable relief to cause Contractor to take action or to refrain from taking action pursuant to this Agreement, or to make restitution of amounts improperly received under this Agreement, (c) make such payments or perform such obligations as are required to cure such Contractor Event of Default, make a claim against any security provided pursuant to this Agreement and offset the cost of such payment or performance against payments otherwise due to Contractor under this Agreement, provided that Owner shall be under no obligation to cure any such Contractor Event of Default, or (d) otherwise seek damages, including proceeding against any bond, guarantee, letter of credit, or other security given by or for the benefit of Contractor for its performance under this Agreement.

12.2 Owner Default. Owner's failure to pay to Contractor any required payment that is not in dispute, which failure continues for thirty (30) Days after written notice of failure has been received by Owner from Contractor, shall constitute an event of default by Owner hereunder (an "Owner Event of Default"). Upon any Owner Event of Default, Contractor may terminate this Agreement thirty (30) days after giving written notice thereof to Owner so long as the amount owed by Owner (other than any amount disputed in accordance with the terms of this Agreement) is not paid within such thirty (30)-day period (a "Contractor Termination for Cause"). In the event of a Contractor Termination for Cause, Contractor shall be entitled to recover an amount equal to the Termination Payment. Unless Contractor terminates this Agreement pursuant to the foregoing provisions, Contractor shall not suspend or delay performance of the Work because of any Owner Event of Default. Contractor shall continue performance of the Work during any dispute over payment, so long as Owner continues to pay all undisputed amounts. Other than as stated above, Contractor will have no right to terminate this Agreement, and Contractor acknowledges that its sole and exclusive remedies for any failure of Owner to comply with its obligations under this Agreement (other than nonpayment as described above) are limited to receipt of a Change Order as described in Section 9.5.

12.3 Termination Without Cause. Owner may for its convenience terminate this Agreement after giving notice to Contractor in which event Contractor shall be entitled to be paid the Termination Payment under Section 12.4. As a condition to any termination by Owner pursuant to this Section 12.3 (a "Termination Without Cause"), Owner must provide written notice to Contractor of the Termination Without Cause at least three (3) Business Days prior to the effective date of such termination. If, at the date of termination under this Section 12.3, Contractor has properly performed services or purchased, prepared or fabricated off the Project Site any materials or Equipment for subsequent incorporation at the Project Site, Owner shall have the option of having such materials or Equipment delivered to the Project Site or to such other place as Owner shall reasonably direct.

12.4 Termination Payment.

12.4.1 Termination Payments Due to Contractor. Upon a termination of this Agreement pursuant to Section 12.2 or Section 12.3 and subject to Owner's rights under Sections 4.6 and 4.8 Contractor shall be entitled to a payment (the "Termination Payment"), which shall equal the sum of the following, without duplication: (a) that portion of the Contract Price that is applicable to Work completed up to the date of termination that has not previously been paid to Contractor (as determined below); (b) the expenses reasonably incurred by Contractor in withdrawing Contractor's Equipment and Personnel from the Project Site and in otherwise demobilizing plus ten percent (10%) of such expenses; and (c) the expenses reasonably incurred by Contractor in terminating contracts with Subcontractors pertaining to the Work (excluding fees of any Affiliates of Contractor) plus ten percent (10%) of such expenses, except to the extent Owner has instructed Contractor not to terminate such contracts, in which event such contract will be assigned to Owner, subject to Owner's assumption of same and, if required, Owner's adequate assurance to such Subcontractors regarding Owner's ability to pay. The Termination Payment shall not include any costs incurred by Contractor after the date of the event giving rise to such termination that Contractor reasonably could have mitigated. Contractor shall use all reasonable, diligent efforts to mitigate the costs associated with termination of this

Agreement, including identifying and pursuing other uses for Equipment or supplies manufactured or obtained pursuant to this Agreement.

12.4.2 Payment of Termination Payment. Contractor shall submit an invoice to Owner for the Termination Payment with the supporting information and documentation of any fees or expenses claimed by Contractor pursuant to Section 12.4.1. Upon review and agreement that such invoice is proper, Owner shall pay such invoice within thirty (30) days after its receipt of same unless it disputes in good faith certain elements thereof, in which event only the undisputed portion of the Termination Payment need be made within such thirty (30) day period; provided, that payments for termination under Section 12.3 shall be due Contractor within thirty (30) days after receipt of a substantiated invoice and Owner's receipt of any and all Equipment and Work under Sections 12.3 and 12.5. As a condition precedent to receiving any Termination Payment, Contractor shall comply with Section 12.5 in its entirety.

12.4.3 Termination Payment Contractor's Sole Remedy. Payment of the Termination Payment shall be the sole and exclusive liability of Owner, and the sole and exclusive remedy of Contractor, with respect to termination of this Agreement under Section 12.2 or Section 12.3, and in such event Owner shall have no further liability to Contractor notwithstanding the actual amount of damages that Contractor may have sustained in connection with such termination. Calculation of the Termination Payment has been agreed upon and fixed hereunder because of the difficulty of ascertaining the exact amount of such damages Contractor will actually sustain in the event of a termination of this Agreement pursuant to Section 12.2 or Section 12.3, and Owner and Contractor agree that the calculation of the Termination Payment is reasonable.

12.5 Actions Required Following Termination.

12.5.1 Discontinuation of Work. Upon termination of this Agreement under Sections 12.1 or 12.3, Owner shall be immediately released from any and all obligations to Contractor (except for Owner's obligation to pay any amount specified in Section 12.4, if applicable), Contractor shall follow Owner's directions for the orderly turnover of the Project Site and the Work, and except as directed by Owner, Contractor shall remove from the Project Site its Personnel, all Contractor's Equipment, waste, rubbish and Hazardous Material brought onto the Project Site by Contractor or its Subcontractors or for which Contractor is otherwise responsible, and Owner shall be entitled to take exclusive possession of the Work, the Project Site, and any and all Equipment (including materials delivered or en route to the Project Site). Contractor immediately shall take such steps as are reasonably necessary to preserve and protect Work completed and in progress and to protect materials, equipment and supplies at the Project Site, stored off-site, or in transit.

12.5.2 Cancellation and Transfer of Subcontracts and Other Rights. If requested by Owner in the event of termination of this Agreement, Contractor will cancel existing contracts with Subcontractors upon terms as directed by Owner. Any payments to be made to a Subcontractor as a result of any such termination shall be paid by Contractor (subject to Section 12.4, in the event of a termination under Section 12.3). In the event of termination of this Agreement, Contractor shall also, as and to the extent requested by Owner, (a) irrevocably assign and deliver to Owner such Subcontracts, purchase orders, bonds, warranties and options made by

Contractor in performance of the Work (but in no event shall Owner be liable for any action or default of Contractor occurring prior to such delivery and assignment), (b) provide to Owner without charge a license to use all rights to patented copyrighted, licensed or proprietary materials of Contractor and Subcontractors in connection with the Work, except as otherwise restricted herein, and (c) deliver to Owner originals of the Agreement, originals of all Drawings, to the extent available, Contractor Deliverables in process (except that Contractor may keep for its records copies, and, if sufficient originals exist, an original set, of the Agreement executed by Owner), all other materials relating to the Work, and all papers and documents relating to Applicable Permits, orders placed, bills and invoices, Lien releases and financial management under this Agreement. All deliveries hereunder shall be made free and clear of any Liens, security interests or encumbrances, except such as may be created by Owner. Except as provided herein, no action taken by Owner or Contractor after the termination of this Agreement shall prejudice any other rights or remedies of Owner or Contractor provided by Applicable Laws, the Agreement or otherwise upon such termination. In addition, Contractor shall assist Owner in preparing an inventory of all Equipment in use or in storage at the Project Site, and Contractor shall take such other action as required hereunder upon termination of this Agreement.

12.5.3 Surviving Obligations. This Article XII shall survive the termination or expiration of this Agreement.

12.6 Suspension by Owner for Convenience. Owner may suspend all or a portion of the Work to be performed under the Agreement at any time for any reason in its sole discretion by giving written notice thereof to Contractor. Such suspension shall continue for the period specified in the notice of suspension; provided that Contractor agrees to resume performance of the Work promptly upon receipt of notice from Owner. Upon receiving any such notice of suspension, unless the notice requires otherwise, Contractor shall: (a) immediately discontinue the Work on the date and to the extent specified in the notice; (b) place no further orders or subcontracts for Equipment, services or materials with respect to suspended Work, other than to the extent required in the notice; (c) promptly make every reasonable effort to obtain suspension, with terms satisfactory to Owner, of all orders, subcontracts and rental agreements to the extent they relate to performance of suspended Work; (d) continue to protect and maintain the Work performed, including those portions on which Work has been suspended; and (e) take any other reasonable steps to minimize costs and expenses associated with such suspension. Contractor shall use reasonable commercial efforts to include a suspension for convenience provision with terms similar to the foregoing in all subcontracts. After the conclusion of any suspension hereunder, Contractor will be entitled to a Change Order to the extent described in Section 9.5.1(b). If a suspension of Work continues for more than one hundred and eighty (180) days in the aggregate, Contractor may terminate this Agreement, which termination shall be deemed a Termination Without Cause.

## ARTICLE XIII

## TITLE AND RISK OF LOSS

13.1 Title to Project and the Work. Contractor warrants and guarantees that legal title to and ownership of the Work (including all Equipment) shall pass to Owner, free and clear of any and all Liens upon the earlier of (a) payment to Contractor of the portion of the Contract

Price attributable to such Work and Equipment, and (b) in the case of Equipment, the delivery of such Equipment to the Project Site; provided that for all Equipment, title shall pass to Owner upon such payment only if title has previously been transferred to Contractor, otherwise, title shall pass to Owner at such time as Contractor has acquired title to the Equipment, but in no event later than delivery of such Equipment to the Project Site.

13.2 Title to Contractor Deliverables. Except as otherwise provided in this Article XIII, title to Contractor Deliverables, specifications and like materials (including the Job Books contents) which are owned by Contractor shall be transferred to Owner upon creation and delivered to Owner upon Project Substantial Completion. In addition, Contractor grants to Owner an irrevocable, royalty free, non-exclusive license to use and reproduce such Contractor Deliverables, specifications and other design documentation to which Contractor does not have title but has the right to grant sub-licenses for the purpose of completing, repairing, operating, maintaining, rebuilding and expanding the Project. Owner shall have the right to assign the benefit of such license to any financing parties in connection with granting a security interest in the Project, to a purchaser in connection with a transfer of the Project, or to any subsequent purchaser or assignee of same. Any such purchaser or assignee shall acquire such license subject to the same terms and restrictions as stated in this Section 13.2. Owner may retain the necessary number of copies of all such documents for purposes of construction, operation, maintenance and repair of the Project. Any costs to register such licenses in the United States shall be paid by Owner.

13.3 Risk of Loss. Notwithstanding passage of title as provided in Section 13.1, from the date hereof until the Project Substantial Completion Date, Contractor hereby assumes the risk of loss for all Equipment upon Delivery and the Work, including: (a) all Work completed on or off the Project Site and (b) all Work in progress. If any loss, damage, theft or destruction occurs to the Work or other items, on or off the Project Site, for which Contractor has so assumed the risk of loss hereunder, Contractor shall, at the option of Owner and at Contractor's cost, promptly repair or replace the property affected thereby. In such event, Contractor shall have access to Owner's Builder's All Risk Policy, provided that in the event of a covered loss, Contractor shall pay any applicable deductible amount. Risk of loss for the Project and the Work shall pass to Owner (excluding Contractor's Equipment and other items to be removed by Contractor, which shall remain the responsibility of Contractor) on the Project Substantial Completion Date, provided, however, Contractor shall continue to be responsible for claims, physical loss or damage to the Work to the extent resulting from Contractor's or its Personnel's negligent acts or omissions, and failure to comply with the requirements of the Agreement. Notwithstanding the foregoing, if Contractor is obligated by the terms of this Agreement to perform additional Work subsequent to the date of completion for such Work, Contractor shall bear the risk of loss and damage with respect to such Work until such additional Work is complete.

## ARTICLE XIV

## DISPUTE RESOLUTION

14.1 Referral to Senior Management. In the event of any controversy, claim or dispute between the Parties arising out of or related to this Agreement ("Dispute"), the Parties'

Project representatives will first attempt to resolve the Dispute informally through negotiation and consultation. If they are unable to do so, then within three (3) Business Days following the date of delivery of a written request by either Party, (i) each Party shall appoint as its representative a senior officer, and (ii) such senior officers shall meet, negotiate and attempt in good faith to resolve the Dispute quickly, informally and inexpensively.

14.2 Mediation. Any Dispute that is not resolved pursuant to Section 14.1 may be submitted for mediation before a single mediator in accordance with the provisions contained herein and in accordance with the Commercial Mediation Procedures of the AAA in effect at the time of the mediation ("AAA Procedures"); provided, however, that in the event of any conflict between the procedures herein and the AAA Procedures the procedures herein shall control. The mediator will be named by mutual agreement of the Parties or by obtaining a list of five (5) qualified Persons from the Parties and alternately striking names. All mediation shall be administered by the AAA. All mediation shall take place in the City of Portland, Oregon, unless otherwise agreed to by the Parties. Each Party shall be required to exchange documents to be used in the mediation not less than five (5) Business Days prior to the mediation. The Parties shall use all commercially reasonable efforts to conclude the mediation as soon as practicable. All aspects of the mediation shall be treated as confidential. Neither the Parties nor any mediator may disclose the content or results of the mediation, except as necessary to comply with legal, audit or regulatory requirements. Before making any such disclosure, a Party shall give written notice to the other Party and shall afford such Party a reasonable opportunity to protect its interests. Each Party shall be responsible for its own expenses and one-half of any mediation expenses incurred to resolve the dispute. The mediator will provide the Parties with a fee and expense schedule in advance of mediation. Mediation will terminate by: (a) written agreement signed by both Parties, (b) determination by the mediator that the Parties are at an unresolvable impasse, or (c) two unexcused absences by either Party from the mediation sessions. The mediator will never participate in any claim or controversy covered by this Article XIV as a witness, collateral contract, or attorney and may not be called as a witness to testify in any proceeding involving the subject matter of mediation. O.R.S. §§ 36.100 to 36.238 will apply to the entire process of mediation.

14.3 Legal Action. If the Parties are still unable to resolve their differences after good faith consideration of a resolution through mediation pursuant to Section 14.2, then each of the Parties hereby irrevocably consents and agrees that any legal action or proceedings with respect to this Agreement may be brought in the United States District Court for the District of Oregon or, if such court lacks subject matter jurisdiction, the courts of the State of Oregon located in the City of Portland, and any appellate court from any thereof. By execution and delivery of this Agreement and such other documents executed in connection herewith, each Party hereby irrevocably and unconditionally (a) consents to the personal and exclusive jurisdiction of the aforesaid courts, and agrees that it will not commence or consent to participate in any action, litigation or proceeding of any kind whatsoever against any the other Party in any way related to such documents in any forum other than such courts, (b) agrees to be bound by any final judgment (after any and all appeals) of any such court with respect to such documents, (c) waives, to the fullest extent permitted by law, any objection it may now or hereafter have to the laying of venue of any action or proceeding with respect to such documents brought in any such court, and further waives, to the fullest extent permitted by law, any claim that any such action or proceeding brought in any such court has been brought in any inconvenient forum, (d)

agrees that services of process in any such action or proceeding may be effected by mailing a copy thereof by registered or certified mail (or any substantially similar form of mail), postage prepaid, to such Party at its address set forth in Section 16.4, or at such other address of which the Parties have been notified, and (e) acknowledges that there is no agreement between the Parties to arbitrate any dispute that may arise between them related to the subject matter of this Agreement.

14.4 WAIVER OF JURY TRIAL. EACH PARTY IRREVOCABLY WAIVES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, ANY AND ALL RIGHTS TO TRIAL BY JURY IN ANY LEGAL PROCEEDING ARISING OUT OF OR RELATING TO THIS AGREEMENT OR THE TRANSACTIONS CONTEMPLATED HEREBY.

14.5 Attorneys' Fees. If either Party institutes any legal suit, action or proceeding against the other party arising out of or relating to this Agreement, including, but not limited to, contract, equity, tort, fraud and statutory claims, the prevailing party in the suit, action or proceeding will be entitled to receive, in addition to all other remedies to which the prevailing party may be entitled, the costs and expenses incurred by the prevailing party in conducting the suit, action or proceeding, whether incurred before suit, during suit, or at the appellate level, including reasonable attorneys' fees and expenses, court costs and other legal expenses such as expert witness fees, and all fees, taxes, costs and expenses incident to appellate, bankruptcy and post-judgment proceedings.

14.6 Survival. The provisions set forth in this Article XIV shall survive the termination or expiration of this Agreement.

## ARTICLE XV

## REPRESENTATIONS AND WARRANTIES

15.1 Contractor Representations. Contractor represents and warrants the following:

15.1.1 Organization. It is a corporation duly organized, validly existing and in good standing under the laws of the state of its organization, and is duly authorized and qualified to do business in the State where the Project is located, and all other jurisdictions in which the nature of the business conducted by it makes such qualification necessary and where failure to so qualify would have a material adverse effect on its ability to perform any of its obligations under this Agreement.

15.1.2 No Violation of Law; Litigation. It is not in violation of any Applicable Laws or Applicable Permits or judgments entered by any Government Authority which violations, individually or in the aggregate, would affect its performance of any of its obligations under this Agreement. Except as Contractor has disclosed in writing to the Owner prior to the Effective Date, there are no legal, administrative or arbitration proceedings or actions, controversies, investigations, actions or other proceedings, now pending or (to the best knowledge of Contractor) threatened against Contractor which, if adversely determined, could reasonably be expected to effect on the ability of Contractor to perform any of its obligations

under this Agreement. Contractor does not know of any basis for any such proceedings, controversies, actions or investigations.

15.1.3 Licenses. It is the holder of all governmental consents, licenses, permissions and other authorizations and Permits required to operate and conduct its business now and as contemplated by this Agreement.

15.1.4 No Breach. None of the execution, delivery and performance of this Agreement, the consummation of the transactions herein contemplated, or compliance with the terms and provisions hereof, shall conflict with or result in a violation or breach of the terms, conditions or provisions of, or require any consent under, the charter or by-laws of Contractor, or any Applicable Law or regulation, order, writ, injunction, award, judgment or decree of any court, or any agreement, contract, indenture or other instrument to which Contractor is a party or by which it or its assets is bound or to which it or its assets is subject, or constitute a default under any such agreement or instrument.

15.1.5 Corporate Action. It has all necessary power and authority to conduct its business, own its properties and to execute, deliver and perform its obligations under this Agreement; the execution, delivery and performance by Contractor of this Agreement have been duly authorized by all requisite corporate action; and this Agreement has been duly and validly executed and delivered by Contractor and constitutes the legal, valid and binding obligation of Contractor enforceable in accordance with its terms, except as the enforceability thereof may be limited by bankruptcy, insolvency, reorganization or moratorium or other similar laws relating to the enforcement of creditors' rights generally and by general equitable principles.

15.1.6 Experience. It has by itself and through its Subcontractors, full experience and proper qualifications to perform the Work, including to construct the Project and to erect and install the equipment.

15.1.7 Intellectual Property. It owns or has the right to use all Intellectual Property Rights necessary to perform the Work without conflict with the rights of others.

15.1.8 Solvency. It is financially solvent, able to pay its debts as they mature, and possessed of sufficient working capital to complete its obligations under this Agreement.

15.1.9 Certifications. All Persons who will perform any portion of the Work have and will have all business and professional certifications required by Applicable Law to perform their respective services under this Agreement.

15.1.10 Site Access. The access rights granted to or obtained by Contractor to the Project Site are adequate for the performance of the Work and operation of the Project.

15.2 Owner Representations. Owner represents and warrants that:

15.2.1 Organization. It is a _____company duly formed, validly existing and in good standing under the laws of the State of _____, and is duly authorized and qualified to do business in the State where the Project is located and all other jurisdictions in which the nature of the business conducted by it makes such qualification necessary and where

failure to so qualify would have a material adverse effect on its ability to perform this Agreement.

15.2.2 No Breach. None of the execution and delivery of this Agreement, the consummation of the transactions herein contemplated, or compliance with the terms and provisions hereof and thereof, conflicts with or will result in a breach of, or require any consent under, the limited liability company agreement of Owner, or any Applicable Law or regulation, order, writ, injunction or decree of any court, or any agreement or instrument to which Owner is a party or by which it is bound or to which it is subject, or constitute a default under any such agreement or instrument.

15.2.3 Corporate Action. It has all necessary power and authority to conduct its business, own its properties and to execute, deliver and perform its obligations under this Agreement; the execution, delivery and performance by Owner of this Agreement have been duly authorized by all requisite limited liability company action; and this Agreement has been duly and validly executed and delivered by Owner and constitutes the legal, valid and binding obligation of Owner enforceable in accordance with its terms, except as the enforceability thereof may be limited by bankruptcy, insolvency, reorganization or moratorium or other similar laws relating to the enforcement of creditors' rights generally and by general equitable principles.

15.3 Survival of Representations and Warranties. The representations and warranties of Contractor herein shall survive execution and termination of this Agreement.

## ARTICLE XVI

## MISCELLANEOUS PROVISIONS

16.1 Confidentiality and Publicity.

16.1.1 Confidential Information and Permitted Disclosures. Each Party shall hold in confidence (a) any information provided or supplied by the other Party or its Personnel that is marked to be confidential, including such information as may have been provided or supplied prior to the Effective Date, (b) the commercial terms of any leases or other documents related to the Real Property Rights, and (c) the contents of this Agreement (collectively, "Confidential Information"). Both Parties shall inform their Affiliates, Subcontractors, suppliers and Personnel of their obligations under this Section 16.1 and require such Persons to adhere to the provisions hereof. Notwithstanding the foregoing, the following categories of information will not constitute Confidential Information.

(a) information that was in the public domain prior to receipt thereof by such Party or which subsequently becomes part of the public domain by publication or otherwise except by a wrongful act of such Party or its Affiliates, Subcontractors, employees, directors, officers, agents, advisers or representatives;

(b) information that such Party can show was lawfully in its possession prior to receipt thereof from the other Party through no breach of any confidentiality obligation;

(c) information received by such Party from a third party having no obligation of confidentiality with respect thereto;

(d) information at any time developed independently by such Party providing it is not developed from otherwise Confidential Information.

16.1.2 Permitted Disclosures. Notwithstanding anything herein to the contrary, a Party may disclose Confidential Information as follows:

(a) Confidential Information may be disclosed pursuant to and in conformity with Applicable Law or in connection with any legal proceedings described in Article XVI, or by Owner to the Oregon Public Utility Commission or the independent evaluator retained by Owner and approved by the Oregon Public Utility Commission in connection with the Project, provided that the Party required to disclose such information shall give prior notice to the other Party of such required disclosure and, if so requested by the other Party, shall use all reasonable efforts to oppose the requested disclosure as appropriate under the circumstances or to seek, through a protective order or other appropriate mechanism, to maintain the confidentiality of the Confidential Information;

(b) Confidential Information may be disclosed as required to be disclosed under securities laws applicable to publicly traded companies and their subsidiaries;

(c) Confidential Information may be disclosed to Affiliates, Subcontractors, employees, directors, officers, agents, advisors or representatives of such Party as necessary in connection with the Project; provided that such Persons are informed of the confidential nature of the Confidential Information, and such Party shall be liable to the other for any disclosure by such Person in violation of the terms of this Section 16.1; and

(d) Owner may disclose a copy of this Agreement to any actual or potential financing parties or insurers.

16.1.3 Consent. Notwithstanding the foregoing, either Party may disclose Confidential Information with the express written consent of the other Party, which consent shall not be unreasonably conditioned, withheld, or delayed.

16.1.4 Publicity. Until expiration of the Warranty Period, neither Party shall issue any press or publicity release or otherwise release, distribute or disseminate any Confidential Information for publication concerning this Agreement or the participation of the other Party in the transactions contemplated hereby without the prior written consent of the other Party; provided, however, that such limitation on disclosure shall not apply to disclosures or reporting required by a Government Authority if the Party seeking disclosure informs the other Party of the need for such disclosure and, if reasonably requested by the other Party, seeks, through a protective order or other appropriate mechanism, to maintain the confidentiality of Confidential Information.

16.1.5 Right to Relief. It is agreed that each Party shall be entitled to relief both at law and in equity, including injunctive relief and specific performance, in the event of any breach or anticipated breach of this Section 16.1, without proof of any actual or special damages.

16.1.6 Ownership of Confidential Information. All right and title to, and interest in, a Party's Confidential Information shall remain with such Party. All Confidential Information obtained, developed or created by or for Contractor exclusively for the Project, including copies thereof, is the exclusive property of Owner whether delivered to Owner or not. No right or license is granted to Contractor or any third party respecting the use of Confidential Information by virtue of this Agreement, except to the extent required for Contractor's performance of its obligations hereunder. Contractor shall deliver the Confidential Information, including all copies thereof, to Owner upon request.

16.1.7 Survival. The Parties' obligations under this Article XVI shall remain in force during the term of this Agreement and for a period of five (5) years after Final Completion.

16.2 Consequential Damages. In no circumstances shall either Party (or the parent companies and Affiliates of each, and their respective members, shareholders, officers, directors, agents and employees) be liable to the other Party (or its parent companies and Affiliates, and their respective members, shareholders, officers, directors, agents and employees) for any consequential, incidental, indirect, special, exemplary or punitive damages (including loss of power, loss of production, loss of actual or anticipated profits, revenues or product; increased expense of borrowing or financing, claims of Owner's customers and damage to property or equipment, and increased cost of capital) (collectively, "Consequential Damages") arising out of this Agreement; and, regardless of whether any such claim arises out of breach of contract, guarantee or warranty, tort, (including negligence and strict liability), product liability, indemnity, contribution, strict liability or any other legal or equitable theory. Increased expense of borrowing or financing, and increased cost of capital arising by virtue of a contractual obligation owed to an off-taker or purchaser of electricity generated by the Work are agreed for the purposes of this Agreement to be Consequential Damages. For avoidance of doubt, any liquidated damages as set forth in this Agreement and any third party indemnification claims for loss of actual or anticipated profits, revenues or product shall not constitute Consequential Damages under this Agreement.

16.3 Limitation on Liability. Notwithstanding anything to the contrary contained in this Agreement, in no event shall Contractor be liable to Owner for any damages, claims, demands, suits, causes of action, losses, costs, expenses or liabilities in excess of an amount equal to one hundred percent (100%) of the Contract Price, as adjusted for Change Orders (other than those which reduce the Contract Price related to damages of Owner hereunder), regardless of whether such liability arises out of breach of contract, tort, product liability, contribution, strict liability or any other legal theory; *provided, however*, that the preceding limitation of liability shall not apply to, and no liability amounts shall be apply against such limitation of liability for (a) liabilities resulting from the negligence, fraud, willful misconduct or illegal or unlawful acts of Contractor or its Personnel (including their Subcontractors), (b) liabilities arising out of Contractor's obligations to indemnify Owner or other indemnitees for third party claims under this Agreement, or (c) costs incurred by Contractor (and, in the event Contractor fails to perform, Owner) in performing Warranty Service, or (d) any taxes payable by Contractor; (e) damages for risks required to be insured by Contractor under this Agreement, or (f) costs incurred by Contractor (and in the event of Contractor Default, Owner) in achieving Project Substantial Completion.

16.4 Notice. All notices and other communications required or permitted by this Agreement or by law to be served upon or given to a Party by any the other Party shall be in writing signed by the Party giving such notice and shall be deemed duly served, given and received (i) when actually received by the Party to whom it is sent, if served personally or if delivered by nationally recognized courier service to the Party to whom notice is to be given, (ii) when received by the Party to whom it is sent, if sent in the form of a signed letter on the sending Party's letterhead, transmitted by email in Portable Document Format (pdf) or similar format; (iii) when received (with confirmation of receipt) if delivered by facsimile or email, or (iv) at the end of the first Business Day following actual delivery, if mailed by first class registered or certified mail, return receipt requested, postage prepaid, addressed to the appropriate Party, at the address or facsimile numbers of such Party set forth below (or at such other address as such Party may designate by written notice to the other Party in accordance with the Section):

| **If to Owner:** | **If to Contractor:** |
|---|---|
| with a copy to : | with a copy to : |

16.5 Time of the Essence. Time is of the essence in the performance of the Work in accordance with the requirements of this Agreement.

16.6 No Rights in Third Parties. Except as otherwise set forth herein including in Section 3.2, hereof, with respect to the rights of permitted successors and assigns, and the rights of indemnitees under Article X, (a) nothing in this Agreement nor any action taken hereunder shall be construed to create any duty, liability or standard of care to any Person that is not a Party, (b) no Person that is not a Party shall have any rights or interest, direct or indirect, in this Agreement or the services to be provided hereunder and (c) this Agreement is intended solely for the benefit of the Parties, and the Parties expressly disclaim any intent to create any rights in any third party as a third-party beneficiary to this Agreement or the services to be provided hereunder.

16.7 Entire Agreement. This Agreement contains the entire understanding of the Parties with respect to the subject matter hereof and supersedes all prior agreements, arrangements, discussions, undertakings and commitments (whether written or oral) with respect thereto. All the Exhibits (Exhibit A through Exhibit S-2) attached hereto are incorporated into and made a part of this Agreement. There are no other oral understandings, terms or conditions and neither Party has relied upon any representation, express or implied, not contained in this Agreement.

16.8 Amendments. No amendment or modification of this Agreement shall be valid or binding upon the Parties unless such amendment or modification shall be in writing and duly executed by authorized officers of both Parties. For the avoidance of doubt, emails between the Parties shall not be considered a writing for purposes of this Section 16.8.

16.9 GOVERNING LAW. THIS AGREEMENT SHALL BE GOVERNED BY AND CONSTRUED IN ACCORDANCE WITH THE LAWS OF THE STATE OF OREGON, WITHOUT REGARD TO CONFLICT OF LAW PRINCIPLES.

16.10 Right of Waiver. No delay, failure or refusal on the part of any Party to exercise or enforce any right under this Agreement shall impair such right or be construed as a waiver of such right or any obligation of another Party, nor shall any single or partial exercise of any right hereunder preclude other or future exercise of any right. The failure of a Party to give notice to the other Party of a breach of this Agreement shall not constitute a waiver thereof. Any waiver of any obligation or right hereunder shall not constitute a waiver of any other obligation or right, then existing or arising in the future. Each Party shall have the right to waive any of the terms and conditions of this Agreement that are for its benefit. To be effective, a waiver of any obligation or right must be in writing and signed by the Party waiving such obligation or right.

16.11 Severability. If any provision of this Agreement is held to be illegal, invalid, or unenforceable under present or future laws, such provision shall be fully severable; this Agreement shall be construed and enforced as if such illegal, invalid or unenforceable provision had never comprised a part of this Agreement; and the remaining provisions of this Agreement shall remain in full force and effect and shall not be affected by the illegal, invalid, or unenforceable provision or by its severance from this Agreement. Furthermore, in lieu of such illegal, invalid or unenforceable provision, there shall be added automatically as a part of the this Agreement a provision as similar in its terms to such illegal, invalid or unenforceable provision as may be possible and be legal, valid and enforceable.

16.12 Successors and Assigns; Assignment. Subject to the following, this Agreement shall be binding upon the Parties, their successors and permitted assigns. Except as set forth herein, this Agreement and all of Contractor's rights, duties and obligations under this Agreement are personal in nature and shall not be assigned, delegated or otherwise disposed of by Contractor without the prior written consent of Owner. Owner may assign this Agreement in whole or in part; provided that Contractor is provided written notice as soon as reasonably possible following such assignment. Contractor agrees and acknowledges that any third party receiving such an assignment provided it assumes all obligations hereunder, in writing, shall be entitled to exercise any and all rights of Owner under this Agreement in accordance with the terms hereof (in its own name or in the name of Owner) and Contractor shall comply in all respects with such exercise. Provided the assignee assumes, in a writing reasonably satisfactory to Contractor, all obligations of Owner hereunder, Owner shall be released upon assignment. Nothing in this Section 16.12 shall affect Owner's ability to collaterally assign this Agreement to any financing parties.

16.13 Survival. All provisions of the Agreement that are expressly or by implication to come into or continue in force and effect after the expiration or termination of this Agreement, including Articles VII, X and XIII, shall remain in effect and be enforceable following such

expiration or termination. The representations and warranties of Contractor contained herein shall survive the execution and delivery hereof and thereof.

16.14 Expenses and Further Assurances. Each Party shall pay its own costs and expenses in relation to the negotiation, preparation execution and carrying into effect this Agreement. Contractor and Owner agree to provide such information, execute and deliver any instruments and documents and to take such other actions as may be necessary or reasonably requested by the other Party (at the cost and expense of the other Party) in order to give full effect to this Agreement and to carry out the intent of this Agreement.

16.15 Counterparts. This Agreement may be executed in any number of counterparts and each counterpart shall represent a fully executed original as if executed by both Parties, with all such counterparts together constituting but one and the same instrument.

16.16 Status of Contractor; No Partnership; No Agency. Contractor shall be an independent contractor with respect to any and all Work performed and to be performed under the Agreement. The Agreement shall not be interpreted or construed to create an association, joint venture or partnership relationship among or between the Parties or any similar relationship, obligations or liabilities. Neither Party shall have any right, power or authority to enter into any agreement or undertaking for, act on behalf of, or to act as or be an agent or representative of, or to otherwise bind or obligate the other Party.

16.17 Compliance with Applicable Laws. Contractor and its Subcontractors are familiar with and shall comply with and observe, all Applicable Laws, including but not limited to the federal Foreign Corrupt Practices Act (15 U.S.C.S. §§ 78a and 78m et seq.) ordinances, rules, regulations, executive orders, all applicable safety orders and all orders or decrees of administrative agencies, courts or other legally constituted authorities having jurisdiction or authority over Contractor and its Subcontractors, Owner or the Equipment which may now or hereafter exist.

[Signatures on following page]

IN WITNESS WHEREOF, the Parties have caused this Agreement to be executed by their duly authorized representatives as of the date and year first above written.

Owner:

By: _____
Name: _____
Title: _____

Contractor:

By: _____
Name: _____
Title: _____

# 14 Appendix D - Parent Guaranty

# PARENT GUARANTY

# GUARANTY

This GUARANTY ("**Guaranty**") is made as of the __ day of _____, 20__, by _____ ("**Guarantor**"), to and for the benefit of **Portland General Electric Company**, an Oregon corporation having a principal office at 121 SW Salmon Street, Portland, OR 97204 ("**Owner**"), with reference to the following.

WHEREAS, _____ ("**Contractor**"),[1] is wholly owned, directly or indirectly, by Guarantor; and

WHEREAS, Contractor and Owner have entered into the [_____] dated as of [_____, 20__] (the "**Contract**"); and

WHEREAS, to induce Owner to enter into the Contract, Guarantor is willing to furnish to Owner this Guaranty;

NOW, THEREFORE, for and in consideration of the foregoing premises, and for other good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, Guarantor covenants and agrees as follows:

1. Definitions. Unless otherwise defined herein, all capitalized terms used herein which are defined in the Contract shall have their respective meanings as therein defined. All references to the Contract contained herein shall be construed to mean the Contract as it may be amended from time to time. Unless otherwise required by the context in which any term appears in this Guaranty: (a) the singular shall include the plural and vice versa; (b) the words "herein," "hereof" and "hereunder" shall refer to this Guaranty as a whole and not to any particular sections or subsections hereof; (c) the words "including" or "includes" shall be construed to mean without limitation" or "but not limited to" and (d) the word "or" is not necessarily exclusive.

2. Guaranty. Guarantor hereby absolutely, irrevocably and unconditionally guarantees to Owner, its successors and permitted assigns the full and prompt payment and performance when due of all of Contractor's warranties, covenants, indebtedness, duties and agreements contained in the Contract including, but not limited to, payment obligations under the Contract. All obligations, representations, warranties, covenants, indebtedness, duties and agreements described above are individually referred to herein as an "Obligation" and collectively as the "Obligations." This Guaranty is in no way conditioned upon any requirement that Owner first attempt to enforce any of the Obligations against Contractor. If at any time Contractor fails, neglects or refuses to timely or fully perform any of the Obligations as provided in the Contract, Guarantor shall promptly perform or cause to be performed such Obligation upon receipt of written notice of such default and demand for performance from Owner. Notwithstanding anything set forth to the contrary herein, with respect to any claim, action or

[1] Counterparty name to be modified as appropriate in the event the guaranty is used in connection with the Asset Purchase Agreement.

proceeding against Guarantor in connection with this Guaranty, Guarantor shall be entitled to assert any rights, remedies and defenses that Contractor would be able to assert if such claim, action or proceeding were to be asserted or instituted against Contractor based upon the Contract, including, but not limited to, any limitations of liability and cure periods set forth in the Contract, but provided that: (i) no defense previously raised by Contractor arising out of or in connection with an Obligation claimed hereunder that has been settled in Owner's favor may be raised by Guarantor; (ii) no cure period previously used by Contractor may be used by Guarantor; and (iii) in no event shall Guarantor be entitled to assert any defenses that arise by operation of law on account of an Event of Bankruptcy (as defined below) or the bankruptcy or insolvency of Contractor. Guarantor agrees that this Guaranty is a guaranty of performance including, but not limited to, payment, and not merely a guaranty of collection and shall apply regardless of whether recovery of any or all of the Obligations may be or become discharged or uncollectible in Event of Bankruptcy (as defined below) in which Contractor is the debtor. All payments hereunder shall be made without reduction, whether by set-off or otherwise.

3. Unconditional Guaranty. The obligations of Guarantor hereunder are independent, absolute and unconditional, irrespective of any genuineness, validity, regularity or enforceability of the Obligations and irrespective of any genuineness, validity, regularity or enforceability of the Contract, or any substitution, release or exchange of any other guarantee of or security for any of the Obligations, and, to the fullest extent permitted by applicable law, irrespective of any other circumstance whatsoever that might otherwise constitute a legal or equitable discharge or defense of a surety or guarantor. Without limiting the generality of the foregoing, the occurrence of any one or more of the following shall not affect the liability of Guarantor hereunder:

(a) at any time or from time to time, without notice to Guarantor, the time for any performance of or compliance with any of the Obligations shall be extended, or such performance or compliance shall be waived;

(b) any acts or omissions by Contractor with respect to the Obligations;

(c) any of the Obligations shall be modified, supplemented or amended in any respect, or any right with respect to the Obligations shall be waived or any other guaranty of any of the Obligations or any security therefore shall be released or exchanged in whole or in part or otherwise modified or dealt with;

(d) any lien or security interest granted to, or in favor of, Owner as security for any of the Obligations shall fail to be valid or perfected;

(e) the voluntary or involuntary liquidation, dissolution, sale or other disposition of the assets and liabilities, or the voluntary or involuntary receivership, insolvency, bankruptcy, assignment for the benefit of creditors, reorganization or other similar proceeding affecting Contractor, or rejection of the Contract in any such proceeding, or any action taken by any trustee or receiver in connection therewith (an "Event of Bankruptcy");

(f) any lack of authorization, in whole or in part, of the Obligations or any term or provision hereof or of the Contract for any reason, or the rejection or purported rejection thereof in any Event of Bankruptcy;

(g) Owner shall have taken or failed to have taken any steps to collect or enforce any obligation or liability from Contractor or shall have taken any actions to mitigate its damages;

(h) Owner shall have taken or failed to have taken any steps to collect or enforce any guaranty of or to proceed against any security for any Obligation;

(i) any applicable law that might in any manner cause or permit to be invoked any alteration in the time, amount or manner of payment or performance of any of the Obligations or the obligations of Guarantor hereunder;

(j) any merger or consolidation of Contractor or Guarantor into or with any other person or any sale, lease or transfer of all or any of the assets of Contractor or Guarantor to any other person;

(k) any change in the ownership of any of the voting securities of Contractor or Guarantor;

(l) to the extent as may be waived by applicable law, the benefit of all principles or provisions of laws, rules and regulations which may be in conflict with the terms hereof; or

(m) any failure on the part of Contractor or Guarantor to comply with any applicable law.

4. Subordination of Subrogation Rights. Guarantor hereby subordinates to all claims, rights and remedies that Owner or any of Owner's permitted assigns may have against Contractor any claim, right or remedy that Guarantor may now have or hereafter acquire against Contractor that arises hereunder or in connection herewith, including any claim, remedy or right of subrogation, reimbursement, indemnity, exoneration, contribution or participation in any claim, remedy or right against Contractor that arises in connection herewith, whether or not such claim, right or remedy arises in equity, under contract, by statute, under common law or otherwise until the Obligations have been paid and performed in full. If any amount shall erroneously be paid to Guarantor on account of such subrogation, reimbursement, indemnity, exoneration, contribution, and similar rights, such amount shall be held in trust for the benefit of Owner and shall forthwith be paid to Owner to be credited against the payment of the Obligations, whether matured or unmatured.

5. Remedies. Guarantor agrees that the Obligations shall be due and payable for purposes of this Guaranty notwithstanding any stay, injunction or other prohibition preventing a declaration of payment as against Contractor.

6. Certain Waivers. Guarantor hereby unconditionally and irrevocably waives, to the extent permitted by applicable law, (i) notice of any of the matters referred to in Section 3 hereof; (ii) all notices that may be required by applicable law or otherwise, now or hereafter in effect, to preserve any rights against Guarantor hereunder, including, any demand, proof or notice of non-payment of the Obligations except as otherwise required by Section 2 hereof; (iii) acceptance of this Guaranty, demand, protest, promptness, diligence, presentment, notice of default or dishonor and any requirement of diligence, notice of intent to accelerate, notice of acceleration and notice of the incurring of the Obligations; (iv) any right to assert against Owner any defense (legal or equitable), counter-claim, set-off, cross-claim or other claim that Guarantor may now or at any time hereafter have (a) against Contractor or (b) acquired from any other party to which Owner may be liable; (v) any defense arising by reason of any claim or defense based upon an election of remedies by Owner which in any manner impairs, affects, reduces, releases, destroys or extinguishes Guarantor's subrogation rights, rights to proceed against Contractor for reimbursement, or any other rights of the Guarantor to proceed against Contractor or against any other person, property or security and (vi) any right to require Owner to marshal, or have recourse to other collateral or surety, before exercising its rights hereunder.

7. Separate Enforcement. The obligations of Guarantor under this Guaranty are independent of and may be enforced separately from the Obligations, in a separate action or actions that may be brought and prosecuted against Guarantor whether or not action is brought against Contractor. Guarantor agrees that payment or performance of any of the Obligations or other acts which toll any statute of limitations applicable to the Obligations or the Contract shall also toll the statute of limitations applicable to Guarantor's liability under this Guaranty.

8. Representations and Warranties. Guarantor additionally represents and warrants to Owner as follows:

(a) Guarantor is a corporation duly organized, validly existing, authorized to do business and in good standing under the laws of the State of its formation.

(b) Guarantor has the requisite corporate power and authority to own its property and assets, transact the business in which it is engaged and to enter into this Guaranty and carry out its obligations hereunder. The execution, delivery, and performance of this Guaranty have been duly and validly authorized and no other corporate proceedings on the part of Guarantor or its affiliates are necessary to authorize this Guaranty or the transactions contemplated hereby.

(c) No authorization or approval or other action by, and no notice to or filing with, any governmental authority or other regulatory body or third party is required for the due execution, delivery and performance by Guarantor of this Guaranty.

(d) This Guaranty, when executed, shall constitute a valid and binding agreement of Guarantor and is enforceable against Guarantor in accordance with the terms of this Guaranty, except as may be limited by bankruptcy or insolvency or by other laws affecting the rights of creditors generally and except as may be limited by the availability of equitable remedies, and except to the extent that the execution

of this Guaranty was induced by fraud, misrepresentation, or fraudulent concealment by or on behalf of the Owner.

(e) As of the date hereof, the execution, delivery, and performance of this Guaranty does not and will not (i) result in a default, breach or violation of the certificate or articles of incorporation or bylaws of Guarantor, or (ii) constitute an event which would permit any person or entity to terminate rights or accelerate the performance or maturity of any indebtedness or obligation of Guarantor, the effect of which would materially affect Guarantor's ability to meet its obligations under this Guaranty, (iii) constitute an event which would require any consent of a third party or under any agreement to which Guarantor is bound, the absence of which consent would materially and adversely affect Guarantor's ability to meet its obligations under this Guaranty, or (iv) result in any default, breach or violation of any license, permit, franchise, judgment, writ, injunction, decree, order, charter, law, ordinance, rule or regulation applicable to Guarantor and which default, breach or violation would materially and adversely affect Guarantor's ability to meet its obligations under this Guaranty.

9. Amendments. No amendment of any provision of this Guaranty shall be effective unless it is in writing and signed by Guarantor, Owner and any permitted assignee of Owner's rights hereunder, and no waiver of any provision of this Guaranty, and no consent to any departure by Guarantor therefrom, shall be effective unless it is in writing and signed by Owner or any permitted assignee of Owner's rights hereunder. No delay on the part of Owner in exercising any right, power or privilege hereunder shall operate as a waiver thereof, nor shall any waiver or any partial exercise of any such right, power or privilege preclude any further exercise thereof or the exercise of any other such right, power or privilege. No waiver of any breach, term or condition of this Guaranty by Owner shall constitute a subsequent waiver of the same or any other breach, term or condition. No notice to or demand on Guarantor shall entitle Guarantor to any other or further notice or demand in similar or other circumstances or constitute a waiver of the rights of Owner to any other or further action in any circumstances without notice or demand. The rights and remedies herein expressly provided are cumulative and not exclusive of any rights or remedies which Owner would otherwise have.

10. Continuing Guaranty; Successor and Assigns. This Guaranty is a continuing guaranty and (i) shall apply to all Obligations whenever arising, (ii) shall remain in full force and effect until satisfaction in full of all of the Obligations, (iii) shall be binding upon Guarantor and its successors and permitted assigns and (iii) shall inure to the benefit of and be enforceable by Owner and its successors, and assigns permitted under the Contract. Notwithstanding the foregoing, however, Guarantor may not assign all or any portion of its rights or delegate all or any portion of its duties under this Guaranty without the prior written consent of Owner. Any assignment by Guarantor without the foregoing consent shall be void.

11. Payments. Owner shall have the right from time to time to make demand for Obligations. With respect to payments to be made by Guarantor under this Guaranty, all such payments shall be made in United States dollars promptly following written demand by Owner, by wire transfer into a bank account designated in writing from time to time by Owner. All

payments required to be made by Guarantor hereunder shall be made without set-off or counterclaim and shall be made without deduction for any withholding or other taxes or charges. If in compliance with the laws of any jurisdiction, any deduction or withholding on account of any taxes is required to be made from any amount paid or payable by Guarantor to Owner (other than any amount Contractor would have been required to deduct or withhold pursuant to the Contract), Guarantor shall pay to Owner any such additional amount as shall be necessary to ensure that Owner receives on the due date for payment hereunder, after the payment by Guarantor of such taxes, an amount equal to what it would have received and retained had no such deduction or withholding been required.

12. Expenses. Guarantor agrees to pay on demand all reasonable out-of-pocket expenses (including the reasonable fees and expenses of Owner's counsel) in any way relating to the enforcement or protection of the rights of Owner hereunder; provided that the Guarantor shall not be liable for any expenses of Owner if no payment under this Guarantee is due.

13. Reinstatement. In the event that Owner for any reason (including but not limited to bankruptcy preferences or alleged fraudulent transfers), is required to repay or disgorge any amounts received by it in respect of the Obligations, then the liability of Guarantor under this Guaranty, with respect to such amounts, shall be reinstated.

14. Governing Law. This Guaranty shall be governed by and construed in accordance with the laws of the state of Oregon, excluding rules governing conflicts of laws.

15. Dispute Resolution.

a. Informal Consultation. In the event of any controversy, claim or dispute between the Parties arising out of or related to this Guaranty ("Dispute"), the parties' representatives will first attempt to resolve the Dispute informally through negotiation and consultation. If they are unable to do so, then within three (3) business days following the date of delivery of a written request by either Party, (i) each party shall appoint as its representative a senior officer, and (ii) such senior officers shall meet, negotiate and attempt in good faith to resolve the Dispute quickly, informally and inexpensively.

b. Mediation. Any Dispute that is not resolved pursuant to Section 15(a) may be submitted for mediation before a single mediator in accordance with the provisions contained herein and in accordance with the Commercial Mediation Procedures of the AAA in effect at the time of the mediation ("AAA Procedures"); provided, however, that in the event of any conflict between the procedures herein and the AAA Procedures the procedures herein shall control. The mediator will be named by mutual agreement of the Parties or by obtaining a list of five (5) qualified Persons from the Parties and alternately striking names. All mediation shall be administered by the AAA. All mediation shall take place in the City of Portland, Oregon, unless otherwise agreed to by the Parties. Each Party shall be required to exchange documents to be used in the mediation not less than five (5) Business Days prior to the mediation. The Parties shall use all commercially reasonable efforts to conclude the mediation as soon as practicable.

All aspects of the mediation shall be treated as confidential. Neither the Parties nor any mediator may disclose the content or results of the mediation, except as necessary to comply with legal, audit or regulatory requirements. Before making any such disclosure, a Party shall give written notice to the other Party and shall afford such Party a reasonable opportunity to protect its interests. Each Party shall be responsible for its own expenses and one-half of any mediation expenses incurred to resolve the dispute. The mediator will provide the Parties with a fee and expense schedule in advance of mediation. Mediation will terminate by: (a) written agreement signed by both Parties, (b) determination by the mediator that the Parties are at an unresolvable impasse, or (c) two unexcused absences by either Party from the mediation sessions. The mediator will never participate in any claim or controversy covered by this Section 15 as a witness, collateral contract, or attorney and may not be called as a witness to testify in any proceeding involving the subject matter of mediation. O.R.S. §§ 36.100 to 36.238 will apply to the entire process of mediation.

c. Legal Action. If the Parties are still unable to resolve their differences after good faith consideration of a resolution through mediation pursuant to Section 15(b), then each of the Parties hereby irrevocably consents and agrees that any legal action or proceedings with respect to this Guaranty may be brought in the United States District Court for the District of Oregon or, if such court lacks subject matter jurisdiction, the courts of the State of Oregon located in the City of Portland, and any appellate court from any thereof. By execution and delivery of this Guaranty and such other documents executed in connection herewith, each Party hereby irrevocably and unconditionally (a) consents to the personal and exclusive jurisdiction of the aforesaid courts, and agrees that it will not commence or consent to participate in any action, litigation or proceeding of any kind whatsoever against any the other Party in any way related to such documents in any forum other than such courts, (b) agrees to be bound by any final judgment (after any and all appeals) of any such court with respect to such documents, (c) waives, to the fullest extent permitted by law, any objection it may now or hereafter have to the laying of venue of any action or proceeding with respect to such documents brought in any such court, and further waives, to the fullest extent permitted by law, any claim that any such action or proceeding brought in any such court has been brought in any inconvenient forum, (d) agrees that services of process in any such action or proceeding may be effected by mailing a copy thereof by registered or certified mail (or any substantially similar form of mail), postage prepaid, to such Party at its address set forth in Section 16, or at such other address of which the Parties have been notified, and (e) acknowledges that there is no agreement between the Parties to arbitrate any dispute that may arise between them related to the subject matter of this Guaranty.

d. Waiver of Jury Trial. EACH PARTY IRREVOCABLY WAIVES, TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAW, ANY AND ALL RIGHTS TO TRIAL BY JURY IN ANY LEGAL PROCEEDING ARISING OUT OF OR RELATING TO THIS GUARANTY OR THE TRANSACTIONS CONTEMPLATED HEREBY.

e. Survival. The provisions set forth in this Section 15 shall survive the termination or expiration of this Guaranty.

16. Notices. Any notices or other communication to be given hereunder shall be given in writing, sent by (a) personal delivery, (b) internationally recognized expedited delivery service, (c) registered or certified United States mail, postage prepaid, or (d) facsimile (followed by registered or certified United States mail, postage prepaid) as follows:

To Guarantor:

To Owner: Portland General Electric Company
121 SW Salmon Street
Portland, OR 97204
Attention: [_____]

With a copy to: Portland General Electric Legal Department
121 SW Salmon Street, 1WTC13
Portland, OR 97204
Attention: [_____]

or to such other address or to the attention of such other individual as hereafter shall be designated in writing by the applicable party sent in accordance herewith. Any such notice or communication shall be deemed to have been given either at the time of personal delivery or, in the case of delivery service or mail, as of the date of receipt at the address and in the manner provided herein, or in the case of facsimile, upon receipt.

17. Severability. In the event that any of the provisions, or portions or applications thereof, of this Guaranty are held to be unenforceable or invalid by any court of competent jurisdiction, Owner and Guarantor shall negotiate an equitable adjustment in such provisions of this Guaranty with a view toward effecting the purpose of this Guaranty, and the validity and enforceability of the remaining provisions, or portions or applications thereof, shall not be affected thereby.

18. Duty to Keep Informed. Guarantor assumes the responsibility for being and keeping itself informed of the financial condition and performance under the Contract of Contractor until the termination of all of the Obligations, and of all other circumstances bearing upon the risk of nonpayment or default under the Obligations which diligent inquiry would reveal, and agrees that Owner shall have no duty to advise Guarantor of information known to it regarding such condition or any such circumstances.

19. Entire Agreement. This Guaranty contains the entire agreement and understanding of Guarantor and Owner with respect to the subject matter hereof and supersedes all prior agreements and understandings, whether written or oral, of Guarantor and Owner relating to the subject matter hereof. Any oral or written representation, warranty, course of dealing or trade usage not contained or referenced herein shall not be binding on either Guarantor or Owner.

20. No Third Party Beneficiaries. The provisions of this Guaranty shall only be for the benefit of, and enforceable by, Owner and its permitted assigns and shall not inure to the benefit of or be enforceable by any other person or entity.

21. Further Assurances. Guarantor and Owner shall each, at the request of the other, execute and deliver or cause to be executed and delivered such documents and instruments not otherwise specified herein, and take or cause to be taken all such other reasonable actions, as may be necessary or desirable to more fully and effectively carry out the intent and purposes of this Guaranty.

22. Counterparts. This Guaranty may be executed in two or more separate counterparts (including by facsimile transmission), each of which shall be deemed an original, and all of said counterparts taken together shall be deemed to constitute one and the same instrument.

23. Captions. The captions contained in this Guaranty are for convenience and reference only and in no way define, describe, extend or limit the scope or intent of this Guaranty or the intent of any provision contained herein.

IN WITNESS WHEREOF, the undersigned, intending to be legally bound hereby, has executed this Guaranty as of the date first written above.

Accepted:

[GUARANTOR]

PORTLAND GENERAL ELECTRIC COMPANY

By: _____

Name: _____

Title: _____

By: _____

Name: _____

Title: _____

# 15 Appendix E - Credit Requirement Guidance

# Appendix E – Credit Guidance

A Bidder must provide reasonable assurance to PGE that PGE will be able to readily recover its actual damages in the event of default by the Bidder. All transactions are contingent upon the Bidder meeting and maintaining, during the term of the transaction, the credit requirements established by PGE's Credit Risk Management Department. All Bidders will be subject to credit review under PGE's internal guidelines by PGE's Credit Risk Management Department for qualification.

Each Bidder must provide performance assurance in a form and amount reasonably acceptable to PGE based on PGE's assessment of the Bidder's credit profile and the amount of expected financial exposure related to the bid.

**Bidder Credit Eligibility Thresholds**

All bidders must meet PGE's credit eligibility thresholds. Investment grade bidders meet PGE's credit eligibility thresholds if their long-term, senior unsecured debt has been recently rated BBB- or higher by Standard & Poor's and Fitch, BBB (low) or higher by DBRS, or Baa3 or higher by Moody's Investor Services, Inc. Bidders that have recently been rated below the above standards, or not rated, are deemed non-investment grade. Those bidders that are non-investment grade must demonstrate, prior to bidding, that a qualified institution (defined below) is willing to support the bidder's pre-COD performance obligations through a Letter of Credit Commitment Letter and, for applicable utility-owned bids, a Guarantor Commitment Letter.

"Qualified Institution" means a major U.S. commercial bank or a U.S. branch office of a major foreign commercial bank which is acceptable to PGE, organized under the laws of the United States (or any state or political subdivision thereof) with such bank having shareholders' equity of at least $10 billion (U.S. Dollars) and a Credit Rating of at least A- by S&P or A1 by Moody's, or an insurance company with assets of $2 billion or greater, an A.M. Best financial strength rating of an A or greater and authorized to issue surety bonds in the state in which the project will be located.

**Required Performance Assurances for New, Utility-Owned Resources**

Winning bidders offering new, utility owned resources under APA and EPC (or similar) agreements must provide pre-COD performance assurances. The pre-COD performance assurance will include $200/kW of collateral. The collateral will take the form of cash, or an irrevocable, transferable, standby letter of credit issued by a Qualified Institution (defined above) in a form and substance reasonably acceptable to PGE. The pre-COD performance assurance will also include a payment and performance bond in a penal sum up to 100% of the contract price. The payment and performance bond must be issued by a Qualified Institution in a form and substance reasonably acceptable to PGE.

In addition, non-investment grade bidders will be required to provide a guarantee from an investment grade guarantor. At time of bid, non-investment grade bidders offering a new, utility-owned resource must provide a Guarantee Commitment Letter from the Bidder's guarantor.

In the event the Bidder experiences a material adverse change (i.e., is no longer creditworthy as defined above or as defined in the negotiated contract) during the term of the contract, the Bidder may be required to provide additional eligible performance assurances in one or more of the forms defined above.

The performance assurances for new, utility owned resources are summarized in the following table:

| Timing | Performance Assurance |
|---|---|
| Pre-COD Amount | 1. $200/kw collateral<br>2. Payment and performance bond up to 100% of the contract price<br>3. Guarantee |
| Post-COD Amount | No Post-COD collateral required |

**Required Performance Assurances for Power Purchase Agreements (PPA)**

For long-term Power Purchase Agreements, PGE will require pre-COD (for facilities not yet constructed) and post-COD performance assurance to provide adequate protection if the counterparty defaults under the PPA . PGE requires that Bidders include the cost of adequate, acceptable performance assurance as part of their bid proposal as shown below. Proposed exceptions or alternatives to these required performance assurances need to be explicitly stated in the Form PPA.

The performance assurances power purchase agreements are summarized in the following table:

| Timing | Performance Assurance |
|---|---|
| Pre-COD Amount | $200/kW collateral |
| Post-COD Amount | 60 months of estimated contract margin or minimum performance assurance * |

*The estimated contract margin will be based on a mark-to-market assessment of the expected facility output, the Contract Price and replacement forward power and bundled REC replacement costs. The minimum performance assurance will be based on the expected facility output and an estimated replacement bundled REC cost.

Post-COD performance assurances will be the amount calculated by taking the difference of the current market forward price for power and bundled RECs compared to the contract price for the prompt five years, and multiplying this difference by the forecasted megawatt hours for delivery over the same prompt five year period. In no event shall Post-COD performance assurance(s) be less than the minimum performance assurance equal to the forecasted megawatt hours for delivery over an 18 month period multiplied by the forecasted bundled REC price. Market forward prices and REC prices will be based on reasonably available forecasts and broker quotes. The performance assurance requirement may be reduced by any credit threshold (see below) granted to Bidder by PGE. PGE calculates these exposures at least once a week. Below are two examples of required post-COD performance assurances:

| (A) | (B) | (C) | (D) | (E) | (F) | (G) | (H) | (I) |
|---|---|---|---|---|---|---|---|---|
| Facility Size (MW) | Forecasted Capacity Factor (%) | Annual Forecasted Energy or Specified Amount (MWa) | Number of Hours in Five Prompt Years (hrs) | Contract Price ($/MWh) | Delivered Average Market Forward Price and Bundled REC ($/MWh) | Forecasted Imputed Bundled REC Price ($/MWh) | Minimum Performance Assurance [C*D*30%*G] | Performance Assurance Required Greater of [C*D*(F-E)] or [H] |
| 300 MW | 33% | 100 MWa | 43,800 | 35 | 40 | 5 | $6,570,000 | $21,900,000 |
| 500 MW | 20% | 100 MWa | 43,800 | 45 | 40 | 5 | $6,570,000 | $6,570,000 |

**Potential Credit Threshold Granted by PGE**

For some energy and REC sale structures, investment grade bidders may be eligible for a credit threshold to be applied against the required performance assurance. The table below provides a range of potential thresholds for which a Bidder may be eligible. These amounts may be increased or decreased by PGE Credit Risk Management based on other factors such as company size, credit rating, bid type, payment history, financial analyses, and overall risk assessment.

| | Credit Threshold (Estimated) Matrix | | | | |
|---|---|---|---|---|---|
| | Range of Moddy's Credit Rating | | | | |
| **Tangible Net Worth** | **Aaa - A1** | **A2 - A3** | **Baa1 - Baa2** | **Baa3** | **< Baa3** |
| Up to $250M | 1,000,000 | 500,000 | 250,000 | 125,000 | - |
| $250M to $500M | 1,650,000 | 825,000 | 412,500 | 206,250 | - |
| $500M to $750M | 2,500,000 | 1,250,000 | 625,000 | 312,500 | - |
| $750M to $1B | 7,500,000 | 3,750,000 | 1,875,000 | 937,500 | - |
| $1B to $25B | 10,000,000 | 5,000,000 | 2,500,000 | 1,250,000 | - |
| $25B to $50B | 15,000,000 | 7,500,000 | 3,750,000 | 1,875,000 | - |
| Over $50B | 20,000,000 | 10,000,000 | 5,000,000 | 2,500,000 | - |

If the Bidder is an established counterparty of PGE, then the combined amounts of existing thresholds and the additional threshold will not exceed the above amounts, after any adjustments made by PGE Credit Risk Management.

Attachment 1

**GUARANTY COMMITMENT LETTER**

(Must be on letterhead of Bidder's credit support provider)

Portland General Electric Company
121 SW Salmon Street
3 World Trade Center - 0306
Portland, Oregon 97204
Attn: Credit Dept.

Dear Sirs or Madams:

_____, ("Bidder") (insert Bidder name) plans to submit a bid in response to the Portland General Electric Company's 2018 Renewable Resources Request For Proposals ("RFP"). Bidder is the _____ (insert nature of relationship, e.g., wholly owned subsidiary, partially owned subsidiary, affiliate, etc.) of the undersigned. The undersigned will directly benefit from the bid submitted by Bidder into the RFP. And the undersigned and Bidder have their own, separate legally enforceable arrangement with respect to the undersigned's promise set forth in this letter.

The undersigned promises and agrees that, if a Bid by Bidder is selected, that we will at that time issue an unconditional guaranty in form and substance consistent with PGE's Form Parent Guaranty, and that we will guarantee all obligations of payment and performance of Bidder to you as our independent obligation, plus expenses of enforcing the guaranty.

We understand that said guaranty is a required element in evaluating the Bidder's bid and that the execution and delivery of the guaranty is a condition precedent to you entering into an agreement with Bidder. We also understand that you are under no obligation to enter into any agreement with Bidder, under the RFP or otherwise.

Yours truly,

(Name of guarantor)
(Name of authorized officer)

Attachment 2

**LETTER OF CREDIT COMMITMENT LETTER**

(Must be on letterhead of Bidder's letter of credit issuer)

Portland General Electric Company
121 SW Salmon Street
3 World Trade Center - 0306
Portland, Oregon 97204
Attn: Credit Dept.

Dear Sirs or Madams:

_____, ("Bidder") (insert Bidder name) plans to submit a bid in response to the Portland General Electric Company's 2018 Renewable Resources Request For Proposals ("RFP"). The undersigned promises that, should any bid submitted by Bidder in the RFP be selected for negotiations, that we will issue an irrevocable standby letter of credit in a form reasonably acceptable to you up to a maximum amount of $_____.

We understand that said letter of credit is a required element in evaluating the Bidder's bid and that the execution and delivery of the letter of credit is a condition precedent to you entering into an agreement with Bidder. We also understand that you are under no obligation to enter into any agreement with Bidder, under the RFP or otherwise.

Yours truly,
(Name of letter of credit issuer)

# 16 Appendix F - Confidentiality Agreement

## Mutual Confidentiality Agreement

This Mutual Confidentiality Agreement (the "**Agreement**"), effective as of _____, 2018 (the "**Effective Date**"), is entered into by and between [NAME OF PARTY 1], a [PARTY 1 STATE OF ORGANIZATION] [ENTITY TYPE] having its principal place of business at [PARTY 1 BUSINESS ADDRESS] and Portland General Electric Company ("PGE"), an Oregon corporation having its principal place of business at 121 SW Salmon Street, Portland, OR 97204 (together, the "**Parties**", and each, a "**Party**").

WHEREAS, PGE is in the process of acquiring electricity resources to fulfill certain electricity needs, including but not limited to issuing a Request for Proposal ("**RFP**") to fulfill such needs (collectively, the "**Purpose**");

WHEREAS, in furtherance of the Purpose, each Party desires to share with the other Party certain information that is non-public, confidential or proprietary in nature.

NOW, THEREFORE, in consideration of the mutual covenants, terms and conditions set forth herein, the Parties agree as follows:

1. Confidential Information. Except as set forth in Section 2 below, "**Confidential Information**" means all non-public, confidential or proprietary information disclosed on or after the Effective Date, by either Party (a "**Disclosing Party**") to the other Party (a "**Recipient**"), or to any of such Recipient's employees, officers, directors, agents, attorneys, accountants or advisors (collectively, "**Representatives**"), whether disclosed orally or disclosed or accessed in written, electronic or other form or media, and whether or not marked, designated or otherwise identified as "confidential," which may include:

(a) all information concerning the Disclosing Party's and its affiliates', and their customers', suppliers' and other third parties' past, present and future business affairs including, without limitation, finances, customer information, supplier information, products, services, organizational structure and internal practices, forecasts, sales and other financial results, records and budgets, and business, marketing, development, sales and other commercial strategies;

(b) the Disclosing Party's unpatented inventions, ideas, methods and discoveries, trade secrets, know-how, unpublished patent applications and other confidential intellectual property;

(c) all designs, specifications, documentation, components, source code, object code, images, icons, audiovisual components and objects, schematics, drawings, protocols, processes, and other visual depictions, in whole or in part, of any of the foregoing;

(d) any third-party confidential information included with, or incorporated in, any information provided by the Disclosing Party to the Recipient or its Representatives; and

(e) all notes, analyses, compilations, reports, forecasts, studies, samples, data, statistics, summaries, interpretations and other materials (the "**Notes**") prepared by or for the Recipient or its

Representatives that contain, are based on, or otherwise reflect or are derived from, in whole or in part, any of the foregoing.

Any Confidential Information disclosed orally shall be clearly identified as such by Disclosing Party at the time it is disclosed.

2. Exclusions from Confidential Information. Except as required by applicable federal, state or local law or regulation, the term "Confidential Information" as used in this Agreement shall not include information that:

(a) at the time of disclosure is, or thereafter becomes, generally available to and known by the public other than as a result of, directly or indirectly, any violation of this Agreement by the Recipient or any of its Representatives;

(b) at the time of disclosure is, or thereafter becomes, available to the Recipient on a non-confidential basis from a third-party source, provided that such third party is not and was not prohibited from disclosing such Confidential Information to the Recipient by a legal, fiduciary or contractual obligation to the Disclosing Party;

(c) was known by or in the possession of the Recipient or its Representatives, as established by documentary evidence, prior to being disclosed by or on behalf of the Disclosing Party pursuant to this Agreement; or

(d) was or is independently developed by the Recipient, as established by documentary evidence, without reference to or use of, in whole or in part, any of the Disclosing Party's Confidential Information.

3. Recipient Obligations. The Recipient shall:

(a) protect and safeguard the confidentiality of all such Confidential Information with at least the same degree of care as the Recipient would protect its own Confidential Information, but in no event with less than a commercially reasonable degree of care;

(b) not use the Disclosing Party's Confidential Information, or permit it to be accessed or used, for any purpose other than the Purpose;

(c) not disclose any such Confidential Information to any person or entity, except to the Recipient's Representatives who:

(i) need to know the Confidential Information to assist the Recipient, or act on its behalf, in relation to the Purpose or to exercise its rights under the Agreement;

(ii) are informed by the Recipient of the confidential nature of the Confidential Information; and

(iii) are subject to confidentiality duties or obligations to the Recipient that are no less restrictive than the terms and conditions of this Agreement; and

(d) be responsible for any breach of this Agreement caused by any of its Representatives.

Notwithstanding the foregoing, PGE may disclose Confidential Information pursuant to the following Protective Order (or other Protective Order(s) that may be issued by the OPUC in connection with the RFP or related proceedings): Order No. _____ dated _____ (as such Orders may be modified by the OPUC). In addition, PGE may disclose Confidential Information to the independent evaluator retained by PGE for the RFP.

4. Security. Recipient will maintain and comply with administrative, technical and physical safeguards that are designed to protect the security and integrity of the Confidential Information, including in connection with any transfer, communication, remote access or storage of the Confidential Information as permitted or required under this Agreement. Recipient will promptly notify the disclosing Party of any unauthorized disclosure or use of the Disclosing Party's Confidential Information.

5. Required Disclosure. Any disclosure by the Recipient or its Representatives of any of the Disclosing Party's Confidential Information pursuant to applicable federal, state or local law, regulation or a valid order or other legally supported data request issued by a court or governmental agency of competent jurisdiction (a "**Legal Order**") shall be subject to the terms of this Section. Prior to making any such disclosure, the Recipient shall provide the Disclosing Party with:

(a) to the extent reasonably possible and not prohibited by law, prompt written notice of such requirement so that the Disclosing Party may seek, at its sole cost and expense, a protective order or other remedy; and

(b) reasonable assistance, at the Disclosing Party's sole cost and expense, in opposing such disclosure or seeking a protective order or other limitations on disclosure.

If, after providing such notice and assistance as required herein, the Recipient remains subject to a Legal Order to disclose any Confidential Information, the Recipient (or its Representatives or other persons to whom such Legal Order is directed) shall disclose no more than that portion of the Confidential Information which, such Legal Order specifically requires the Recipient to disclose. Recipient shall not be in breach of this Agreement or liable to Disclosing Party for any disclosure made pursuant to this Section 6 (Required Disclosure).

6. Return or Destruction of Confidential Information. At any time during or after the term of this Agreement, at the Disclosing Party's written request, the Recipient and its Representatives shall promptly return to the Disclosing Party all copies, whether in written, electronic or other form or media, of the Disclosing Party's Confidential Information, or destroy all such copies and certify in writing to the Disclosing Party that such Confidential Information has been destroyed; provided, however, that Recipient may keep copies of the Confidential Information for legal compliance, systematic backup or archival purposes, and will hold such copies subject to the terms of this Agreement. In addition, the

Recipient shall also destroy all copies of any Notes created by the Recipient or its Representatives and certify in writing to the Disclosing Party that such copies have been destroyed; provided, however, that Recipient may keep copies of the Notes for legal compliance, systematic backup or archival purposes, and will hold such copies subject to the terms of this Agreement.

7. Term and Termination. The term of this Agreement shall commence on the Effective Date and shall expire two (2) years from the Effective Date. Notwithstanding anything to the contrary herein, each Party's rights and obligations under this Agreement shall survive any expiration or termination of this Agreement for a period of one (1) year from the date of such expiration or termination, even after the return or destruction of Confidential Information by the Recipient.

8. No Representations or Warranties. Neither the Disclosing Party nor any of its Representatives make any representation or warranty, expressed or implied, as to the accuracy or completeness of the Confidential Information disclosed to the Recipient hereunder. Neither the Disclosing Party nor any of its Representatives shall be liable to the Recipient or any of its Representatives relating to or resulting from the Recipient's use of any of the Confidential Information or any errors therein or omissions therefrom.

9. No Transfer of Rights, Title or Interest. Each Party hereby retains its entire right, title and interest, including all intellectual property rights, in and to all of its Confidential Information. Any disclosure of such Confidential Information hereunder shall not be construed as an assignment, grant, option, license or other transfer of any such right, title or interest whatsoever to the Recipient or any of its Representatives.

10. No Other Obligation. The Parties agree that neither Party shall be under any legal obligation of any kind whatsoever, or otherwise be obligated to enter into any business or contractual relationship, investment, or transaction, by virtue of this Agreement, except for the matters specifically agreed to herein. Either Party may at any time, at its sole discretion with or without cause, terminate discussions and negotiations with the other Party, in connection with the Purpose or otherwise and may pursue a similar purpose without the involvement of, or liability to, the other party.

11. Remedies. Each Party acknowledges and agrees that money damages might not be a sufficient remedy for any breach or threatened breach of this Agreement by such Party or its Representatives. Therefore, in addition to all other remedies available at law (which neither Party waives by the exercise of any rights hereunder), the non-breaching Party shall be entitled to seek specific performance and injunctive and other equitable relief as a remedy for any such breach or threatened breach, and the Parties hereby waive any requirement for the securing or posting of any bond or the showing of actual monetary damages in connection with such claim.

12. Limitation of Liability.

(a) No Consequential or Indirect Damages. IN NO EVENT SHALL EITHER PARTY OR ANY OF ITS REPRESENTATIVES BE LIABLE UNDER THIS AGREEMENT TO THE OTHER PARTY OR ANY THIRD PARTY FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY, SPECIAL OR PUNITIVE DAMAGES, INCLUDING ANY DAMAGES FOR

BUSINESS INTERRUPTION, LOSS OF USE, REVENUE OR PROFIT, WHETHER ARISING OUT OF BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, REGARDLESS OF WHETHER SUCH DAMAGES WERE FORESEEABLE AND WHETHER OR NOT THE BREACHING PARTY WAS ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

(b) Maximum Liability. IN NO EVENT SHALL EITHER PARTY'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THIS AGREEMENT, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, EXCEED ONE HUNDRED THOUSAND DOLLARS ($100,000.00). THE FOREGOING LIMITATIONS SHALL APPLY EVEN IF THE NON-BREACHING PARTY'S REMEDIES UNDER THIS AGREEMENT FAIL OF THEIR ESSENTIAL PURPOSE.

13. Governing Law, Jurisdiction and Venue. This Agreement shall be governed by and construed in accordance with the internal laws of the State of Oregon without giving effect to any choice or conflict of law provision or rule (whether of the State of Oregon or any other jurisdiction) that would cause the application of laws of any jurisdiction other than those of the State of Oregon. Any legal suit, action or proceeding arising out of or related to this Agreement or the matters contemplated hereunder shall be instituted exclusively in the federal courts of the United States or the courts of the State of Oregon in each case located in the city of Portland and County of Multnomah, and each Party irrevocably submits to the exclusive jurisdiction of such courts in any such suit, action or proceeding and waives any objection based on improper venue or *forum non conveniens*. Service of process, summons, notice or other document by mail to such Party's address set forth herein shall be effective service of process for any suit, action or other proceeding brought in any such court.

14. Waiver of Jury Trial. PGE AND COUNTERPARTY WAIVE ANY RIGHT TO TRIAL BY JURY OR TO HAVE A JURY PARTICIPATE IN RESOLVING ANY DISPUTE, WHETHER SOUNDING IN CONTRACT, TORT, OR OTHERWISE, BETWEEN PGE AND COUNTERPARTY ARISING OUT OF THIS AGREEMENT OR OTHER INSTRUMENT, DOCUMENT, OR AGREEMENT EXECUTED OR DELIVERED IN CONNECTION HEREWITH.

15. Attorney Fees. In the event that any party institutes any legal suit, action or proceeding, including arbitration, against the other party to enforce the covenants contained in this Agreement, the prevailing party in the suit, action or proceeding shall be entitled to receive in addition to all other damages to which it may be entitled, the costs incurred by such party in conducting the suit, action or proceeding, including reasonable and actual attorneys' fees and expenses and court costs.

16. Notices. All notices, requests, consents, claims, demands, waivers and other communications hereunder shall be in writing and shall be deemed to have been given: (a) when delivered by hand (with written confirmation of receipt); (b) when received by the addressee if sent by a nationally recognized overnight courier (receipt requested); (c) on the date sent by facsimile or e-mail of a PDF document (with confirmation of transmission) if sent during normal business hours of the recipient, and on the next business day if sent after normal business hours of the recipient; or (d) on the third day after the date mailed, by certified or registered mail, return receipt requested, postage prepaid. Such communications

must be sent to the respective parties at the addresses set forth on the first page of this Agreement (or to such other address that may be designated by a Party from time to time in accordance with this Section).

17. Entire Agreement. This Agreement constitutes the sole and entire agreement of the Parties with respect to the subject matter contained herein, and supersedes all prior and contemporaneous understandings, agreements, representations and warranties, both written and oral, with respect to such subject matter. This Agreement may only be amended, modified or supplemented by an agreement in writing signed by each Party hereto.

18. Severability. If any term or provision of this Agreement is invalid, illegal or unenforceable in any jurisdiction, such invalidity, illegality or unenforceability shall not affect any other term or provision of this Agreement or invalidate or render unenforceable such term or provision in any other jurisdiction.

19. Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original, but all of which together shall be deemed to be one and the same agreement. A signed copy of this Agreement delivered by facsimile, e-mail or other means of electronic transmission shall be deemed to have the same legal effect as delivery of an original signed copy of this Agreement.

20. Assignment. Neither Party may assign any of its rights hereunder without the prior written consent of the other Party. Any purported assignment in violation of this Section shall be null and void. No assignment shall relieve the assigning Party of any of its obligations hereunder. This Agreement is for the sole benefit of the parties hereto and their respective successors and permitted assigns and nothing herein, express or implied, is intended to or shall confer upon any other person or entity any legal or equitable right, benefit or remedy of any nature whatsoever under or by reason of this Agreement.

21. Waivers. No waiver by any Party of any of the provisions hereof shall be effective unless explicitly set forth in writing and signed by the Party so waiving. No waiver by any Party shall operate or be construed as a waiver in respect of any failure, breach or default not expressly identified by such written waiver, whether of a similar or different character, and whether occurring before or after that waiver. No failure to exercise, or delay in exercising, any right, remedy, power or privilege arising from this Agreement shall operate or be construed as a waiver thereof; nor shall any single or partial exercise of any right, remedy, power or privilege hereunder preclude any other or further exercise thereof or the exercise of any other right, remedy, power or privilege.

[*Signature page begins on the following page.*]

IN WITNESS WHEREOF, the parties have executed this Agreement to be effective as of the Effective Date.

[PARTY 1 NAME]

By_____

Name:
Title:

Portland General Electric Company

By_____

Name:
Title:

## Mutual Confidentiality Agreement

This Mutual Confidentiality Agreement (the "**Agreement**"), effective as of _____, 2018 (the "**Effective Date**"), is entered into by and between [NAME OF PARTY 1], a [PARTY 1 STATE OF ORGANIZATION] [ENTITY TYPE] having its principal place of business at [PARTY 1 BUSINESS ADDRESS] and Portland General Electric Company ("PGE"), an Oregon corporation having its principal place of business at 121 SW Salmon Street, Portland, OR 97204 (together, the "**Parties**", and each, a "**Party**").

WHEREAS, PGE is in the process of acquiring electricity resources to fulfill certain electricity needs, including but not limited to issuing a Request for Proposal ("**RFP**") to fulfill such needs (collectively, the "**Purpose**");

WHEREAS, in furtherance of the Purpose, each Party desires to share with the other Party certain information that is non-public, confidential or proprietary in nature.

NOW, THEREFORE, in consideration of the mutual covenants, terms and conditions set forth herein, the Parties agree as follows:

1. Confidential Information. Except as set forth in Section 2 below, "**Confidential Information**" means all non-public, confidential or proprietary information disclosed on or after the Effective Date, by either Party (a "**Disclosing Party**") to the other Party (a "**Recipient**"), or to any of such Recipient's employees, officers, directors, agents, attorneys, accountants or advisors (collectively, "**Representatives**"), whether disclosed orally or disclosed or accessed in written, electronic or other form or media, and whether or not marked, designated or otherwise identified as "confidential," which may include:

(a) all information concerning the Disclosing Party's and its affiliates', and their customers', suppliers' and other third parties' past, present and future business affairs including, without limitation, finances, customer information, supplier information, products, services, organizational structure and internal practices, forecasts, sales and other financial results, records and budgets, and business, marketing, development, sales and other commercial strategies;

(b) the Disclosing Party's unpatented inventions, ideas, methods and discoveries, trade secrets, know-how, unpublished patent applications and other confidential intellectual property;

(c) all designs, specifications, documentation, components, source code, object code, images, icons, audiovisual components and objects, schematics, drawings, protocols, processes, and other visual depictions, in whole or in part, of any of the foregoing;

(d) any third-party confidential information included with, or incorporated in, any information provided by the Disclosing Party to the Recipient or its Representatives; and

(e) all notes, analyses, compilations, reports, forecasts, studies, samples, data, statistics, summaries, interpretations and other materials (the "**Notes**") prepared by or for the Recipient or its

Representatives that contain, are based on, or otherwise reflect or are derived from, in whole or in part, any of the foregoing.

Any Confidential Information disclosed orally shall be clearly identified as such by Disclosing Party at the time it is disclosed.

2. Exclusions from Confidential Information. Except as required by applicable federal, state or local law or regulation, the term "Confidential Information" as used in this Agreement shall not include information that:

(a) at the time of disclosure is, or thereafter becomes, generally available to and known by the public other than as a result of, directly or indirectly, any violation of this Agreement by the Recipient or any of its Representatives;

(b) at the time of disclosure is, or thereafter becomes, available to the Recipient on a non-confidential basis from a third-party source, provided that such third party is not and was not prohibited from disclosing such Confidential Information to the Recipient by a legal, fiduciary or contractual obligation to the Disclosing Party;

(c) was known by or in the possession of the Recipient or its Representatives, as established by documentary evidence, prior to being disclosed by or on behalf of the Disclosing Party pursuant to this Agreement; or

(d) was or is independently developed by the Recipient, as established by documentary evidence, without reference to or use of, in whole or in part, any of the Disclosing Party's Confidential Information.

3. Recipient Obligations. The Recipient shall:

(a) protect and safeguard the confidentiality of all such Confidential Information with at least the same degree of care as the Recipient would protect its own Confidential Information, but in no event with less than a commercially reasonable degree of care;

(b) not use the Disclosing Party's Confidential Information, or permit it to be accessed or used, for any purpose other than the Purpose;

(c) not disclose any such Confidential Information to any person or entity, except to the Recipient's Representatives who:

(i) need to know the Confidential Information to assist the Recipient, or act on its behalf, in relation to the Purpose or to exercise its rights under the Agreement;

(ii) are informed by the Recipient of the confidential nature of the Confidential Information; and

(iii) are subject to confidentiality duties or obligations to the Recipient that are no less restrictive than the terms and conditions of this Agreement; and

(d) be responsible for any breach of this Agreement caused by any of its Representatives.

Notwithstanding the foregoing, PGE may disclose Confidential Information pursuant to the following Protective Order (or other Protective Order(s) that may be issued by the OPUC in connection with the RFP or related proceedings): Order No. _____ dated _____ (as such Orders may be modified by the OPUC). In addition, PGE may disclose Confidential Information to the independent evaluator retained by PGE for the RFP.

4. Security. Recipient will maintain and comply with administrative, technical and physical safeguards that are designed to protect the security and integrity of the Confidential Information, including in connection with any transfer, communication, remote access or storage of the Confidential Information as permitted or required under this Agreement. Recipient will promptly notify the disclosing Party of any unauthorized disclosure or use of the Disclosing Party's Confidential Information.

5. Required Disclosure. Any disclosure by the Recipient or its Representatives of any of the Disclosing Party's Confidential Information pursuant to applicable federal, state or local law, regulation or a valid order or other legally supported data request issued by a court or governmental agency of competent jurisdiction (a "**Legal Order**") shall be subject to the terms of this Section. Prior to making any such disclosure, the Recipient shall provide the Disclosing Party with:

(a) to the extent reasonably possible and not prohibited by law, prompt written notice of such requirement so that the Disclosing Party may seek, at its sole cost and expense, a protective order or other remedy; and

(b) reasonable assistance, at the Disclosing Party's sole cost and expense, in opposing such disclosure or seeking a protective order or other limitations on disclosure.

If, after providing such notice and assistance as required herein, the Recipient remains subject to a Legal Order to disclose any Confidential Information, the Recipient (or its Representatives or other persons to whom such Legal Order is directed) shall disclose no more than that portion of the Confidential Information which, such Legal Order specifically requires the Recipient to disclose. Recipient shall not be in breach of this Agreement or liable to Disclosing Party for any disclosure made pursuant to this Section 6 (Required Disclosure).

6. Return or Destruction of Confidential Information. At any time during or after the term of this Agreement, at the Disclosing Party's written request, the Recipient and its Representatives shall promptly return to the Disclosing Party all copies, whether in written, electronic or other form or media, of the Disclosing Party's Confidential Information, or destroy all such copies and certify in writing to the Disclosing Party that such Confidential Information has been destroyed; provided, however, that Recipient may keep copies of the Confidential Information for legal compliance, systematic backup or archival purposes, and will hold such copies subject to the terms of this Agreement. In addition, the

Recipient shall also destroy all copies of any Notes created by the Recipient or its Representatives and certify in writing to the Disclosing Party that such copies have been destroyed; provided, however, that Recipient may keep copies of the Notes for legal compliance, systematic backup or archival purposes, and will hold such copies subject to the terms of this Agreement.

7. Term and Termination. The term of this Agreement shall commence on the Effective Date and shall expire two (2) years from the Effective Date. Notwithstanding anything to the contrary herein, each Party's rights and obligations under this Agreement shall survive any expiration or termination of this Agreement for a period of one (1) year from the date of such expiration or termination, even after the return or destruction of Confidential Information by the Recipient.

8. No Representations or Warranties. Neither the Disclosing Party nor any of its Representatives make any representation or warranty, expressed or implied, as to the accuracy or completeness of the Confidential Information disclosed to the Recipient hereunder. Neither the Disclosing Party nor any of its Representatives shall be liable to the Recipient or any of its Representatives relating to or resulting from the Recipient's use of any of the Confidential Information or any errors therein or omissions therefrom.

9. No Transfer of Rights, Title or Interest. Each Party hereby retains its entire right, title and interest, including all intellectual property rights, in and to all of its Confidential Information. Any disclosure of such Confidential Information hereunder shall not be construed as an assignment, grant, option, license or other transfer of any such right, title or interest whatsoever to the Recipient or any of its Representatives.

10. No Other Obligation. The Parties agree that neither Party shall be under any legal obligation of any kind whatsoever, or otherwise be obligated to enter into any business or contractual relationship, investment, or transaction, by virtue of this Agreement, except for the matters specifically agreed to herein. Either Party may at any time, at its sole discretion with or without cause, terminate discussions and negotiations with the other Party, in connection with the Purpose or otherwise and may pursue a similar purpose without the involvement of, or liability to, the other party.

11. Remedies. Each Party acknowledges and agrees that money damages might not be a sufficient remedy for any breach or threatened breach of this Agreement by such Party or its Representatives. Therefore, in addition to all other remedies available at law (which neither Party waives by the exercise of any rights hereunder), the non-breaching Party shall be entitled to seek specific performance and injunctive and other equitable relief as a remedy for any such breach or threatened breach, and the Parties hereby waive any requirement for the securing or posting of any bond or the showing of actual monetary damages in connection with such claim.

12. Limitation of Liability.

(a) No Consequential or Indirect Damages. IN NO EVENT SHALL EITHER PARTY OR ANY OF ITS REPRESENTATIVES BE LIABLE UNDER THIS AGREEMENT TO THE OTHER PARTY OR ANY THIRD PARTY FOR ANY CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY, SPECIAL OR PUNITIVE DAMAGES, INCLUDING ANY DAMAGES FOR

BUSINESS INTERRUPTION, LOSS OF USE, REVENUE OR PROFIT, WHETHER ARISING OUT OF BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, REGARDLESS OF WHETHER SUCH DAMAGES WERE FORESEEABLE AND WHETHER OR NOT THE BREACHING PARTY WAS ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

(b) Maximum Liability. IN NO EVENT SHALL EITHER PARTY'S AGGREGATE LIABILITY ARISING OUT OF OR RELATED TO THIS AGREEMENT, WHETHER ARISING OUT OF OR RELATED TO BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE) OR OTHERWISE, EXCEED ONE HUNDRED THOUSAND DOLLARS ($100,000.00). THE FOREGOING LIMITATIONS SHALL APPLY EVEN IF THE NON-BREACHING PARTY'S REMEDIES UNDER THIS AGREEMENT FAIL OF THEIR ESSENTIAL PURPOSE.

13. Governing Law, Jurisdiction and Venue. This Agreement shall be governed by and construed in accordance with the internal laws of the State of Oregon without giving effect to any choice or conflict of law provision or rule (whether of the State of Oregon or any other jurisdiction) that would cause the application of laws of any jurisdiction other than those of the State of Oregon. Any legal suit, action or proceeding arising out of or related to this Agreement or the matters contemplated hereunder shall be instituted exclusively in the federal courts of the United States or the courts of the State of Oregon in each case located in the city of Portland and County of Multnomah, and each Party irrevocably submits to the exclusive jurisdiction of such courts in any such suit, action or proceeding and waives any objection based on improper venue or *forum non conveniens*. Service of process, summons, notice or other document by mail to such Party's address set forth herein shall be effective service of process for any suit, action or other proceeding brought in any such court.

14. Waiver of Jury Trial. PGE AND COUNTERPARTY WAIVE ANY RIGHT TO TRIAL BY JURY OR TO HAVE A JURY PARTICIPATE IN RESOLVING ANY DISPUTE, WHETHER SOUNDING IN CONTRACT, TORT, OR OTHERWISE, BETWEEN PGE AND COUNTERPARTY ARISING OUT OF THIS AGREEMENT OR OTHER INSTRUMENT, DOCUMENT, OR AGREEMENT EXECUTED OR DELIVERED IN CONNECTION HEREWITH.

15. Attorney Fees. In the event that any party institutes any legal suit, action or proceeding, including arbitration, against the other party to enforce the covenants contained in this Agreement, the prevailing party in the suit, action or proceeding shall be entitled to receive in addition to all other damages to which it may be entitled, the costs incurred by such party in conducting the suit, action or proceeding, including reasonable and actual attorneys' fees and expenses and court costs.

16. Notices. All notices, requests, consents, claims, demands, waivers and other communications hereunder shall be in writing and shall be deemed to have been given: (a) when delivered by hand (with written confirmation of receipt); (b) when received by the addressee if sent by a nationally recognized overnight courier (receipt requested); (c) on the date sent by facsimile or e-mail of a PDF document (with confirmation of transmission) if sent during normal business hours of the recipient, and on the next business day if sent after normal business hours of the recipient; or (d) on the third day after the date mailed, by certified or registered mail, return receipt requested, postage prepaid. Such communications

must be sent to the respective parties at the addresses set forth on the first page of this Agreement (or to such other address that may be designated by a Party from time to time in accordance with this Section).

17. Entire Agreement. This Agreement constitutes the sole and entire agreement of the Parties with respect to the subject matter contained herein, and supersedes all prior and contemporaneous understandings, agreements, representations and warranties, both written and oral, with respect to such subject matter. This Agreement may only be amended, modified or supplemented by an agreement in writing signed by each Party hereto.

18. Severability. If any term or provision of this Agreement is invalid, illegal or unenforceable in any jurisdiction, such invalidity, illegality or unenforceability shall not affect any other term or provision of this Agreement or invalidate or render unenforceable such term or provision in any other jurisdiction.

19. Counterparts. This Agreement may be executed in counterparts, each of which shall be deemed an original, but all of which together shall be deemed to be one and the same agreement. A signed copy of this Agreement delivered by facsimile, e-mail or other means of electronic transmission shall be deemed to have the same legal effect as delivery of an original signed copy of this Agreement.

20. Assignment. Neither Party may assign any of its rights hereunder without the prior written consent of the other Party. Any purported assignment in violation of this Section shall be null and void. No assignment shall relieve the assigning Party of any of its obligations hereunder. This Agreement is for the sole benefit of the parties hereto and their respective successors and permitted assigns and nothing herein, express or implied, is intended to or shall confer upon any other person or entity any legal or equitable right, benefit or remedy of any nature whatsoever under or by reason of this Agreement.

21. Waivers. No waiver by any Party of any of the provisions hereof shall be effective unless explicitly set forth in writing and signed by the Party so waiving. No waiver by any Party shall operate or be construed as a waiver in respect of any failure, breach or default not expressly identified by such written waiver, whether of a similar or different character, and whether occurring before or after that waiver. No failure to exercise, or delay in exercising, any right, remedy, power or privilege arising from this Agreement shall operate or be construed as a waiver thereof; nor shall any single or partial exercise of any right, remedy, power or privilege hereunder preclude any other or further exercise thereof or the exercise of any other right, remedy, power or privilege.

[*Signature page begins on the following page.*]

IN WITNESS WHEREOF, the parties have executed this Agreement to be effective as of the Effective Date.

[PARTY 1 NAME]

By_____

Name:
Title:

Portland General Electric Company

By_____

Name:
Title:

# 17 Appendix G – PGE Technical Specifications

# APPENDIX G

# TECHNICAL SPECIFICATIONS

# RENEWABLE ENERGY RESOURCES

# PORTLAND GENERAL ELECTRIC

# 2018

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# APPENDIX G1

# GENERAL SPECIFICATIONS

# RENEWABLE ENERGY RESOURCES

# PORTLAND GENERAL ELECTRIC

# 2018

# REQUEST FOR PROPOSAL

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 01**

# APPROVED VENDORS AND SERVICE SUPPLIERS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 13Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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# 1.0 GENERAL

## 1.1 EXTENT

The following document 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 deltas from the “Preferred” Supplier.

Final major equipment supplier list is to be approved by Owner.

# 2.0 APPROVED SUPPLIERS

## 2.1 APPROVED EQUIPMENT VENDORS

### 2.1.1 Bridge Cranes

- *Kone Cranes
- Accent Sales & Service Company Inc
- ACE World Companies
- E Crane International USA Inc
- Morris Material Handling Ltd
- National Crane
- Shannahan Crane & Hoist Incorporated
- Stewart Engineering & Sales Company
- Whiting & Associates Inc

### 2.1.2 Building Electrical Panels

- *Schneider Electric / Square D
- Eaton
- General Electric
- Siemens

### 2.1.3 Caulking

- Non-exposed joints
  - Tremco “Curtain Wall Sealant”
- Exposed joints
  - Pecora “Dynatrol”
  - Tremco “Dymoric”

### 2.1.4 Caulking tape

- Pecora "BB-50 Extruseal"
- Tremco "MBT"

### 2.1.5 Climb Assist Systems

- Ibex
- PowerClimber

### 2.1.6 Collection System Cable

- Southwire
- Prysmian Power Cables and Systems
- General Cable
- Okonite

### 2.1.7 Fire Water Pumps

- *Peerless Pump Company
- Chamco Industries LTD
- Fairbanks Morse Pump Corp
- ITT A C Fire Pump Systems
- Shambaugh & Sons

### 2.1.8 Fire Protection System

- *Janus
- Simplex Grinnell
- F.E. Moran
- Shambaugh & Sons
- International Fire Protection
- Siemens-Sentry

### 2.1.9 Generator Circuit Breaker

- *ABB
- GE Grid Solutions

- Mitsubishi
- Siemens
- HVB

### 2.1.10 Generator Step-up Transformer (substation main power transformer)

- ABB, Varennes, Canada shop
- ABB, St. Louis, Missouri shop
- ABB, Bad Honnef, Germany shop
- ABB, South Boston, Virginia shop
- HICO, ChangWon, South Korea shop
- Hyundai, Montgomery, Alabama shop
- Hyundai, Ulsan, South Korea shop
- Smit, Nijimegen, The Netherlands shop
- SPX Waukesha, Waukesha, Wisconsin shop
- EFACEC, Arroteia, Portugal shop
- Siemens, Guanajuato, Mexico shop
- GE Prolec, Monterrey, Mexico shop
- Shihlin, Taipei, Taiwan shop

### 2.1.11 Ground Reference Transformers

- ABB
- Cooper Power Systems
- GE
- Virginia Transformer
- Pacific Crest Transformers

### 2.1.12 GSU Pad-mount Transformers

- ABB
- CG Power Systems USA
- General Electric
- Cooper Power Systems
- Siemens
- Pacific Crest Transformers

### 2.1.13 Historian

- OSIsoft PI

### 2.1.14 Instrument Transformers

- ABB
- Trench Ltd

- GE/Alstom

### 2.1.15 Load Center Unit Substations

- ABB
- Eaton
- General Electric
- Powell Manufacturing
- Schneider Electric / Square D
- Siemens Power T&D

### 2.1.16 Louvers (horizontal 6 inch (152 mm) fixed drainable blade)

- Construction Specialties
- Ruskin Manufacturing
- CESCO
- American Warming
- Air Balance Inc
- Arrow United Industries

### 2.1.17 Louvers (vertical stormproof)

- CESCO "ASL-6"
- Ruskin "EME-6225"

### 2.1.18 LV Motor Control Centers

- *Eaton
- ABB
- Allen Bradley
- General Electric
- Powell Manufacturing
- Schneider Electric / Square D
- Siemens Power T&D

### 2.1.19 Medium Voltage Switchgear, Starters and Controllers

- Powercon
- Siemens Power T&D
- ABB
- Eaton
- General Electric
- Powell Manufacturing
- Schneider Electric / Square D

### 2.1.20 Photovoltaic Combiner Box

- SolarBOS
- Bentek
- Amtec Industries, Inc.
- Shoals Technologies Group

### 2.1.21 Photovoltaic Inverters

- SMA
- Power Electronics
- TMEIC
- Eaton
- General Electric
- ABB

### 2.1.22 Photovoltaic Modules

- JA Solar
- Trina Solar
- Jinko
- Canadian Solar
- Hanwha Q-Cells
- First Solar
- Sunpower
- Kyocera
- LG
- REC

### 2.1.23 Photovoltaic Module Mounting Systems

- Fixed Tilt:
    - Applied Energy Technologies (AET)
    - RBI Solar
    - GameChange Solar

- Single Axis Tracking:
    - Array Technologies, Inc. (ATI)
    - NexTracker

### 2.1.24 Protective Relays and Revenue Meters

- Schweitzer Engineering Laboratories (SEL)

### 2.1.25 Relay Panels

- Electrical Power Products (EP2)

### 2.1.26 SF6 Circuit Breakers (High Voltage and Medium Voltage)

- Siemens
- ABB
- Mitsubishi
- GE/Alstom
- Hitachi/HVB (Georgia)

### 2.1.27 Single Mode Fiber Cable & Attachment Hardware

- AFL
- OFS
- Preformed Line Products
- Anixter

### 2.1.28 Substation Capacitors

- Cooper Power Systems
- General Electric

### 2.1.29 Substation Control Enclosure

- Trachte
- AZZ

### 2.1.30 Substation Disconnect Switches (115-230KV)

- Pascor
- Cleaveland Price

### 2.1.31 Substation Distribution Metering

- Novatech Bitronics M871 (SCADA distribution feeder metering)
- Novatech Bitronics M650 (SCADA distribution transformer metering)

### 2.1.32 Substation Human/Machine Interface

- Schneider Electric

### 2.1.33 Substation Remote Terminal Unit

- Eaton Cooper Power System

### 2.1.34 Substation SCADA Ethernet Switches and Port Servers

- Siemens RuggedCom RSG2300 – Managed Layer 2 switch, Rack mount, 32 ports
- Siemens RuggedCom RS900 – Managed Layer 2 switch, Rail mount, 9 ports
- Siemens RuggedCom RX1500 – Managed Layer 2 & Layer 3 switch, Rack mount, maximum 24 ports
- Siemens RuggedComm RS416 – Serial port server, Rack mount, 16 ports

### 2.1.35 Substation SCADA Gateway

- Eaton Cooper SMP SG4250

### 2.1.36 Substation SCADA Input/Output Devices

- Eaton Cooper Power Systems

### 2.1.37 Transformer Bushings

- PCORE
- ABB

### 2.1.38 Transformer Fans

- Krenz & Co Inc
- Dayton

### 2.1.39 Transmission Line Type Grips

- *Chicago
- Alcoa Pocket
- Kellum (for stringing operation)

### 2.1.40 Transmission Tubular Steel Towers

- Valmont
- Sabre
- Trinity Meyer
- Dis-Tran

### 2.1.41 Uninterruptible Power Supply System (UPS)

- *Vertiv Chloride (formerly Emerson Network Power)
- Ametek Solidstate Controls
- CEG

- Gutor/Schneider

### 2.1.42 Vibration Collocation and Analysis System

- Gram & Juhl

### 2.1.43 Wind Turbine Generators

- General Electric
- Siemens Gamesa
- Vestas
- Nordex/Acciona

### 2.1.44 48VDC Battery & Charger

- East Penn Manufacturing
- C&D Technologies
- Eltek/Valere

### 2.1.45 125 VDC Chargers

- *SENS
- *Vertiv Chloride (formerly Emerson Network Power)
- Ametek Solid State Controls
- Cyberex
- Hindle Power

### 2.1.46 125 VDC Batteries

- *GNB
- BAE
- Hoppecke
- C&D Technologies

## 2.2 APPROVED SUBCONTRACTORS

### 2.2.1 Collection System Design

- Power Engineers
- Burns & McDonnell

### 2.2.2 Collection System Installation

- RES Earth and Cable
- Robinson Brothers Construction
- PLC

- Blattner Energy

### 2.2.3 Communication System Design

- Burns & McDonnell
- Gillespie, Prudhon & Associates (GP&A)
- Summit Telecom Solutions (Damascus, OR)

### 2.2.4 Cranes and Rigging

- Wilhelm Trucking and Rigging Co.
- Bigge Crane and Rigging
- Barnhart Crane and Rigging
- KR Wind
- Bragg Crane and Rigging
- NessCampbell Crane & Rigging
- Mountain Crane

### 2.2.5 Earthwork and Roads

- RES Earth & Cable
- Nelson Engineering
- Tower Foundations (TFS Wind)
- Builders Construction Services
- Narum Construction
- Goodfellow Brothers
- Lydig Construction
- Royce Hydroseeding
- Wildlands Inc.
- Geotech Foundation Company West
- Barker Inc.

### 2.2.6 Electrical Contractors

- Rosendin Electric
- Tice Electric
- Potelco
- Mountain Power Construction Company
- Michels
- Christenson Electric
- Henkels & McCoy
- Par Electrical Contractors
- EC Electrical Construction
- NAES

- Blattner Energy

### 2.2.7 Geotechnical Engineering

- Barr Engineering
- Renewable Resource Consultants, LLC
- GeoEngineers
- GN Northern
- Cornforth Consultants

### 2.2.8 Met Towers

- World Tower
- Magnum Tower
- CER
- Aerial Erectors
- Anetech
- Sabre
- Tower Systems
- Nello
- Sioux Falls Towers
- Vertical Technologies

### 2.2.9 O&M Building

- Thomas L Wood Heath Construction
- Apollo Sheet Metal Inc.
- Adran
- Shamrock Construction
- Opp & Seibold
- Metal Structures LLC
- SM Andersen Company

### 2.2.10 Overhead Transmission Line

- Wilson Construction
- International Line Builders
- Michels
- Potelco

### 2.2.11 Single Mode Fiber Splicing & Testing

- Gillespie, Prudhon & Associates Inc.
- Precision Fiber, INC.

### 2.2.12 Structural Engineering Design (wind turbine foundations)

- Barr Engineering
- Renewable Resource Consultants, LLC
- HDR, Inc.

### 2.2.13 Substation Design

- Black and Veatch
- Power Engineers
- NV5

### 2.2.14 Survey and Civil Engineering

- Pioneer Surveying and Engineering, Inc.
- Tenneson Engineering Corp.
- Encompass Energy Services
- David Evans and Associates
- Pacific Community Design
- Westwood Professional Services, Inc.

### 2.2.15 Transmission Line Foundations

- Crux
- DMI Drilling Construction
- Brent Woodward Inc.
- Malcolm Drilling
- Tri-State Drilling

### 2.2.16 Transmission Engineering Design

- POWER Engineers
- Black & Veatch
- HDR
- Burns & McDonnell

### 2.2.17 Transportation

- Wilhelm Trucking and Rigging Co.
- ATS Wind Energy Service
- Omega Morgan
- Contractors Cargo Co.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 02**

# ENGINEERING DOCUMENTS, DRAWINGS, AND OTHER DELIVERABLES

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
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## 1.0 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 G1-01-02-01 Deliverables Tables.xlsx. Items marked in the submittals table shall be submitted for the Owner's review and approval prior to equipment purchase or construction.

Within 60 days of the Effective Date, Parties shall identify and mutually agree upon all OEM equipment submittals and specifications which will be submitted to the Owner and those that the Owner will review. Conformed to construction record drawings (as-builts) shall be provided for selected drawings marked as Level C.

Contractor shall organize a face to face 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 listed herein according to the normal project communication distribution to be decided upon during project kickoff. These distributions shall be provided in electronic copy in Adobe PDF 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.

## 2.0 DOCUMENT SUBMITTAL REQUIREMENTS

### 2.1 DRAWINGS

Drawings requested by the technical specifications are to be sent as directed therein. Drawings associated with this Contract shall be in the English language and English system of units.

Each submitted drawing shall be unique and shall be clearly marked with the name of the Project, facility name, facility designation, specification title, specification number, project equipment or structure nomenclature, component identification numbers, Owner’s name, revision number, and revision history.

Final as-built drawings, including Contractor drawings and vendor drawings, shall be submitted in electronic format on electronic storage device. Each form of media shall be clearly labeled for content and date.

Contractor shall submit all drawings in AutoCAD (.dwg) version 2014 format including bound files, XREF files, 3D models (saved out to Autodesk Plant 3D 2014 or approved equal), sheet drawing files, and Acrobat Adobe (.pdf) format. All color settings files (*.ctb), font files, block libraries, title blocks, and CAD Standards used on the Project

shall follow the PGE CAD Standards and Drafting Procedures (Rev 1) documents (Appendix G1 Attachment 01 Exhibit 09 – CAD Standards and Drafting Procedures) 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.

| Dwg No. | Revision | RevDate | Title | X-Ref | Submittal Date | Discipline | Document Status | Document Type | Plant System |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

In addition to normally prepared design drawings, the Contractor shall provide equipment interface drawings that shall include details such as connection sizes, weld end preparation, delineation of responsibilities, etc. Interface dimensions shall be in English system of units.

### 2.1.1 Design Masters

Contractor shall produce applicable drawings per Owner's standard Design Masters. In addition to standard design requirements, Design Masters dictate scope, size, symbology, nomenclature, and level of information required in a drawing. Contractor to request latest version of Design Masters from Owner. Microstation CAD files can be provided. The following apply:

1. High Voltage Lines
2. RAS
3. GSU Transformers
4. Unit Aux Transformers

5. Standby Transformer Metering and Protective Relaying One Lines
6. Three Lines
7. DC Metering and Protective Relaying Schematics
8. Panel Layout Drawings
9. Wiring Diagrams
10. Bill of Materials
11. Medium Voltage Switchgear and Generator Breaker Three Lines
12. DC Control Schematics
13. SCADA Block Diagram
14. SCADA DC Power Schematic
15. SCADA Panel Layout Drawings
16. SCADA Wiring Diagrams
17. SCADA Bill of Materials.

## 2.2 CONTRACTOR DRAWING STANDARD

Contractor shall follow the standards and procedures described in the PGE PSES CAD Standards and Procedures document (see Appendix G1 Attachment 01 Exhibit 09 – CAD Standards and Drafting Procedures ).

## 2.3 HEALTH, SAFETY AND ENVIRONMENT

Both the SSSHP and the EMP shall be specific to the Agreement and Work as specified in Appendix G1 Attachment 01 Exhibit 06 – Safety, Health, and Environment.

The SSSHP and EMP shall be reviewed at monthly intervals or as agreed between Owner and Contractor to ensure that it remains current and relevant to the Work.

The SSSHP and EMP shall establish the process for incident reporting in accordance with the Contract requirements.

## 2.4 CORRESPONDENCE AND DOCUMENTATION

Correspondence and documentation related to this Contract shall be in the American English language. Correspondence affected by the above requirements shall include, but not be limited to: administrative and technical correspondence; tenders; contracts; drawings; calculations; reports and documentation related to the design, testing, installation, operation, or maintenance of goods; and descriptive literature relating to the physical and/or performance characteristics of the goods. Engineering documents, including drawings, calculations, reports, and specifications, shall have dimensions or

units expressed in the English system. Emails containing any of the above as body text or attachment are considered correspondence.

## 3.0 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:

a. Purchase order number

b. Project Facility – Unit Number - System number

c. Contractor's reference drawing number

d. Document revision status

e. Owner's documentation number (less submittal number)

This information shall be placed on the documents in or near the title block

Documents submitted shall be assigned an Owner documentation number assigned by the originator using the convention below. This number shall appear on the copy returned to the Contractor and shall be transferred by the Contractor to the Contractor's original, so that the document number will appear on subsequent submittals.

Correspondence including emails shall contain the Project Facility – Unit Number - System number, specification number, and equipment identification number.

All correspondence between Owner and Contractor shall be sequentially numbered as follows and provided in the subject line of emails:

AAA-BBB-SSSS-YYYY.X

Where: AAA denotes the company originating the correspondence.
BBB denotes the company receiving the correspondence.
SSSS denotes the specification number
YYYY denotes the correspondence sequential number
X denotes the revision number of the correspondence beginning with zero.

Resubmittals shall bear the original submittal number and append a number sequentially as follows.

AAA-BBB-SSSS-YYYY.1
AAA-BBB-SSSS-YYYY.2
etc.

The Project Documentation Coordinator ([GPDC@PGN.com] for Owner; [ ] for Contractor) is responsible for assigning the correspondence number and maintaining their respective company transmittal log.

All correspondence shall be distributed electronically.

## 4.0 DOCUMENT REVIEW AND APPROVAL

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

| 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 PDF's shall be combined into a single file. For example, 30% design documents level of detail shall include (at minimum):<br>- General arrangement drawings<br>- Single line drawings<br>- Cable and road layouts<br>- Equipment specifications and data sheets<br><br>Refer to G1-01-02-01 Documents and Deliverables Tables.xlsx 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 PDF's shall be combined into a single file. For example, 60% design documents level of detail shall include (at minimum):<br><br>Design Basis:<br>- Design criteria for each engineering discipline<br>- Contractor's equipment and system designation methods<br>- List of systems and system designations<br><br>Electrical Package:<br>- Schematics and single line drawings detailing: collection system circuits, ac collection system, auxiliary and backup power, MET stations, SCADA/DAS and communications systems, grounding design<br>- 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.<br>- Equipment arrangement including conduit entry<br>- Supporting documentation for all components including: specification of all requirements for all components, manufacturer's datasheets, installation manuals, operations and maintenance manuals<br><br>Civil/Structural Package:<br>- Calculations in accordance with Specifications<br>- Geotechnical and Hydrology Reports<br>- Structural inspection results/reports<br>- Detailed Site layouts with elevation and topographic detail depicting mounting configurations for all equipment, grading plans, etc.<br>- Foundation designs<br>- Corrosion analysis<br><br>Refer G1-01-02-01 Documents and Deliverables Tables.xlsx 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):<br>- An updated version of the 60% design documents with revisions and additional detail where applicable.<br>- Shall include equipment ratings for all power systems equipment, bus Work, enclosures, protective devices, etc.<br>- Include all detailed information required to obtain all necessary construction permits from the AHJ<br>- Commissioning Plan<br>- Acceptance Test Plan<br>- Final Energy Estimate<br><br>Refer to G1-01-02-01 Documents and Deliverables Tables.xlsx 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:<br>- An updated version of the 90% design documents with revisions and additional detail where applicable.<br>- Shall include all completed test results such as pile uplift and lateral resistance testing<br>- Shall address any responses/comments from the AHJ<br><br>Refer to G1-01-02-01 Documents and Deliverables Tables.xlsx 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.<br><br>Refer to G1-01-02-01 Documents and Deliverables Tables.xlsx 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.

## 4.1 DOCUMENTS

Documents submitted for review shall be provided in the document's original 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.

## 4.2 DRAWINGS

Drawings submitted for review shall be provided in Adobe Acrobat (.pdf) format. A separate file shall be provided for each sheet in each unique drawing number.

Drawing revisions shall be clouded.

## 4.3 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.

### 4.3.1 Status Level S1

Documents and drawings that receive status level S1 are approved.

### 4.3.2 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.

## 4.4 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

## 4.5 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.

# 5.0 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:

1. Prints shall be sharp, clear, and suitable for direct reading. The prints shall be black line reproducible on bond paper.
2. Hardcopy documents shall be folded, collated sets mailed flat in a regular mailing envelope. Electronic formats of documents shall be submitted on CD, DVD or electronic storage device (as appropriate) and shall be adequately protected to prevent damage during shipment.
3. 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.

## 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.

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

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

b. 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 | |

| Description Element | Identify by answering the question: | Descriptor | Abbreviation Spelled out |
|---|---|---|---|
| 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 |

5.1.1 6.4.1 Dimensions Descriptors

a. Dimensions shall be spelled out to avoid confusion for the ordering party, the vendor, or PGEOwner. 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 |

b. 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

5.1.2 6.4.2 Standards Requirements Reference

Requirements based on particular standards shall be included in the following format:

| Standard Abbreviated | Specific Standard Number |
|---|---|
| ASTM | A153 |
| ANSI | C135.1 |
| ASTM | A36 |

5.1.3 6.4.3 Special Characters

6.4.3.1 Information NOT to be Included in the Item Description

a. Manufacturer's Name

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

b. Manufacturer's Model Number

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

c. Vendor's Name

d. Vendor's Catalog Number

e. 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.

5.1.4 6.4.4 Use of Special Characters in the Descriptions

a. Item Descriptions may contain any of the following characters.

| Description | Character |
|---|---|
| Comma | , |
| Period | . |
| Hyphen | - |

b. 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 | ~ | | |

## 5.2 INSTRUCTION MANUALS

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.

5.2.1 6.5.1 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.

5.2.2 6.5.2 Design

a. 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.

b. When multiple model numbers are shown on the drawings, the equipment supplied for the project shall be clearly identified.

c. Specifications, test data, and all performance curves specified in the technical specifications.

d. Outline drawing - final. Assembly drawings - final.

e. All fluid systems schematics and piping diagrams. Electrical wiring diagrams.

f. Motor Information Sheets.

g. Electric Actuator Information Sheets.

h. Control Panel Arrangements, including interior equipment arrangements identifying the individual components.

i. Program, software, and firmware configuration, modeling, editing, and troubleshooting guides.

5.2.3 6.5.3 Installation

a. Instructions for receiving, inspection, storage, and handling of equipment prior to installation.

b. Installation instructions including step-by-step alignment and calibration procedures.

c. Online and offline iInspection procedures.

d. Lists of trips and alarms, complete with set points.

e. Calibration Data Sheet for each adjustable instrument included in the scope of supply.

f. List of acceptable lubricants, insulating fluids, flushing fluids, hydraulic fluids, and fluid additives.

5.2.4 6.5.4 Operation

Complete and detailed operating instructions, including safety precautions, startup procedures, shutdown procedures, normal operation procedures, non- standard event procedures, and freeze protection requirements and philosophy of operation. Operating procedures and instructions shall provide the operator with information when and how to operate the equipment, including precautions, limitations and set points. Procedures listed in step-by-step sequence shall include preoperational checkout, startup, normal, remote or emergency modes of operation, and stopping or shutting down part or all of the subject equipment. Troubleshooting charts and tables shall be used to list likely evidence of malfunction and what could be responsible. The effect of loss of normal power and effect of electricity supply frequency drop shall be addressed.

5.2.5 6.5.5 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:

a. 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 other consolidated database, if approved).

b. Step-by-step procedures for all anticipated equipment repairs.

c. Troubleshooting guide.

d. 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.

e. Recommended six (6) month layup procedure.

f. List of maintenance tools furnished with the equipment.

h. Safety provisions.

i. Torque values for critical bolts.

j. Field disassembly and assembly.

k. Field overhaul of specific components.

l. Tube plugging instructions including plug dimensions and recommended material.

m. Overhaul instructions.

n. Control system troubleshooting instructions.

o. 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 PGE’s 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 (eg. 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.

## 5.3 PROJECT WORKBOOK

At the conclusion of the project and prior to Wind Plant Final Completion or Solar Plant Final Completion, the Contractor shall provide the Project Workbook listing the Project documentation as specified below.

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

Document Types:

- Bid Document
- Budget
- Calculation
- Certificate
- Collection System
- Construction Work Package
- Contract
- Correspondence
- Design Basis
- Drawing
- Easement
- Estimate
- GIS
- Historical Document
- Incident Reports

- Inspection
- Invoice
- Job Books
- License
- Manual
- Meeting
- Model
- Permit
- Photograph
- Plant Systems
- Presentation
- Plan/Procedure
- Proposal
- Purchase Order
- Regulatory
- Report
- RFI
- RFP
- Schedule
- Schematic
- Site Certificate
- Specification
- Submittal
- Transmittal

- Vendor Information
- Video
- Welding

Disciplines:

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

Document Status:

- 30%, 60%, or 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 to 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
- VOID

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 02**
**ANNEX 01**

# DOCUMENTS AND DELIVERABLES TABLE

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

**KEY**

Level A: Contract Documentation - Documentation submitted prior to execution of the Agreement
Level B: Construction Documentation - Documentation to be submitted prior to the commencement of Work on Site or issuing of any completion certificate
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Certification | 3rd party structural design certificate | Third-party Registered Professional Engineer's Certificate confirming the suitability of the Wind Turbine foundation(s) and that they are in accordance with the As-built drawings. | | | X | | | |
| Certification | Acceptance certificates | All completed Acceptance Certificates for Works prior to Substantial Completion milestone | | | X | X | | |
| Certification | Calibration certificates | Copies of calibration certificates for all instrumentation mounted on all met stations/masts, provided by recognized independent agencies and done in accordance with the appropriate calibration standards. | | X | | | 4 weeks after met station installation | |
| Certification | Capacity and Availability test report | Upon satisfactory completion or upon failure of the Capacity and Availability Test, as the case may be, the Contractor will issue an Acceptance Test Certificate to that effect. | | | X | X | | |
| Certification | Civil Works concrete and grout design supporting information | Contractor shall provide evidence from field, production or trial tests to justify the design of the concrete or grout mix proposed. | | X | | X | 3 months after Agreement execution | |
| Certification | Electrical safety certficates | Electrical Safety Certificates for all electrical works to Applicable Laws, Regulations and Standards | | X | | X | Prior to energization | |
| Certification | Electrical system certificates of compliance | All electrical certificates of compliance | | | X | | | |
| Certification | Factory acceptance test reports | Copies of test certificates for all routine factory tests applied to all major items included in the Work, including Wind Turbines, PV Module, and electrical system components including, but not limited to, switchgear, power transformers, instrument transformers, protection relays and revenue metering systems. | | X | | | 8 weeks prior to start of relevant site work | |
| Certification | Factory acceptance test reports for electrical components | FAT certificates to be provided by Contractor shall include, but not necessarily be limited to, the following components:<br>• Transformers, including:<br>o Substation main power MV/HV transformer/s<br>o Auxiliary MV/LV transformer/s<br>o Wind Turbine MV/LV transformers<br>o PCS/Inverter skid MV/LV transformers<br>o Reactive plant transformers (if applicable)<br>• Instrument transformers (i.e. CTs, VTs)<br>• Reactive plant equipment (if applicable)<br>• HV and MV switchgear and switchboards<br>• LV distribution boards (AC and DC)<br>• Cabling (HV, MV, LV and fiber optic)<br>• HV and MV surge arrestors<br>• Protection relays<br>• Metering systems (revenue, check and power quality)<br>• UPS systems<br>• Stand-by diesel generator, and<br>• Switchroom batteries and chargers | | X | | | Prior to delivery to Site | |
| Certification | Factory acceptance test reports for wind turbine components | FAT certificates to be provided by Contractor shall include, but not necessarily be limited to, the following components: | | X | | | Prior to delivery to Site | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Rotor<br>• Blades<br>• Gearbox (where applicable)<br>• Step-up transformer<br>• Generator<br>• Yaw system<br>• Main bearings<br>• Service crane<br>• Wind Turbine tower<br>• Service ladder<br>• Service lift<br>• Fall arrest and safety systems | | | | | | |
| Certification | Performance test report | Report summarizing test as specified. Upon satisfactory completion or upon failure of the Performance Test, the Employer will issue an Acceptance Test Certificate to that effect. | | | X | X | | |
| Certification | Permanent on-site buildings | Permanent building designs shall be independently checked and approved by a certified structural engineer | | X | | | 6 weeks prior to building work | |
| Certification | Power Curve Test Report and Certificate | Upon satisfactory completion or upon failure of the Power Curve Test, as the case may be, the Consultant shall issue to Owner a report and a Performance Test Certificate to that effect. | | | X | | | |
| Certification | Protection settings signoff | Written endorsement by the interconnection provider in respect of all protection settings of the Project | | X | | | Prior to Plant energization | |
| Certification | PV Mounting structure 3rd party certificate | 3rd Party Civil/Structural Engineer's Certificate confirming the suitability of the PV Array Mounting Structure and all Civil Works, that they are in accordance with the As-built drawings and documentations and as required under the Applicable Laws, Regulations and Standards in respect of the entire Solar Farm and site building electrical works. | | | X | | | |
| Certification | Reinforcement specifications and testing certificates | Certificates confirming manufacturers and processors of steel reinforcement hold a valid certificate of approval. | | X | | | 6 weeks prior to start of relevant work | |
| Certification | SCADA system warranty and results | Documentary evidence that the SCADA system is sufficient for recording and analysis of the data for the warranty tests; and confirmation and detailed report of how the SCADA system stores data and provides values to enable availability calculations. | | X | | | 6 weeks prior to start of relevant work | |
| Certification | Type test certificates | Type Test Certificates for any piece of Plant or Equipment | | X | | | 8 weeks prior to start of relevant site work | |
| Certification | Wind Turbine certification | Type certification or design assessment of the Wind Turbine applicable to the proposed Wind Turbine configuration | X | | | X | Agreement close | |
| Certification | Wind Turbine geotechnical certification | Geotechnical certification from a qualified geotechnical engineer confirming design founding conditions in the base of the excavation prior to pouring the foundation or blinding. | | X | | | 6 weeks prior to start of relevant work | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Civil works | 30% Design including the following:<br>• Buildings and structures<br>• Roads<br>• Crane pads<br>• Site drainage<br>• Earthwork and compaction<br>• Met mast foundation/footings<br>• HV/MV substation foundation/footings<br>• Site landscaping<br>• Site restoration/reclamation | | X | | X | 3 months after Agreement execution | |
| Design | Civil works | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable:<br>• Detailed foundation design drawings required.<br>• ALTA survey map | | X | | X | | |
| Design | Civil works | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Civil works | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Civil works | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Electrical collector system | 30% Design including the following:<br>• Wind Power Plant collector system SLD, showing connection to Wind Turbine step-up MV/LV transformers, all junction boxes, ground reference transformers (if applicable) and Wind Turbines; protection SLD to be incorporated or provided separately<br>• Cable route layout for collector system, including including details of creek and road crossings approximate in-line joint locations (if applicable). Diagram shall include GPS coordinates of Wind Turbines and meteorological masts<br>• Earthing drawings | | X | | X | 3 months after Agreement execution | |
| Design | Electrical collector system | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required. | | X | | X | | |
| Design | Electrical collector system | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Electrical collector system | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |

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Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate

Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Electrical collector system | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility including the following:<br>• A GIS database which shall include all as-built cable routes recorded in a minimum of 10 meter steps and in-line joints (if installed).<br>• MV Protection Schematics<br>• MV CB Control Schematics<br>• LV Air CB Schematics<br>• UPS Schematic<br>• Battery Charger Schematic<br>• Distribution Board schedules<br>• Cable schedules (HV, MV and LV)<br>• LV systems and auxiliary generator schematics<br>• As-built MV Switchroom GA drawings, including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.<br>• As-built Wind Turbine transformer kiosk GA drawings (if applicable), including LV cabling between Wind Turbine and transformer kiosk | | | X | | | |
| Design | Fire Protection System documentations and drawings | Including as a minimum:<br>• Fire Risk Evaluation/Fire Protection Design Basis Document<br>• Complete and detailed design drawings for each system. Drawings shall clearly indicate all wiring and equipment that is supplied or installed by Contractor. Drawing shall call out any design and material requirements (manufacture and code/standard). Contractor is responsible for reviewing materials and designs as part of the overall fire protection system, to ensure compliance with codes, standards and manufacturers' requirements.<br>• Site fire protection plan drawings<br>• Hydraulic calculations<br>• Room integrity test results for clean agent suppression systems<br>• Detailed control panel drawings<br>• Detailed communication drawings | | X | | X | 3 months after Agreement execution | |
| Design | Fire Protection System documentations and drawings, as builts | Including as a minimum:<br>• Operation and Maintenance manuals shall be provided. | | | X | X | | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Complete all required documentation and obtain necessary inspection required for the fire protection systems to be operated. Signed and filled out test forms shall be provided for each system provided.<br>• As built drawings | | | | | | |
| Design | Meteorological station | 30% Design drawing and specification of the following:<br>• Information on the Met Masts installations including number of Permanent Met Masts | X | | | X | Agreement close | |
| Design | Meteorological station | 60% Design including the following (if applicable):<br>• An updated version of 30% Design with revisions and additional detail where applicable<br>• Mast general layout<br>• Instrumentation specifications and calibrations;<br>• Proposed locations and non-wake-affected sectors<br>• Earthing and lightning protection<br>• Mast instrumentation & mounting arrangements<br>• Aviation warning markings (e.g. marker balls)<br>• Enclosures and cabling<br>• Fencing/protection<br>• UPS<br>• Power supply and SCADA connection | | X | | X | | |
| Design | Meteorological station | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Meteorological station | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Meteorological station | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Permanent on-site buildings | 30% Design including but not limited to the following:<br>• Layout<br>• Elevation drawings<br>• Structural<br>• Architectural<br>• Fire rating<br>• Hold down | X | | | X | Agreement close | |
| Design | Permanent on-site buildings | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required. | | X | | X | | |

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Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Permanent on-site buildings | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Permanent on-site buildings | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Permanent on-site buildings | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Pre-engineered metal buildings (if applicable) | Including, but not limited to:<br>• Detailed shop and erection drawings and product data<br>• Foundation loads, anchor bolt setting diagrams, and details of required anchorage to concrete foundations<br>• All calculations used in the development of building and anchor bolt design and of fabrication drawings | | X | | X | 1 week after Agreement execution | |
| Design | PV Array design drawings | 30% Design: Includes the general arrangement drawings of the following:<br>• PV Array, including Sub-Array(s), Strings and Modules<br>• Inverter Blocks<br>• PV String Combiner Boxes and PV Sub-Array Combiner Boxes<br>• PCS<br>• MV/HV Substations<br>• Permanent and temporary buildings | | X | | | 3 months after Agreement execution | |
| Design | PV Array design drawings | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. | | X | | X | | |
| Design | PV Array design drawings | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | PV Array design drawings | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | PV Array design drawings | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Substation | 30% Design including the following (as applicable):<br>• Substation general arrangement drawing<br>• Main power transformer(s)<br>• Wind Turbine 34.5 kV system interface drawings, showing MV switchgear and Wind Turbine transformer | | X | | X | 3 months after Agreement execution | |

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Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Manufacturer specifications for all reactive power compensation equipment (if applicable) and associated transformers<br>• Protection equipment and switchgear specifications (including MV/HV substation, Wind Turbine-located MV switchgear, NER/NET if applicable), including insulating medium, description of interlocking and protection, thermal, fault and insulation ratings, IP level, manufacturer and standards compliance, relevant type test certificates<br>• LV systems, diesel generator and associated equipment specifications, including battery and UPS capacities/back-up time<br>• Revenue and power quality meter specifications<br>• Drawings and schematics for Wind Turbine-located MV switchgear (if applicable), including configuration, placement, connections, civil works and/or mounting arrangements, cable terminations, and<br>• Single line diagram (SLD) of substation, including main power transformer, reactive power compensation resources; protection SLD to be incorporated or provided separately | | | | | | |
| Design | Substation | 60% Design including the following:<br>• An updated version of 30% Design with revisions and additional detail where applicable<br>• Main power MV/HV transformer specifications and drawings, including MVA rating, nominal voltage rating, on-load tap changer (OLTC) configuration, AVR, insulating medium, vector group, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, fire protection, corrosion protection, load and no-load loss guarantees, oil/water separator and bund details, manufacturer and standards compliance. Also required is the Type test certificate (considering environmental conditions, corrosion, cyclic loading, peak voltages and fire risk) and a fitness for purpose statement.<br>• Submittals as required in Appendix G1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification. | | X | | X | | |
| Design | Substation | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Substation | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Substation | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | SCADA and communications network | 30% Design including the following:<br>• Information on the communications system, including specifications and drawings | | X | | X | 3 months after Agreement execution | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Information on the SCADA system, including specifications and drawings<br>• Fiber optic network drawings<br>• Fiber optic splicing drawings, fiber optic distribution panel drawings<br>• Complete list of all the data points and operational parameters applicable to the Contractor's proposed SCADA system.<br>• Documentation describing how the availability and performance is calculated, stored and analysed in the SCADA system. | | | | | | |
| Design | SCADA and communications network | 60% Design including the following (if applicable):<br>• An updated version of 30% Design with revisions and additional detail where applicable<br>• I/O connections drawings<br>• Network used to communicate (transmission medium, network topology, communication protocols and fault tolerance)<br>• Interfaces<br>• Network layout<br>• Point addressing scheme<br>• Grounding requirements<br>• Redundancy and UPS<br>• Sensor locations and sensor orientations<br>• Remote access<br>• Viewing and display<br>• Data collection and storage<br>• Control<br>• Reporting<br>• Software and licenses<br>• Comprehensive user manual explaining the operation and use of all the functions<br>• Hardware manuals for all hardware and computers systems<br>• Documentation including manuals, quality control, installation, commissioning and testing procedures | | X | | X | | |
| Design | SCADA and communications network | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | SCADA and communications network | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | SCADA and communications network | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility including the following:<br>• Detailed architecture, interfacing and component product identification | | | X | | | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Network Data Communication, detailed wiring diagram<br>• Fiber optic network<br>• Interfacing<br>• Power supply – SCADA distribution board SLD | | | | | | |
| Design | Site layout/plans | Proposed Preliminary Layout including (as applicable):<br>• Wind Turbines (including padmount transformers)<br>• PV array sections<br>• Landowner boundaries<br>• Public roads<br>• Access roads<br>• Inverter stations<br>• Cable routes<br>• Laydown areas<br>• Meteorological stations<br>• Substation<br>• Transmission line<br>• Borrow pits<br>• Batch plant(s)<br>• Permanent and temporary buildings | X | | | X | Agreement close | |
| Design | Site layout/plans | 30% Design including the following (as applicable):<br>• An updated version of Preliminary Layout with revisions and additional detail where applicable<br>• Junction boxes<br>• Ground-reference transformers<br>• Foundations/footings<br>• Crane pads/hardstands<br>• Crane paths<br>• Drainage and erosion control features<br>• Spares, parts, tools and permanent storage<br>• Temporary utilities, and<br>• Fencing, gate, signage and label details | | X | | X | 3 months after Agreement execution | |
| Design | Site layout/plans | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Site layout/plans | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Site layout/plans | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Site layout/plans | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-constructed facility. | | | X | | | |
| Design | Solar control drawings and documentation | 30% Design: Single line diagram, in sufficient detail to show all protective devices, overvoltage protection, isolation and earthing facilities;<br>• Wiring diagrams (three-wire) for all main power and auxiliary circuits in the Solar Project<br>• Control system block diagram of the Solar Project<br>• Solar Project earthing drawings<br>• Solar Project MV/HV system interface drawings, showing MV switchgear and HV/MV Transformer<br>• GA drawings and schematics for Solar Project located MV/HV switchgear (if applicable), including configuration, placement, connections, civil works and/or mounting arrangements, cable terminations, and<br>• Vendor data sheets for main electrical components in the Solar Project, including generator, main circuit breaker and converter/inverter (if present) | | X | | X | 3 months after Agreement execution | |
| Design | Solar control drawings and documentation | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. | | X | | X | | |
| Design | Solar control drawings and documentation | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Solar control drawings and documentation | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Solar control drawings and documentation | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Solar electrical BOS specfications and design drawings | 30% Design: Includes specifications and design drawings of all elements of the electrical system including, but not limited to the following:<br>• Inverter Stations, including overall GA drawings and connection diagram, in addition to individual equipment specifications and compliance certification<br>• (if applicable) Switchgear Stations, including overall GA drawings and connection diagram, in addition to individual equipment specifications and compliance certification. | | X | | X | 3 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Transformer specifications, including kVA rating, nominal voltage rating, tap changer configuration, insulating medium, vector group, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, fire protection, corrosion protection, load and no-load loss guarantees, manufacturer and standards compliance. Design drawings, including enclosure, fittings, locations and bund details (and oil/water separator specification if applicable). Transformer type test certificate and a fitness for purpose statement (considering Environmental Conditions, corrosion, cyclic loading, peak voltages and fire risk).<br>• Cable specifications and schedules for all MV, LV, earthing and fibre-optic cabling in the Works. Cable sizing.<br>• Full technical specifications for all termination kits, jointing kits, lugs and connectors to be used in the primary power circuits and in the earth network<br>• Protection equipment and switchgear specifications, including insulating medium, description of interlocking and protection, thermal, fault and insulation ratings, IP level, manufacturer and standards compliance, relevant type test certificates<br>• Auxiliary power systems and associated equipment specifications, including battery and UPS capacities/back-up time<br>• Revenue and power quality meter specifications<br>• In-line cable jointing kits | | | | | | |
| Design | Solar electrical BOS specfications and design drawings | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. | | X | | X | | |
| Design | Solar electrical BOS specfications and design drawings | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Solar electrical BOS specfications and design drawings | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Solar electrical BOS specfications and design drawings | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Spare parts, tools, and permanent storage | 30% Design including the following:<br>• List of components and consumables that do not satisfy the Design Life for Work including additional information | | | | X | | |
| Design | Spare parts, tools, and permanent storage | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required. | | X | | X | | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Spare parts, tools, and permanent storage | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Spare parts, tools, and permanent storage | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Transmission lines | 30% Design including the following (if applicable):<br>• Transmission line route including proposed pole/tower locations<br>• Transmission line typical span and pole/tower drawings<br>• Proposed transmission line structures and foundations<br>• Approved Rebar Shop Drawings<br>• Approved Concrete Mix Design<br>• Power Cable Data Sheets<br>• OPGW/Fiber Optic Cable Data Sheets | | X | | X | 3 months after Agreement execution | |
| Design | Transmission lines | 60% Design including the following (if applicable):<br>• An updated version of 30% Design with revisions and additional detail where applicable<br>• Power line systems PLS-CADD model<br>• All geotechnical data, including LPILE and SHAFT program inputs<br>• Detailed foundation design drawings<br>• Transmission line profile design<br>• Structure assembly drawings, including required tolerances for installation<br>• Drawings showing details of conductor clearances and member clearances<br>• Drawings showing clearances of conductor sagging and existing vegetation and other objects<br>• Line route survey drawings and data<br>• Design of access routes, including drawings<br>• Pole assembly<br>• Pole erection<br>• Conductor, and<br>• OPGW stringing, earthing, jointing and terminations | | X | | X | | |
| Design | Transmission lines | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable:<br>• Rebar/Anchor Bolt Mill Certs.<br>• Anchor Bolt Tension Test Data.<br>• Operational test of all equipment when complete, prior to Electrical Substantial Completion.<br>• Mill certs for embedment ring. | | X | | X | 6 weeks prior to start of relevant work | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Transmission lines | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable:<br>• Concrete Cylinder Test Results<br>• Foundation-concrete air test results.<br>• Foundation-concrete slump test results.<br>• Ground loop test.<br>• Foundation-compaction test dry density and moisture content of fill.<br>• Grout cube strength test results. | | X | | X | | |
| Design | Transmission lines | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Wind Power Plant Collection System Cable Route Layout and associated design drawings | Layout and associated design drawings including, but not limited to:<br>• MV cable route diagram, including details of creek and road crossings<br>• Trench layout diagrams, showing cross-section of all buried cable configurations<br>• LV cable route diagrams between the Wind Turbines and transformer kiosks (if applicable) | | X | | X | 3 months after Agreement execution | |
| Design | Wind Turbine foundations | 30% Design including the following:<br>• Design basis document prepared by the foundation designer, outlining standards, methods and approach to be used in the foundation design.<br>• Wind Turbine standard foundation design<br>• Proposed foundation design types used for costing estimate based on preliminary assessment of Wind Power Plant<br>• Foundation design, construct & test philosophy<br>• General arrangement drawings | | X | | X | 3 months after Agreement execution | |
| Design | Wind Turbine foundations | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable. Detailed foundation design drawings required. | | X | | X | | |
| Design | Wind Turbine foundations | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Wind Turbine foundations | IFC Design: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Design | Wind Turbine foundations | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |
| Design | Wind Turbine general descriptions and diagrams | 30% Design including the following:<br>• Nacelle<br>• Hub (including electrical and hydraulic systems as applicable);<br>• Blades<br>• Tower sections including internals (platforms, ladders, hatches, control cabinets and safety equipment)<br>• Gearbox (if applicable)<br>• Generator including bearings, cooling system<br>• Mechanical braking system<br>• Hydraulic systems<br>• WTG Electrical cabinets<br>• Cooling system<br>• Condition monitoring system<br>• Safety equipment<br>• Service lift<br>• Single line diagram of the Wind Turbine(s) , in sufficient detail to show all protective devices, overvoltage protection, isolation and earthing facilities<br>• Wiring diagrams (three-wire) for all main power and auxiliary circuits in the Wind Turbines<br>• Wind Turbine earthing drawings<br>• Wind Turbine MV system interface drawings, showing MV switchgear and Wind Turbine Transformer<br>• Control system block diagram of the Wind Turbines | | X | | X | 3 months after Agreement execution | |
| Design | Wind Turbine general descriptions and diagrams | 60% Design: An updated version of 30% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Wind Turbine general descriptions and diagrams | 90% Design: An updated version of 60% Design with revisions and additional detail where applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Design | Wind Turbine general descriptions and diagrams | IFC Design Packagge: An updated version of 90% Design with revisions and additional detail where applicable | | X | | X | | |
| Design | Wind Turbine general descriptions and diagrams | As-built Design: Design changes after the release of the IFC Design Documents and to document the design of the as-consctucted facility. | | | X | | | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| File | PVsyst model | The Contractor will provide their PVsyst model file (including all supporting component, horizon and other necessary files) to support their energy production figure. | X | | | | Agreement close | |
| Licenses | Software licenses | All licenses, software keys, hardware keys (dongles) and the like for all software included in the Works. | | | X | | | |
| List | Sub-contractors list | List of all sub-contractors to be included as approved sub-contractors. | X | | | X | Agreement close | |
| Manuals | O&M Manuals | Draft, comprising Overview and Manuals from key equipment suppliers; equipment maintenance requirements | | X | | X | 120 business days prior to commissioing activities | |
| Manuals | O&M Manuals | Complete and final O&M Manuals, including but not limited to (as applicable):<br>• Overview of the Plant Works<br>• All relevant specifications<br>• All details for the safe and effective use, operation and maintenance of the complete Plant Works<br>• Procedure to mitigate grease contamination from oil leaks or other contaminants that can enter blade bearing.<br>• System description<br>• Safety Plan with Supporting Lock-out-tag-out procedures<br>• Equipment startup procedures<br>• Equipment shutdown procedures<br>• Equipment warning and trip setpoints<br>• Normal system operations controls<br>• Abnormal system operations controls<br>• Equipment fault codes<br>• Troubleshooting guides<br>• Maintenance intervals and tasks; including:<br>• Procedures<br>• Tools<br>• Inspection criteria, as required<br>• Systems Descriptions describing normal and abnormal control for system components<br>• Condition monitoring intervals and tasks; including:<br>• Inspection procedures<br>• Inspection criteria | | | X | | 30 business days prior to commissioning activities | |
| Manuals | SCADA system documentation | The SCADA system shall be supplied with three sets of comprehensive, complete and up-to-date documentation packages relevant to all the hardware and software supplied.<br>This shall include but not limited to (as applicable): | | | X | | | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • A comprehensive user manual explaining the operation and use of all the functions<br>• Detailed descriptions of the underlying theory and calculations employed especially with regard to availability and power curve measurements. These shall include complete details of any data processing carried out by the Wind Turbine controllers<br>• A complete electrical wiring diagram showing connections to the controller and the communications links<br>• Hardware manuals for all hardware and computers systems<br>• An administrator manual for system administration and configuration<br>• Quality control, installation and commissioning documentation | | | | | | |
| Permits | Permits | Permits including but not limited to:<br>• 1200c (NPDES and Sediment and Erosion control)<br>• Removal/fill<br>• Septic<br>• WPCF | | X | | X | 5 business days upon obtaining | |
| Plan | Capacity test plan | Method Statement describing the Contractor's proposal to perform Capacity Test and Availability Test in accordance with the requirements set in the Specifications.<br>• Details of the equipment to be used<br>• Any deviations<br>• The methodology for dealing with those deviations<br>• Details of the site calibration procedure | | X | | X | 6 months after Agreement execution | |
| Plan | Civil works, concrete procedure | A procedure for on-Site concrete batching, including as a minimum:<br>• Source of materials<br>• Transport plan<br>• Quality control<br>If Contractor proposes to utilize a pre-existing off-Site batch plant, details shall be provided on the concrete supplier including:<br>• Quarry materials suppliers and any additives required<br>• How the delivery of concrete to site is to be managed<br>Contractor shall additionally provide a method statement for forming cold joints should concrete supply be disrupted. | | X | | X | 2 months after Agreement execution | |
| Plan | Document control plan | The document control plan shall address how documents are transmitted, named, reviewed, tracked, and edited. | | X | | X | 2 weeks after Agreement execution | |
| Plan | Emergency response plan | Emergency response procedures and information | | X | | | 1 month prior to accessing Site | |
| Plan | Environment Management Plan | Including, but not limited to:<br>• NPDES permit | | X | | X | 1 month after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • SPCC Plan<br>• Noxious weeds management plan<br>• Cultural resources plan<br>• Stormwater plan<br>• Drinking water plan | | | | | | |
| Plan | Grounding and bonding plan | Plan and details, including fence as applicable | | X | | X | 6 weeks prior to start of relevant work | |
| Plan | Hazardous Material Management plan | Plan includes spill and recovery procedures. | | X | | X | 1 month prior to accessing Site | |
| Plan | HSE management plan | Updated and final. This shall include a comprehensive list of all HSE laws and Applicable Standards applicable to the Work | | X | | | 1 month prior to accessing Site | |
| Plan | Typical commissioning plan | Proposed installation and commissioning plan | X | | | X | Agreement close | |
| Plan | Installation and commissioning plan, Commissioning Test Manual | Procedure describing pre-commissioning and commissioning tests on all items in preparation for completion of individual Section of Works and to reach Substantial Completion. | | X | | X | 30 days before start of comissioning | |
| Plan | Loss of grid power procedure | Provide procedures to achieve the aim of ensuring the Work is able to withstand periods without grid electrical power. | X | | | X | Agreement close | |
| Plan | Project management plan | Proposed Project Plan including:<br>• List of key personnel with CVs<br>• Project organization diagram<br>• Project schedule including all milestone dates for completion of Work | X | | | X | Agreement close | |
| Plan | Project management plan | Including:<br>• Construction project manager and key team members (including curricula vitae)<br>• Project organization diagram<br>• Communication plan<br>• Permits, licenses, certifications and agreements required<br>• Procurement and sub-contracting plan<br>• Project schedule and payment milestones (as defined in Appendix 01 Exhibit 01 Annex 04 Milestone Payment Schedule)<br>• Resource loading plan<br>• Environment, health and safety plan including description of HSE system and associated certificates<br>• Quality control / quality assurance plan (including equipment inspections and factory acceptance tests)<br>• Management of Owner and other external interfaces<br>• Change control plan – including change order process<br>• Escalation matrix – how and when to escalate issue for resolution | | X | | X | 30 days after Agreement execution | |
| Plan | Project quality plan | Proposed Quality Management Plans applicable to:<br>• Design of the Work | | X | | X | 45 days following NTP | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Manufacture of the Work<br>• Transportation and storage of the Work<br>• Installation and erection of the Work<br>• Testing, commissioning, and Substantial Completion of the Work<br>• Shall include, where appropriate, references for FATs of major components<br>• Description of quality management system and associated certificates | | | | | | |
| Plan | Project quality plan | Update and final Project specific quality management plan | | X | | | 1 month following Owner comments | |
| Plan | Project schedule | The Schedule shall include, but not be limited to, the following:<br>• Schedule Basis Memorandum<br>• Engineering activities (i.e. engineering studies, calculations, and designs)<br>• Procurement activities<br>• Material and equipment deliveries<br>• Construction activities<br>• Tie-ins to existing plant systems<br>• Equipment factory tests<br>• Interfaces with Owner and other external interfaces<br>• Major milestones<br>• Milestone payments, if applicable<br>• Startup and commissioning activities<br>• Testing activities | | X | | X | 8 weeks after NTP | |
| Plan | Site Specific Safety and Health Plan | Including elements as specified in Appendix G1 Attachment 01 Exhibit 06 – Safety, Health, and Environment.<br>• Resumes of Safety Professional | X | | | X | Agreement close | |
| Plan | Solar energy performance test plan | Plan shall include, but not limited to:<br>• Test procedure<br>• Project Model (PVsyst files and loss assumptions)<br>• Project summary<br>• Interested parties (stakeholder) details<br>• Start and end test dates<br>• All sensors and transducers used<br>• SCADA channels and calibration factors<br>• Quality concerns<br>• Time stamp convention and data logger averaging | | | X | X | 45 business days prior to first day of measurement period | |
| Plan | Solid Waste Recycling/Recovery plan | Plan for solid waste recycling and recovery. | | X | | X | 1 month prior to accessing Site | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Plan | Storm Water Pollution Prevent Plan (SWPPP) or Sediment and Erosion Control Plan | As required | | X | | X | 1 month prior to accessing Site | |
| Plan | Testing, inspection and test plans | Proposed testing plan including but not limited to:<br>• Proposed commissioning procedures including but not limited to:<br>o the Commissioning Tests<br>o the Acceptance Tests<br>o the Performance Tests<br>o SCADA<br>• Details of any Tests on Completion that may threaten the safety of the Plant | | X | | X | 2 months prior to start of relevant work | |
| Plan | Training program | Details of training program required to support the off-site and in-field training of Owner's personnel. | X | | | X | Agreement close | |
| Plan | Training program | Hard and electronic copies of all training material. | | | X | | | |
| Plan | Transportation plan | Procedure for delivery to Site for main transformer, inverter stations and other critical equipment and oversize loads | | X | | X | 1 month prior to Site mobilization | |
| Plan | Transportation plan | Proposed shipping and access routes and major onsite access plan | X | | | X | Agreement close | |
| Plan | Wind performance test plan | Draft of Project Equipment Performance test | X | | | X | Agreement close | |
| Plan | Wind performance test plan | Power Performance Testing Procedure describing the procedure to be undertaken by the Power Performance Testing consultant to measure the power curves of the selected Wind Turbines.<br>• Details of the equipment to be used<br>• Any deviations between the actual conditions for the Power Performance Testing and the requirements specified by the Power Performance Testing Procedure<br>• The methodology for dealing with those deviations<br>• Details of the site calibration procedure | | X | | | 2 months prior to start of relevant work | |
| Plan | Wind performance test plan | Updated and final version | | X | | | 1 month prior to start of relevant work | |
| Plan | Work plans | Procedures for execution of all Work including details of number of personnel and vehicles that will be on site at all the different phases of the Project | | X | | X | 2 months prior to start of relevant work | |
| Report | As left settings | Alarm set points, complete I/O database including description of each I/O | | | X | | | |
| Report | Bankability report | Including as applicable and available:<br>• PV Modules<br>• Solar trackers<br>• Inverters | X | | | | Agreement close | |
| Report | Civil work geotechnical investigation report | Geotechnical investigation of HV/MV substation, access roads, hardstands, underground cabling, Wind Turbine & Met Mast foundation/footing sites. | | X | | X | 2 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Report | Civil works 3rd party structural design report | Third-party Registered Professional Engineer's Report confirming the suitability of:<br>• The permanent buildings<br>• Any other structures as required to be certified under the local building and/or structural codes | | X | | | 6 weeks prior to start of relevant work | |
| Report | Civil Works Civil/Structural design report | The design report shall contain, as a minimum, all method statements, design inputs, design calculations, specifications, design drawings, cross sections, layouts and studies regarding:<br>• Borehole logs and relevant geotechnical test results for the HV/MV substation<br>• HV/MV substation foundations/footings;<br>• Met Mast foundations/footings<br>• Crane hardstands<br>• Access roads<br>• Permanent buildings (including structural, architectural, fire rating and hold down details)<br>• Site drainage<br>• Site landscaping<br>• Site restoration | | X | | X | 3 months after Agreement execution | |
| Report | Document register | Proposal defining the contract drawings and documents in the form of a document register | X | | | X | Agreement close | |
| Report | Document register | Update of document register. | | X | | | | |
| Report | Electrical balance of plant power system studies and design calculations reports | Updated Electrical Design Report following any design changes during construction. | | | X | | | |
| Report | Electrical studies | Include Easypower/Aspen software model and complete system one line diagram, where applicable. Electrical studies including, but not limited to the following:<br>• Auxiliary power study<br>• Coordination study<br>• Arc flash hazard study<br>• Insulation coordination<br>• GSU transformer sizing<br>• DC/UPS sizing<br>• Grounding calculation<br>• Harmonics study<br>• Subsynchronous resonance study (if applicable)<br>• Field effect study | | X | | X | | |
| Report | Electrical studies | Update and final report | | | X | | One month prior to Substantial Completion | |
| Report | Electrical system optimization report | Final optimization of power cable and overhead conductor size | | X | | | 6 months after Agreement execution | |

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| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Report | Energy generation summary | Report summarising loss parameters and energy estimates for the Solar Project | X | | | | Agreement close | |
| Report | Equipment list | List of all equipment | | X | | | | |
| Report | Equipment maintenance records | Maintenance records for equipment | | | X | | | |
| Report | Failure Modes and Effects Analysis | Provide for critical supplied systems and assets:<br>• Known / common failure modes<br>• Potential failure modes and historical/expected mean time between failures<br>• Severity on operation relative to the system provided<br>• Methods of detection based on vendor supplied Preventive Maintenance (PM) or Predictive Maintenance (PdM) Procedures<br>• Improvements due to design modifications, additional PM or PdM measures or optional equipment. | | X | | X | 3 months after Agreement execution | |
| Report | Final substantial completion test reports | Completed installation and commissioning checklists, including commissioning test results, for the entire Plant electrical Works, including, but not limited to, MV/HV Transformer/s, auxiliary transformers, Reactive Plant (if applicable), protection systems and switchgear, transformers and switchgear, MV cables, fiber optic cables, metering, LV equipment, auxiliary generator, in-line cable joints (if applicable), earthing connections, terminations and joints. | | | X | | | |
| Report | Foundations Civil/Structural design report | Including but not limited to the following:<br>• Design loads for all structural components<br>• Design calculations including all assumptions<br>• Demonstration of suitability of all structural components in extreme wind conditions and over the design life<br>• Wind tunnel test results<br>• Modal analysis results<br>• Detailed foundation specifications<br>• Concrete and Grout Design and the mix proposed as described in this document<br>• Borehole logs and relevant geotechnical test results for each Wind Turbine site<br>• All partial safety factors<br>• Decision trees<br>• Reinforcement specifications and testing, and<br>• Conclusions | | X | | X | 3 months after Agreement execution | |
| Report | Geotechnical investigation report | Comprehensive geotechnical investigation, including and as applicable:<br>• PV Array | | X | | X | 2 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Inverter Station<br>• MV/HV Substation<br>• Access Roads<br>• Hardstands<br>• Underground Cabling<br>• Met Station footing sites<br>• Other permanent structures or buildings including the O&M facility<br>• Soil Resistivity (Electrical and Thermal) Surveys | | | | | | |
| Report | Grid connection documentation | Update to all required grid connection documentation. | | | X | | | |
| Report | HSE report | Final HSE report and risk register | | | X | | | |
| Report | HV/MV electrical system design report | Design of proposed electrical systems including, but not limited to:<br>• Single Line Diagrams (SLD) for MV/HV Substation, reactive plant and collector system, incorporating protection (or provided separately)<br>• Earthing general arrangement (GA) drawings and schematic diagrams<br>• Substation GA drawings, including overall GA drawing, MV switchroom GA drawings (including MV and LV switchboards, protection panels, SCADA, battery / UPS, chargers, etc.), lightning mast locations<br>• Schematic diagrams and distribution board schedules for MV switchroom equipment, LV supplies and metering<br>• Details of equipment redundancy<br>• Electronic copies of all studies, models, rating evaluations, etc. performed for the above requirements. Specific software and version information to be provided by Owner. | | X | | X | 6 months after Agreement execution | |
| Report | Hydrology and flood study | To confirm the design for flood requirements for a 1 in 100-year flooding event. | | X | | X | Prior to relevant design work | |
| Report | Installation and commissioning reports | The results of all inspections, checks and tests carried out, together with any subsequent analysis. Including but not limited to protective relay calibration tests, trial of equipment operation summary, and manufaturer field service reports. | | | X | | Within 30 business days of commissioning | |
| Report | Lightning protection study | Detailed assessment of lightning risk to personnel and Works in accordance with Applicable Standards. | | X | | X | 2 months prior to start of relevant work | |
| Report | Master drawing list | Table of all drawings including drawing number, revision letter/number, revision date, drawing title, discipline, document status, document type, plant system, and cross-reference listing for associated vendor drawing numbers, and date submitted to PGE for review. | | X | | X | As drawings are submitted | |
| Report | Meeting minutes | Meeting summary and reports | | X | X | | 3 days following meeting | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Report | Met station/mast installation report(s) | An installation report for each mast including, but not limited to:<br>• Details of installer<br>• Installation date<br>• Grid coordinates of mast (including details of coordinate system and datum)<br>• Elevation of mast above sea level<br>• Mast and equipment details including, but not limited to:<br>o Mast dimensions<br>o Instrumentation types, serials numbers and installation heights and positions<br>o Dimensions and orientations of all booms and arms installed on the mast<br>o Data logger configuration and details<br>o Commissioning details<br>o Reference photos | | X | | | 1 month after installation | |
| Report | Met station/mast maintenance log(s) | Each installed mast shall have a maintenance log detailing all work carried out on the individual mast. The maintenance log shall be such that can be used by Owner for the continuing operation of the mast over its Design Life. | | | X | | | |
| Report | Mounting structure preliminary study | Preliminary design information including footing design, construct & test philosophy; general arrangement drawings | X | | | X | Agreement close | |
| Report | Project schedule | Update as monthly progress reporting showing status, variance, constraints, actual versus planned progress. | | X | X | X | monthly | |
| Report | Project status report | Weekly template provided by Owner. Monthly report to include, as a minimum, for that month:<br>• Safety statistics, issues, and events<br>• Summary of events including equipment delivery dates and status<br>• Major activities accomplished during past month and those planned for the coming month<br>• Project schedule update<br>• Milestone payment schedule status<br>• Earned Value Quantities Report (EVQR)<br>• Contract progress S-curves<br>• Contract overall man-hours S-curves<br>• Contract overall staffing histograms<br>• Contract overall craft histograms<br>• Key quantity S-curves<br>• Risks, delays, and quality concerns | | X | X | X | monthly and weekly | |
| Report | Project workbook | List of Project documentation | | | X | | Prior to Final Completion | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Report | Punch list | Documentation listing and detailing any and all minor non-conformances and proposed rectification not required to be completed prior to Substantial Completion. | | | X | | | |
| Report | PV Array Design Report | The Contractor shall submit PV Design Report describing the Contractor's approach in addressing Project design risks, such as PID, shading and others. | | X | | X | 2 months after Agreement execution | |
| Report | PV module quality documentation | Reports demonstrating PV module quality and specifications:<br>• Fash test reports for all modules<br>• 3rd party workmanship audit report or testing score<br>• EL reports for all modules<br>• Batch flash and EL reports after accelerate lifetime tests | | | X | | | |
| Report | PV Mounting structure 3rd party report | 3rd Party Structural Engineer report confirming the suitability of the PV Mounting Structure for the site conditions. | | X | | X | 6 weeks prior to start of relevant work | |
| Report | PV Mounting structure design report | Including but not limited to the following:<br>• Design loads<br>• Design calculations including all assumptions<br>• Demonstration of suitability of all structural components in extreme wind conditions and over the design life<br>• Detailed foundation specifications<br>• Detailed foundation design drawings<br>• Concrete and Grout Design and the mix proposed as described in this document (if applicable)<br>• Borehole logs and relevant geotechnical test results<br>• All partial safety factors<br>• Decision trees<br>• Reinforcement specifications and testing, and<br>• Conclusions | | X | | X | 3 months after Agreement execution | |
| Report | Quality assurance package | Complete sets of quality assurance documentation for each of the defined construction milestones referenced in the Specifications (commonly recorded via construction job books). | | | X | | | |
| Report | Reactive Plant Voltage Regulation & Reactive Power Control Design Report | Voltage regulation and reactive power flow control and coordination study to demonstrate the proposed methods of integration and coordination of voltage and reactive power control devices. | | X | | | 3 months after Agreement execution | |
| Report | Risk assessment report | Risk Assessment Analysis | | X | | X | 30 days after Agreement execution | |
| Report | Risk assessment report | Periodic submission of risk report showing updates and control measures | | X | | | As updated | |
| Report | Solar cable route layout and associated design drawings | Cable Route Layout and associated design drawings including, but not limited to:<br>• AC and DC cable route diagrams, including details of creek and road crossings and approximate in-line cable joint locations (if applicable) | | X | | X | 3 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Trench layout diagrams, showing cross-section of all buried cable configurations.<br>• LV cable route diagrams between the PCS and Substations (if applicable) | | | | | | |
| Report | Solar earthing verification report | Earthing verification report, which verifies through measurement of the as-built earthing systems, that the Plant will be safe for the lifetime of the Project. | | X | | X | 2 months prior to energization | |
| Report | Solar electrical power system studies and design calculations reports | Electrical design report(s) with detailed calculations indicating method, assumptions and outcomes of design and dimensioning of all elements in the Electrical System, having regard to the potential output of the PV Module, Inverter, the Employer's reliability and availability requirements and good electricity industry practice.<br>The Electrical design report shall include without limitation:<br>• Load flow study, including voltage levels at all buses, cable rating calculations and loss calculation at zero, partial and full loads, and annualised losses for the AC network in percentage of annual energy.<br>• Fault study showing minimum and maximum fault levels at all buses<br>• Soil Electrical Resistivity Survey results, in sufficient number of locations to allow design of the entire Earthing System<br>• Earthing study, based on justifiable assumptions and proving conclusively that the Site will be safe for the lifetime of the Solar Farm, addressing transferred potentials and step and touch voltages<br>• Protection study and protection settings report, showing compliance with the Employer's requirements<br>• Arc flash calculations and labels<br>• Overcurrent device coordination<br>• Power quality study<br>• Inverter saturation and output model calculations<br>• Reactive power capabilities and contributions<br>• Insulation co-ordination study<br>• Conduit sizing calculations<br>• EMF calculations<br>• Detailed availability calculations showing that the availability requirement can be achieved | | X | | X | 3 months after Agreement execution | |
| Report | Solar electrical system design report | Design of proposed electrical systems including, but not limited to: | | X | | X | 6 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • AC design single line diagram(s) and electrical drawings, including connections to the Inverters, Transformers and Protection equipment. Protection SLD to be incorporated or provided separately;<br>• DC design single line diagram(s) and electrical drawing(s), including connections to PV Modules, Combiner Boxes, Inverters and any other equipment connected to the DC network;<br>• Earthing GA drawings and schematic diagrams<br>• Details of equipment redundancy | | | | | | |
| Report | Solar SCADA design report | Details of inverter station interfacing, Solar Project and Substation and equipment with design inputs, design criteria, design outputs comprising:<br>• Systems architecture diagram showing all components in block form, specifically identifying redundant elements and interfaces;<br>• System platform details including details of software OS & hardware for SCADA platform including details of redundant elements and expected availability;<br>• Data map and interfacing details;<br>• Performance ratio and other applicable calculations;<br>• Identification of all data points, interfacing points, including how the interconnection and interfacings are to be provided as described in this Employer's Requirements; and<br>• Optic fibre architecture. | | X | | X | 8 months after Agreement execution | |
| Report | Special tools and vehicles | List of all the tools, vehicles or voice communications equipment required for the safe and effective operation and maintenance of the Plant stating whether the Employer is required to purchase this equipment or not. | X | | | X | Agreement close | |
| Report | Special tools and vehicles | Update to special tools and vehicles list | | X | | | 6 months after Agreement execution | |
| Report | Test reports | The results of all inspections, checks and tests carried out, together with any subsequent analysis including documentation of all Acceptance, and Performance Tests (if complete) and applicable certifications. The final commissioning test summary shall be prepared and document the results of all commissioning tests.<br>• Any mutually agreed upon deviations from the Commissioning Test Manual procedures<br>• Instrument calibration sheets and certificates<br>• Test data, including corrected test data<br>• Field notes (weather conditions, observations, etc.)<br>• Test calculations | | | X | X | Within 5 days after test completion | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Any deficiencies or issues identified during, or as a result, of testing<br>• Conclusions<br>• Signatures of Contractor and Commissioning Manager | | | | | | |
| Report | Topographic survey, pre-construction | See Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements | | X | | | 2 months after Agreement execution | |
| Report | Topographic survey, post construction | See Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements | | | X | | | |
| Report | Transformer field inspections and tests | Upon delivery to the Site, transformer supplier shall perform and record the following:<br>• Check impact recorder<br>• Check blocking<br>• Check transformer trank and fittings<br>• Inspect bushings<br>• Internal inspections - moister, coil supports, etc.<br>• Check all parts have been delivered<br>• Perform field tests and compare to FAT<br>• Check all accessories<br>• Provide all additional field inspections, adjustments, and tests recommended by the transformer manufacturer. | | | X | | Within 5 days of delivery | |
| Report | Transmission line civil/structural design report | Foundation and structure design for every pole location, including but not limited to the following:<br>• Design loads<br>• Design calculations including all assumptions<br>• Demonstration of suitability of all structural components in extreme wind conditions and over the design life<br>• Detailed foundation specifications<br>• Concrete and grout mix design proposed<br>• Borehole logs and relevant geotechnical test results<br>• All partial safety factors<br>• Decision trees<br>• Reinforcement specifications and testing | | X | | X | 3 months after Agreement execution | |
| Report | Transmission line earthing verification report | Earthing Verification Report, which verifies through measurement of the as-built earthing systems, that the HV Transmission Line will be safe for the lifetime of the Facility. This shall include measurements of step and touch potentials. | | X | | | 2 months prior to energization | |
| Report | Transmission line other documentation | Including, but not limited to the following:<br>• Electrical design report, including conductor selection (size, current rating, resistance, number of circuits, type, strength, etc.), insulation, loading, clearances, conductor sagging, etc.<br>• Earthing study and earthing design drawings | | X | | X | 3 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Specifications for all components, including conductors, insulators, optical ground wire (OPGW) and hardware.<br>• Equipment data sheets for all engineered equipment items to be provided as part of the Facility. Data sheets shall include a concise description of performance rating, materials, and design data.<br>• Calculations to confirm audible noise, radio frequency interference, electric field and magnetic fields satisfy the regulatory requirements and Applicable Standards.<br>• Work method statements, ITPs (inspection and test plans) and commissioning plans for all HV transmission line works, including concrete testing, foundations, pole assembly, pole erection, conductor and OPGW stringing, jointing and terminations<br>• Test Procedures (functional and Acceptance and Reliability test procedures for acceptance.<br>• Pole schedule<br>• Line schedule<br>• Minimum clearances for maintenance capability<br>• Lists of special tools furnished with the equipment for erection and maintenance to be provided by Owner<br>• Requirements for storage and protection of equipment upon receipt and following installation, but prior to start up;er<br>• Spare parts list (after design)<br>• Earthwork specifications<br>• Concrete specifications<br>• Structural steel specifications<br>• OPGW/Fiber optic cable specifications<br>• Engineered Equipment Specifications<br>• Grounding Calculations and Details<br>• Signage | | | | | | |
| Report | Transmission line stringing test report | Compress sample mid span joints, as well as phase conductor dead/end assemblies for each wire type used on the project | | | X | X | Prior to stringing commences | |
| Report | Transmission line, post construction | Documentation including, but not limited to the following:<br>• Operation and maintenance manuals for all Contractor-supplied equipment;<br>• Sectional drawings showing materials and construction;<br>• QA/QC books<br>• System Turn Over Packages (TOP)<br>• Test Reports | | | X | X | | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Report | Transportation study | A report that details the proposed access roads to be used together with any off-Site road improvement required and conditions of transportation. Off-Site road improvements shall include road cross sections and construction details. Pre-delivery condition survey of the transport route to the Site access point. | | X | | X | 1 month prior to site mobilization | |
| Report | Transportation study | Condition survey of the transport route to the Site access point post-delivery of all major loads & equipment. | | | X | | | |
| Report | Wind electrical balance of plant power system studies and design calculations reports | Electrical Design Report(s) with detailed calculations indicating method, assumptions and outcomes of design and dimensioning of all elements in the EBoP, having regard to the potential output of the Wind Turbines, the characteristics of the Work, Owner's reliability and availability requirements and prudent industry practices.<br><br>The Electrical Design Report shall include without limitation:<br>• Load flow study, including voltage levels at all buses, cable rating calculations and loss calculation at zero, partial and full loads, and annualized losses in percentage of annual energy<br>• Fault study showing minimum and maximum fault levels at all buses<br>• Soil Electrical Resistivity Survey results, in sufficient number of locations to allow design of the entire Wind Power Plant earthing system<br>• Earthing study, based on justifiable assumptions and proving conclusively that the Site shall be safe for the lifetime of the Facility, addressing transferred potentials and step and touch voltages<br>• Protection study and protection settings report, showing compliance with Owner's requirements and other relevant requirements<br>• Harmonics and flicker study<br>• Insulation co-ordination study<br>• Reactive Power and Voltage Control Report | | X | | | 8 months after Agreement execution | |
| Report | Wind SCADA Design report | Details of Wind Turbine interfacing, Wind Power Plant and Wind Power Plant HV/MV substation and 33kV equipment with design inputs, design criteria, design outputs comprising:<br>• Systems Architecture Diagram showing all components in block form, specifically identifying redundant elements and interfaces<br>• System platform details including details of software OS & hardware for SCADA platform including details of redundant elements and expected availability | | X | | X | 8 months after Agreement execution | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Data map and interfacing details<br>• Identification of all data points, interfacing points, including how the interconnection and interfacings are to be provided as described in this document<br>• Fiber optic architecture | | | | | | |
| Report | Wind Turbine noise report | Noise assessment detailing the predicted Wind Power Plant noise at stakeholder and non-stakeholder receiver locations. | X | | | X | Agreement close | |
| Report | Wind Turbine site specific statement of compliance | Including the following:<br><br>• Site specific statement of compliance for the design assessment from a Certification Body which demonstrates that the combined system of Wind Turbine and Wind Turbine towers is designed to withstand the Site conditions for the full Design Life.<br><br>• All reports associated with the site-specific statement of compliance for the design assessment. | | X | | | Once received | |
| Report | Wind Turbine site suitability report | Provision of evidence and a statement of site suitability if conditions are outside type certified conditions | X | | | X | Agreement close | |
| Specifications | Civil works specifications | Where not covered by the Site Layout, an outline of proposed BoP/BOS Civil Works, including but not limited to:<br>• Overview, specifications<br>• Details of reinforcement<br>• Site testing | X | | | X | Agreement close | |
| Specifications | Contractor specifications | Including the following:<br><br>• Standards as identified by Contractor as being relevant to the Work<br><br>• Equipment suppliers detailing locations, and where major components of the Work shall be manufactured | X | | | | Agreement close | |
| Specifications | Design life | Design Life for PV Modules, Inverters, PV Mounting Structures and other major components. | X | | | X | Agreement close | |
| Specifications | Electrical control documentation | Vendor data sheets for main electrical components in the Wind Turbines, including generator, main circuit breaker and converter/inverter (if present) | | X | | X | Duration of Agreement | |
| Specifications | Grid connection documentation | All required information to assist Owner in its application for Grid Connection. | X | X | | X | Duration of Agreement | |
| Specifications | Grid connection documentation | Including:<br>• Generating System Design Data Sheets<br>• Contractor shall supply a completed performance standard template stating the proposed level of compliance to each access standard in accordance with the TSP's GPS | | X | | | Duration of Agreement | |
| Specifications | HV/MV transformer specifications | Proposed substation transformer specification which shall include at a minimum the following details:<br>• Transformer layout | X | | | X | Agreement close | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Ratings and Design Life<br>• Auxiliary Supply<br>• Radio Interference<br>• Short Circuit Withstand Capacity<br>• Earth Tremors<br>• Insulation Levels<br>• Noise Levels and Vibration<br>• Temperature Rise Limits<br>• Magnetising Current and Flux Density<br>• Transformer Core and Windings<br>• Transformer Losses<br>• Transformer Construction<br>• Transformer Tank<br>• Transformer Oil and Valves<br>• Oil Conservator Tank<br>• Cooling Equipment<br>• Temperature Measuring Equipment<br>• Gas and Oil Actuated Relay<br>• Pressure Relief Devices<br>• Gaskets and Flanges<br>• Marshalling Box<br>• Auxiliary and Control Wiring<br>• Terminations<br>• Bushings<br>• Surge Diverters<br>• Degree of Polymerisation (DP)<br>• Inspection and Testing<br>• Shipping | | | | | | |
| Specifications | Inverter specifications | The following documents shall be submitted by the Contractor.<br>• Datasheet<br>• Track records<br>• Type test certificates to Applicable Standards and test reports<br>• Accelerated test certificates<br>• Warranty terms | X | | | X | Agreement close | |
| Specifications | Manufacturer storage specifications | Manufacturers' storage and protection requirements/recommendations for all equipment and materials should be provided to Owner prior to delivery | | X | | X | 1 month prior to delivery | |
| Specifications | Material safety data sheets | As required | | X | | | As received | |

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|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Specifications | Other plant equipment as applicable (e.g. transformer, switchgear, cables, DC combiner box, met station) | The following documents shall be submitted by the Contractor.<br>• Datasheet<br>• Track records<br>• Type test certificates to Applicable Standards and test reports<br>• Accelerated test certificates (if available)<br>• Warranty terms | X | | | X | Agreement close | |
| Specifications | Permanent on-site buildings | Functional description and preliminary design specifications including:<br>• Layout<br>• Elevation drawings<br>• Structural<br>• Architectural<br>• Fire rating<br>• Hold down | X | | | X | Agreement close | |
| Specifications | PV Module specifications | Functional description and preliminary design specifications including:<br>• Datasheets<br>• Latest installation figures the operational track record<br>• Type test certificates to Applicable Standards and test reports<br>• Accelerated test certificates<br>• Proposed module bill of material (if available)<br>• Warranty terms | X | | | X | Agreement close | |
| Specifications | PV Module specifications | The following documents shall be submitted by the Contractor.<br>• Module bill of material<br>• Estimated annual degradation justified with historical production data<br>• Validate LID, annual degradation, IAM, or other assumptions used in the energy assessment<br>• Demonstrate workmanship quality through a 3rd party factory audit<br>• PID test report and information | | X | | | 3 months after Agreement execution | |
| Specifications | PV mounting structure specifications | Functional description and preliminary design specifications including:<br>• Datasheets<br>• The latest installation figures for the proposed [PV Module Mounting Structures / Trackers] along with an indication of the operational track record<br>• Type test certificates to Applicable Standards and test reports<br>• Accelerated test certificates | X | | | X | Agreement close | |

**KEY**

Level A: Contract Documentation - Documentation submitted prior to execution of the Agreement
Level B: Construction Documentation - Documentation to be submitted prior to the commencement of Work on Site or issuing of any completion certificate
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | • Wind tunnel test results<br>• Warranty terms | | | | | | |
| Specifications | Reinforcement specifications and testing specifications | Reinforcement specifications, testing, FATs | | X | | | 6 weeks prior to start of relevant work | |
| Specifications | SCADA and communications network | Functional description and preliminary design specifications including:<br>• Information on the communications system, including specifications and drawings<br>• Information on the SCADA system, including specifications and drawings | X | | | X | Agreement close | |
| Specifications | SCADA instrumentation specifications | Copies of calibration sheets for all sensors/transducers as appropriate in accordance with the appropriate calibration standards. Sensors/transducers shall include those mounted on:<br>• Temporary and Permanent Wind Turbine met masts<br>• Solar met station<br>• Switchgear<br>• Monitored equipment<br>• Statcom equipment, and<br>• Power Quality Metering | | | X | | | |
| Specifications | Solar electrical specifications | Functional description and preliminary design specifications of proposed electrical systems up to and including the Point of Connection, including:<br>• Preliminary AC design single line diagram/s, including connections to the Inverters, Transformers and Protection equipment. Protection SLD to be incorporated or provided separately<br>• Preliminary DC design electrical drawing/s, including connections to PV Modules, Combiner Boxes, Inverters and any other equipment connected to the DC network<br>• Cable route layout for the AC electrical system, including approximate in-line joint locations (if applicable)<br>• Cable route layout for the DC electrical system<br>• Cable schedules (AC and DC) and cable specifications<br>• Protection philosophy<br>• Primary and Secondary system key equipment specifications, including HV/MV Transformer, MV/LV Transformer, HV and MV switchgear, Reactive Plant (if applicable), Neutral Earthing Resistors or Neutral Earthing Transformers (if applicable)<br>• Optimisation of AC power cable size and preliminary calculations showing electrical efficiency requirement can be achieved | X | | | X | Agreement close | |

**KEY**

Level A: Contract Documentation - Documentation submitted prior to execution of the Agreement
Level B: Construction Documentation - Documentation to be submitted prior to the commencement of Work on Site or issuing of any completion certificate
Level C: As-built Documentation - As-built drawings and other record documentation to be submitted after the issuing of any completion certificate
Owner Approval: Must be submitted for the Owner's review and approval prior to equipment purchase or construction

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| | | Preliminary calculations showing that electrical system availability can be achieved in excess of the value specified. | | | | | | |
| Specifications | Updated solar specifications | Full specification of the PV Module, Inverters, Transformers, MV and HV Switchgear, SCADA and Met Stations including specifications of all main components | | X | | X | 2 months prior to delivery to Site | |
| Specifications | Substation specifications | Functional description and preliminary design specifications including:<br>• Substation general arrangement drawing<br>• Reactive power compensation resources (if applicable)<br>• Reactive power compensation support and voltage control philosophy<br>• Protection philosophy<br>• Primary and secondary system key equipment specifications<br>• HV and MV switchgear, neutral earthing resistors or neutral earthing transformers (if applicable) | X | | | X | Agreement close | |
| Specifications | Welding procedure specfications | Document demonstrating welding procedure shall meet all requirements of the AWS D1.1 code | | X | | X | 6 weeks prior to start of relevant work | |
| Specifications | Wind collection system specifications | Functional description and preliminary design specifications including:<br>• Primary and secondary system key equipment specifications, including step-up Wind Turbine transformer<br>• Optimization of power cable and overhead conductor size | X | | | X | Agreement close | |
| Specifications | Wind collection system specifications | Detailed specification and design drawings:<br>• Cable specifications and schedules for all HV, MV, LV, earthing and fiber optic cabling (including MV/HV substation and collector system)<br>• Full technical specifications for all termination kits, jointing kits, lugs and connectors to be used in the primary power circuits of the Wind Power Plant and in the earth network<br>• In-line cable jointing kits | | X | | X | 3 months after Agreement execution | |
| Specifications | Wind Turbine foundations concrete and grout specifications | Including minimum strength required for any concrete or grout forming part of the wind turbine foundation design | | X | | X | 3 months after Agreement execution | |
| Specifications | Wind Turbine instrumentation specifications | Specification and calibration certificates where applicable of the following Wind Turbine instruments:<br>• Nacelle anemometers<br>• Nacelle wind vanes<br>• Thermometers and other temperature measurement devices such as thermostats<br>• Yaw and pitch sensors or transducers<br>• Accelerometers<br>• Main drive train vibration sensors and collection system<br>• Tower sway/vibration sensor and collection system<br>• Other condition monitoring sensors | | X | | | 1 month prior to start of relevant work | |

**KEY**

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

| Category | Deliverable: | Description: | Level | | | Owner Approval | Owner Proposed Schedule | Contractor Proposed Schedule |
|---|---|---|---|---|---|---|---|---|
| | | | A | B | C | | | |
| Specifications | Wind Turbine specifications | Specification(s) of wind turbines proposed for the Site including (for each proposed turbine type and operating mode):<br>• Technical description and drawings of main components<br>• Description of operational envelope and control system<br>• Failure Modes and Effects Analyses<br>• Maintenance schedule, included routine and major overhaul activity<br>• Operational track record and performance including up-to-date installation figures for the proposed wind turbine model<br>• Warranted power and thrust coefficient curves for the purpose of warranty calculations<br>• Independently certified power curve measurement report<br>• Warranted sound power levels and tonality for the purpose of warranty calculations<br>• Independently certified noise measurement report<br>• Independent Power quality measurement report<br>• Confirm wind turbine meets the requirements of the applicable grid code | X | | | X | Agreement close | |
| Specifications | Wind Turbine specifications | Full technical description of all main components | | X | | X | 2 months prior to start of relevant work | |
| Specifications | Wind Turbine transformer specifications | Functional description and preliminary design specifications including:<br>• Transformer specifications, including MVA rating, nominal voltage rating, tap changer details, insulating medium, vector group, thermal ratings, temperature rise, fault ratings, insulation ratings, IP level, fire protection, corrosion protection, load and no-load loss guarantees, manufacturer and standards compliance.<br>• Transformer design drawings, including enclosure, fittings, locations and bund details.<br>• Transformer type test certificate and a fitness for purpose statement (considering environmental conditions, corrosion, cyclic loading, peak voltages and fire risk) | X | | | X | Agreement close | |

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 03**

# APPLICABLE CODES AND STANDARDS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
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# 1.0 APPLICABLE CODES AND STANDARDS

Systems and equipment shall be designed in accordance with the latest editions of all applicable codes, standards, and local, state and federal regulations in effect at the date of execution of the contract. Codes, standards, and regulations as listed below shall be presumed to apply to the Work unless otherwise indicated within the relevant technical specifications. In some cases, equipment may be purchased based on other standards or codes that the Contractor and Owner consider suitable. In case of conflict among this Project Technical Specification, referenced codes and standards, and manufacturer's standard practices, the Contractor and Owner will mutually agree on which will govern. Where there are no referenced codes, standards, or Owner specifications, power industry practices shall apply. Deviations from listed codes and standards may occur only with Owner approval. Applicable codes, standards and regulations include but are not limited to the following:

## 1.1 STATE AND LOCAL BUILDING CODES, STANDARDS AND ORDINANCES

Applicable codes, standards and regulations for the state of Oregon are included below. If the Project is in another state, equivalent codes, standards, and regulations to those listed below for the Project state shall apply.

1. Oregon Structural Specialty Code (based on the International Building Code)
2. Oregon Mechanical Specialty Code (based on the International Mechanical Code)
3. Oregon Electrical Specialty Code (based on the National Electrical Code)
4. Oregon Plumbing Specialty Code (based on the Uniform Plumbing Code)
5. Oregon Fire Code (based on the International Fire Code)
6. Oregon State Occupational Safety and Health Act
7. Oregon Health Authority
8. Oregon Occupational Safety and Health Act (OR-OSHA) - 29 CFR 1910, 1926

## 1.2 U.S. GOVERNMENT CODES, ORDINANCES, AND STANDARDS

1. Department of Transportation (DOT)
2. Federal Energy Regulation Commission (FERC)
3. Federal Aviation Agency (FAA) - Obstruction Marking and Lighting AC No. 70/7460-IL)
4. American National Standard Institute (ANSI)/ Electronic Industries Alliance / Telecommunications Industry Association Standard 222-G-2: Structural Steel Standards for Steel Antenna Towers and Supporting Structures.
5. US Federal Highway Administration, Gravel Roads Construction and Maintenance Guide
6. US Department of Agriculture (USDA)
    a. RUS Bulletin 50-70 (U-1) REA Specification for 15 kV and 25 kV Primary Underground Power Cable
    b. Bulletin 1724E-200, Design Manual for High Voltage Transmission Lines, Rural Utilities Service, Electric Staff Division
    c. RUS Bulletin 1724E-200, Design Manual for High Transmission Lines

   d. RUS Bulletin 1724E-300, Design Guide for Rural Substations
7. US Code of Federal Regulations (CFR)
   a. Occupational Safety and Health Administration (OSHA) – 29 CFR Part 1910
   b. Safety and Health Regulations for Construction – 20 CFR Part 1926
   c. Protection of Environment – 40 CFR
   d. Guidance of Revisions to ADA Regulation on Nondiscrimination on the Basis of Disability by Public Accommodations and Commercial Facilities – 28 CFR Part 36, Appendix A

## 1.3 INDUSTRY STANDARDS

Applicable standards issued by the following industry organizations:

2. American Association of State Highway and Transportation Officials (AASHTO)
3. American Concrete Institute (ACI)
   a. ACI 301: Specifications for Structural Concrete
   b. ACI 305R: Specification for Hot Weather Concreting
   c. ACI 306R: Guide to Cold Weather Concreting
   d. ACI 318: Building Code Requirements for Structural Concrete
   e. ACI 347: Guide to Formwork for Concrete
4. American Gear Manufacturers Association (AGMA)
5. American Institute of Constructors (AIC)
6. American Institute of Steel Construction (AISC)
   a. Steel Design Guide No. 3 – Serviceability Design Considerations for Steel Buildings
   b. 360 Specification for Structural Steel Buildings with Commentary and Supplements
   c. 341 Seismic Provisions for Structural Steel Buildings with Commentary and Supplements
7. American Iron and Steel Institute (AISI)
   a. Specifications for the Design of Cold Formed Structural Members
8. American Land and Title Association (ALTA)
9. Air Moving and Control Association International, Inc. (AMCA)
10. American National Standards Institute (ANSI)
   a. ANSI A14.3 Safety Requirements for Fixed Ladders
   b. ANSI B1.20 Pipe Threads
   c. ANSI C50.41 Standard Polyphase Induction Motors for Power Generating Stations
   d. ANSI C62.11 – See IEEE C62.11 below
   e. ANSI C80.1 Standard for Electric Rigid Steel
   f. ANSI/TIA 222 Structural Standards for Antenna Supporting Structures and Antennas
   g. ANSI/TIA/EIA-526-7, Optical power loss measurement of installed singlemode fiber cable plant.
   h. ANSI/TIA/EIA-526-14A, Optical power loss measurements of installed multimode fiber cable plant.

i. ANSI/TIA/EIA-559-1, Singlemode fiber system transmission design.
j. ANSI/TIA/EIA-568-B.3, CSA T529, Commercial building telecommunications cabling standard.
k. ANSI/TIA/EIA-569-A, CSA T530, Commercial building standard for telecommunications pathways and spaces.
l. ANSI/TIA/EIA-590-A, Standard for physical location and protection of below-ground fiber-optic cable plant.
m. ANSI/TIA/EIA-607, CSA T527, Commercial building grounding and bonding requirements for telecommunications.
n. ANSI/TIA/EIA-626, Multimode fiber-optic link transmission design.
o. ANSI/TIA/EIA-758-1, Outside plant optical-fiber cabling practices.
p. ANSI/ICEA S-94-649 Standard for Concentric Neutral Cables Rated 5 through 46 KV

11. American Society of Mechanical Engineers (ASME)
    a. ASME B16.5 Requirements for Steel Pipe Flanges, Flanged Valves, and Fittings
    b. ASME A17.1 Safety Code for Elevators and Escalators
    c. ASME A120.1 Safety Requirements for Powered Platforms and Traveling Ladders and Gantries for Building Maintenance
12. American Petroleum Institute (API)
    a. 686, Recommended Practices for Machinery Installation and Installation Design
13. American Society of Civil Engineers (ASCE)
    a. ASCE-AWEA RP, Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures
    b. ASCE 7, Minimum Design Loads for Buildings and Other Structures
    c. ASCE 48-11, Design of Steel Transmission Pole Structures
    d. ASCE Manual 10-97, Design of Latticed Steel Transmission Structures
    e. ASCE Manual No. 74, Guidelines for Electrical Transmission Line Structural Loading
14. American Society for Nondestructive Testing (ASNT)
15. American Society for Testing and Materials (ASTM)
    a. ASTM Annual Book of Standards, Volume 4.08 Soil and Rock (I): D420-D5876 and Volume 4.09 Soil and Rock (II) D5877-latest
    b. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
    c. ASTM A82 Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
    d. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
    e. ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service
    f. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
    g. ASTM A185 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete

h. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 Tensile Strength
i. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
j. ASTM A490 Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
k. ASTM A449 Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
l. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
m. ASTM A615 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
n. ASTM A706 Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement
o. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
p. ASTM B-8 Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
q. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate
r. ASTM B308 Standard Specification for Aluminum and Alloy 6061-T6 Standard Structural Profiles
s. ASTM C31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
t. ASTM C33 Standard Specification for Concrete Aggregates
u. ASTM C39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
v. ASTM C150 Standard Specification for Portland Cement
w. ASTM C172 Standard Practice for Sampling Freshly Mixed Concrete
x. ASTM C231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
y. ASTM C260 Standard Specification for Air-Entraining Admixtures for Concrete
z. ASTM C309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
aa. ASTM C494 Standard Specification for Chemical Admixtures for Concrete
bb. ASTM C579 Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
cc. ASTM C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
dd. ASTM C1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)

ee. ASTM C1157 Standard Performance Specification for Hydraulic Cement
ff. ASTM C1315 Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
gg. ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort
hh. ASTM D924 Standard Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids
ii. ASTM D971 Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method
jj. ASTM D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration
kk. ASTM D1143 Standard Test Methods for Deep Foundations Under Static Axial Compressive Load
ll. ASTM D1275 Standard Test Method for Corrosive Sulfur in Electrical Insulating Liquids
mm. ASTM D1298 Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method
nn. ASTM D1533 Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration
oo. ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
pp. ASTM D1586 Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils
qq. ASTM D1816 Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes
rr. ASTM D2668 Standard Test Method for 2,6-di-tert-Butyl- p-Cresol and 2,6-di-tert-Butyl Phenol in Electrical Insulating Oil by Infrared Absorption
ss. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
tt. ASTM D3487 Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus
uu. ASTM D3612 Standard Test Method for Analysis of Gases Dissolved in Electrical Insulating Oil by Gas Chromatography
vv. ASTM D3689 Standard Test Methods for Deep Foundations under Static Axial Tensile Load
ww. ASTM D3966 Standard Test Methods for Deep Foundations under Lateral Load
xx. ASTM D5837 Standard Test Method for Furanic Compounds in Electrical Insulating Liquids by High-Performance Liquid Chromatography (HPLC)

yy. ASTM D6176 Standard for Measuring Surface Atmospheric Temperature with Electrical Resistance Temperature Sensors
zz. ASTM E927-97 Standard Specification for Solar Simulation Photovoltaic Testing
aaa. ASTM E2848-13 Standard Test Method for Reporting Photovoltaic Non-Concentrator System Performance
bbb. ASTM E2939-13 Standard Practice for Determining Reporting Conditions and Expected Capacity for Photovoltaic Non-Concentrator Systems
ccc. ASTM F593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ddd. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
eee. ASTM F2329 Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

16. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
17. American Water Works Association (AWWA)
18. American Welding Society (AWS)
    a. D1.1 – Structural Welding Code - Steel
19. American Bearing Manufacturers Association (ABMA)
20. Association of Edison Illuminating Companies (AEIC)
    a. AEIC CS-8 Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 KV
21. Avian Power Line Interaction Committee Guidelines
22. Bonneville Power Administration (BPA) Master Specifications (where applicable for transmission line crossings)
23. Code of Federal Regulations (CFR)
24. Crane Manufacturer's Association of America (CMMA)
25. Det Norske Veritas Germanischer Lloyd (DNV GL)
    a. DNV OS C502: Offshore Concrete Structures (for fatigue requirements of onshore wind turbine foundations)
    b. DNV GL: Guidelines for the Certification of Wind Turbines
    c. DNV GL Standard DNV GL-ST-0126: Support Structures for Wind Turbines
    d. DNV GL Capacity Test
26. Expansion Joint Manufactures Association (EJMA)
27. Environmental Protection Agency (EPA)
28. Electric Power Research Institute (EPRI)
29. FM Global (FM)
    a. Property Loss Prevention Data Sheets
30. Hydraulic Institute (HI)
31. Illuminating Engineering Society of North America (IES)
32. Institute of Electrical and Electronics Engineers (IEEE)
    a. C2 National Electrical Safety Code

b. C37.010 Application Guide for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
c. C37.04 Rating Structure for AC High-Voltage Circuit Breakers
d. C37.06 AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis -Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V
e. C37.09 Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis
f. C37.013 Standard for AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis
g. C37.2 Standard Electrical Power System Device Function Numbers and Contact Designations
h. C37.13 Low-Voltage AC Power Circuit Breakers Used in Enclosures
i. C37.20.1 Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
j. C37.20.2 Metal-Clad Switchgear
k. C37.20.7 Guide for Testing Metal-Enclosed Switchgear Rated Up to 38 kV for Internal Arcing Faults
l. C37.23 Metal-Enclosed Bus
m. C37.30 Standard Requirements for High-Voltage Switches
n. C37.90 – Standard for Relays and Relay Systems Associated with Electric Power Apparatus
o. C37.90.1 - Standard Surge Withstand Capability (SWC) Test for Relays and Relay Systems Associated with Electric Power Apparatus
p. C37.91 Guide for Protective Relay Applications to Power Transformers
q. C37.97 Guide for Protective Relay Applications to Power System Buses
r. C37.113 Guide for Protective Relay Applications to Transmission Lines
s. C57.12.00, Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
t. C57.12.10 Requirements for Liquid-Immersed Power Transformers
u. C57.12.28 - Standard for Pad-Mounted Equipment - Enclosure Integrity
v. C57.12.34 Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers, 10 MVA and Smaller; High-Voltage, 34.5 kV Nominal System Voltage and Below; Low-Voltage, 15 kV Nominal System Voltage and Below
w. C57.12.36 Requirements for Liquid-Immersed Distribution Substation Transformers.
x. C57.12.55 Transformers Used in Unit Installations, Including Unit Substations - Conformance Standard
y. C57.12.70 Standard Terminal Markings and Connections for Distribution and Power Transformers
z. C57.12.80 Standard Terminology for Power and Distribution Transformers
aa. C57.12.90 Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
bb. C57.13 Requirements for Instrument Transformers

cc. C57.19.00, General Requirements and Test Procedure for Power Apparatus Bushings
dd. C57.19.01, Standard Performance Characteristics and Dimensions for Outdoor Apparatus Bushings
ee. C57.19.100, IEEE Guide for Application of Power Apparatus Bushings.
ff. C57.100, Standard Test Procedure for Thermal Evaluation of Insulation Systems for Liqued-Immersed Distribution and Power Transformers
gg. C57.104, Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers
hh. C57.109 Guide for Liquid-Immersed Transformer Through-Fault-Current Duration
ii. C57.116, IEEE Guide for Transformers Directly Connected to Generators
jj. C57.143, Guide for Application for Monitoring Equipment to Liquid-Immersed Transformers and Components
kk. C57.155, Guide for Interpretation of Gases Generated in Natural Ester and Synthetic Ester-Immersed Transformers
ll. C62.11 Metal-Oxide Surge Arresters for AC Power Circuits
mm. P1863 – Guide for Overhead AC Transmission Line Design
nn. 21 - General Requirements and Test Procedure for Outdoor Apparatus Bushings
oo. 24 - Bus Reliability Test System
pp. 80 Guide for Safety in AC Substation Grounding
qq. 81: Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System
rr. 242-01 Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
ss. 386 Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V
tt. 399-97 Recommended Practice for Power Systems Analysis
uu. 400/-400.2: Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field
vv. 400.2 Guide for Field Testing of Shielded Power Cable Systems Using Very Low Frequency (VLF)
ww. 400.3 Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment
xx. 484 Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications
yy. 485 Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
zz. 519, Recommended Practice and Requirements for Harmonic Control in Electric Power Systems
aaa. 524, Guide to the Installation of Overhead Transmission Line Conductors
bbb. 575, Guide for Bonding Shields and Sheaths of Single-Conductor Power Cables Rated 5kV through 500kV.

ccc. 592, Standard for Exposed Semiconducting Shields on High-Voltage Cable Joints and Separable Connectors
ddd. 665 Guide for Generating Station Grounding
eee. 693 - Recommended Practice for Seismic Design of Substations
fff. 738 – Standard for Calculating the Current-Temperature Relationship of Bare Overhead Conductors
ggg. 835 Power Cable Ampacity Tables
hhh. 837 Standard for Qualifying Permanent Connections Used in Substation Grounding
iii. 946 Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations
jjj. 1143, Guide on Shielding Practice for Low Voltage Cables
kkk. 1185, Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities
lll. 1215, Guide for the Application of Separable Insulated Connectors
mmm. 1547, Standard for Interconnecting Distributed Resources with Electric Power Systems
nnn. 1584 Guide for Performing Arc Flash Calculations
ooo. 1683 Guide for Motor Control Centers

33. Insulated Cable Engineers Association (ICEA)
    a. ICEA S-95-658 Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
34. International Building Code (IBC)
35. International Electrotechnical Commission (IEC)
    a. IEC 904-9 Solar Simulator Performance Requirements, Photovoltaic Devices
    b. IEC 61400-1 Design requirements
    c. IEC 60287-3-2 Economic Optimization of Power Cable Size
    d. IEC 60826 Design criteria of overhead transmission lines
    e. IEC 61400-1 Wind Turbines – Part 1: Design requirements
    f. IEC 61400-4 Wind Turbines – Part 4: Design requirements for wind turbine gearboxes
    g. IEC 61400-11 Acoustic noise measurement techniques
    h. IEC 61400-12-1 Power performance measurements of electricity producing wind turbines
    i. IEC 61400-21 Measurement and assessment of power quality characteristics of grid connected wind turbines
    j. IEC 61400-22 Conformity testing and certification
    k. IEC 61400-24 Lightning protection
    l. IEC 61724-3 Photovoltaic system performance – Part 3: Energy evaluation method
    m. IEC 62804 Test Methods for the Detection of Potential-Induced Degradation – Part 1: Crystalline Silicon
    n. IEC 62817 Photovoltaic Systems – Design Qualification of Solar Trackers
36. International Federation for Structural Concrete (FIB)

a. FIB Model Code for Concrete Structures
37. International Fire Code (IFC)
38. International Network for Harmonised and Recognised Measurements in Wind Energy (MEASNET)
39. International Organization for Standardization (ISO)
    a. ISO 9000 Series of Quality Standards
    b. ISO 9060 Specification and Classification of Instruments for Measuring Hemispherical Solar and Direct Solar Radiation
40. International Society of Automation (ISA)
    a. ISA Standard ANSI ISA-5.1 Instrumentation Symbols and Identification
41. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS)
42. Metal Building Manufacturers Association (MBMA)
    a. Low Rise Building Systems
43. National Association of Corrosion Engineers (NACE)
44. National Electric Safety Code (NESC)
45. National Electrical Manufacturers Association (NEMA)
    a. NEMA ICS 18 Motor Control Centers
    b. NEMA TC-2 Electrical Polyvinyl Chloride (PVC) Tubing and Conduit
    c. NEMA TR 1 Standards Publication for Transformers, Regulators and Reactors
    d. NEMA WD 1 General Color Requirements for Wiring Devices
46. International Electrical Testing Association (NETA)
    a. NETA Standard for Maintenance Testing Specifications
    b. NETA Standard for Acceptance Testing Specifications
47. National Institute of Standards and Technology (NIST)
48. National Fire Protection Association (NFPA)
    a. NFPA 10 Standard for Portable Fire Extinguishers
    b. NFPA 12 Standard on Carbon Dioxide Extinguishing Systems
    c. NFPA 13 Standard for Installation of Sprinkler Systems
    d. NFPA 14 Standard for the Installation of Standpipe and Hose Systems
    e. NFPA 15 Standard for Water Spray Fixed Systems for Fire Protection
    f. NFPA 24 Standard for the Installation of Private Fire Service Mains
    g. NFPA 54 National Fuel Gas Code
    h. NFPA 70 National Electrical Code
        i. Article 690 Solar Photovoltaic Systems
    i. NFPA 70B – Recommended Practice for Electrical Equipment Maintenance
    j. NFPA 70E Standard for Electrical Safety in the Workplace
    k. NFPA 72 National Fire Alarm Signaling Code
    l. NFPA 90A Standard for the Installation of Air-Conditioning and Ventilating Systems
    m. NFPA 497 Recommended Practice for the Classification of Flammable Liquids, Gasses, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas
    n. NFPA 750 Standard on Water Mist Fire Protection
    o. NFPA 780 Standard for Installation of Lightning Protection

p. NFPA 850 Fire Protection for Plants
q. NFPA 2001 Standard on Clean Agent Fire Extinguishing Systems

49. North American Electric Reliability Corporation (NERC)
50. Pipe Fabrication Institute (PFI)
51. Portland General Electric Co. Transmission Line Designs and Standards
52. Sheet Metal and Air Conditioning Contractors National Association (SMACNA)
53. The Society for Protective Coatings (SSPC)
54. Thermal Insulation Manufacturers Association (TIMA)
55. Underwriters Laboratories, Inc. (UL)
    a. UL 6 Electrical Rigid Metal Conduit - Steel
    b. UL 62 Flexible Cords and Cables
    c. UL 83 Thermoplastic-Insulated Wires and Cables
    d. UL 246 Standard for Hydrants for Fire-Protection Service
    e. UL 360 Standard for Liquid-Tight Flexible Metal Conduit
    f. UL 467 Grounding and Bonding Equipment
    g. UL 514B Standard for Conduit, Tubing, and Cable Fittings
    h. UL 580 Test for Uplift Resistance of Roof Assemblies
    i. UL 651 Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
    j. UL 797 Standard for Electrical Metallic Tubing - Steel
    k. UL 845 Motor Control Centers
    l. UL 1277 Standard for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members
    m. UL 1558 Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
    n. UL 1703 Standard for Flat-Plate Photovoltaic Modules
    o. UL 1741 Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
    p. UL 2703 Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for Use with Flat-Plate Photovoltaic Modules and Panels
    q. UL 3703 Standard for Solar Trackers
56. Welding Research Council (WRC)

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 04**

# ACCESS, MAINTENANCE, OPERATION AND RELIABILITY

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14 Dec 17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
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## 1.0 GENERAL

### 1.1 EXTENT

Contractor shall provide design and/or construction that includes adequate operator interface and information on equipment status, and facilities and space to permit acceptable operation and maintenance of all equipment in the plant, while minimizing shutdown or removal of other critical systems or components. Ease of access to the various pieces of equipment for operation and maintenance is a high priority. Equipment, piping, and components shall be labeled in accordance with Appendix G1 Attachment 01 Exhibit 04 Annex1 Equipment Numbering.

## 2.0 EXECUTION

### 2.1 SAFETY

The Contractor's design of the equipment shall be performed with an emphasis on the asset's safe:

1. Installation
2. Startup
3. Operation
4. Predictive Maintenance
5. Preventive Maintenance
6. Troubleshooting

Equipment and systems shall be provided with isolation capability for personnel safety during maintenance activities. Design shall facilitate lock out, tag out, etc., to satisfy requirements of OSHA 1910.269 – Electric Power Generation, Transmission and, Distribution, OSHA 1910.147 – The Control of Hazardous Energy, and the Owner's or Turbine Manufacturer's Lockout/Tagout Procedure.

Equipment shall be designed and installed to ensure the safe isolation of personnel from energy sources when either routine or invasive maintenance is being performed. Energy sources include but are not limited to:

7. Electrical
8. Mechanical
9. Potential (gravity)
10. Hydraulic
11. Pneumatic

The design shall include a safe and sufficient means to isolate and test the equipment during startup, and operation for purposes of troubleshooting and maintenance.

Equipment and systems shall be designed and installed to allow for:

1. Safe dispensation of energy released or created by equipment or system failure (e.g., arc shunt for switchgear, safety vents outside of building with safe clearance to any accessible area).
- Safely commissioning and/or troubleshooting equipment while the equipment is operational.

Equipment shall be designed and installed to allow personnel to ergonomically access and perform maintenance on the equipment.

Additional safety requirements shall be covered in the Contractor's Site Specific Safety and Health Plan (SSSHP) as discussed in Appendix G1 Attachment 01 Exhibit 06 – Safety, Health, and Environment.

Where maintenance is required at above four feet from grade or a platform tie off points for personnel harness shall be installed for safe personnel access.

## 2.2 OPERATION AND MAINTENANCE CONSIDERATIONS

### 2.2.1 Operability

The equipment shall be designed and constructed to allow easy operation with minimum local operator surveillance. The controls design shall allow routine plant operations by a minimal staff located in the Owner's Work Control Center room, as further specified in Appendix G2 Attachment 01 Exhibit 01 Wind Plant Specifications.

Where redundant (standby) equipment is supplied, the idle component shall be capable of automatic or immediate initiation by the operator into operation upon failure of one or more of the operating components without interruption to critical equipment or systems.

Necessary instrumentation shall be installed to either:

1. Detect a failure of one or more of the operating components.

2. Assess the condition of equipment so that maintenance can be performed before failure occurs.

The following general criteria shall be followed to achieve these objectives:

1. Equipment system design selections shall be based on minimizing the amount of operator attention.

2. Process systems and equipment operation shall be adequately monitored to provide control room operators with all real-time information required for efficient, safe and easy operation of the plant, including remote access. Reference Appendix G1 Attachment 01 Exhibit 04 Annex 02 "Process Data for Pattern Recognition" for recommended instrumentation.

3. Systems and equipment shall be located for easy operational access and logical operation sequences.

4. Special attention shall be given to adequate lighting, ventilation, personnel access platforms and acoustic dampening of all operational spaces.

5. Equipment shall be arranged so the physical arrangement of the “A” equipment is always the same with respect to the “B” equipment. For example, the plant equipment shall be numbered consistently from the north to the south and east to the west.

### 2.2.2 Accessibility

2.2.2.1 Convenient and safe access, including sufficient clearance, shall be provided to all instruments and equipment for both operation and maintenance. Depending on the height, type of device and frequency of required access, the access may consist of permanently installed platforms or stairways.

2.2.2.2 Equipment and components which must be inspected shall be installed so that they are readily accessible from grade, permanent stairs or platforms for operation and maintenance. Equipment and components shall not be blocked or concealed. Equipment and components that only require access for maintenance may be accessed from ladders and platforms. Permanent ladder utilization and locations shall be approved in writing by the Owner. Portable ladders are not permitted for access to permanent plant equipment unless the design is specifically approved by the Owner.

2.2.2.3 All work access platforms in on-site buildings must be designed in accordance with OSHA 2206 (29 CFR 1910. Subpart D). Platform design shall incorporate the best access and most economical use of space. Platform arrangement shall be acceptable to the Owner. Multiple means of egress will be available for platforms used to inspect, operate or maintain high energy systems.

2.2.2.4 Adequate interconnecting aisle ways and walkways shall be provided in on-site buildings. Clearances for walkways, aisle ways, equipment removal areas and access areas for maintenance of equipment shall be provided. A walkway shall be a minimum of 3’-0” wide and 7’-0” high. Major aisle ways, walkways shall be sized 8’ wide and 8’-6” high to allow for forklift access. Trenches with grating covers suitable for forklift wheel loading shall be used instead of curbs, where curbs would block forklift access. Larger walkways and aisle ways shall be provided where required for access to remove equipment.

2.2.2.5 Access roads suitable for safe vehicle travel shall be provided to all project equipment.

2.2.2.6 Installation of electrical equipment shall be such that it does not interfere with normal maintenance requirements of other equipment.

2.2.2.7 Clearances to the front and rear of electric equipment shall be not less than the greater of the distance required by the National Electric Code (NEC) or the manufacturer's recommendation, whichever is greater.

2.2.2.8 Equipment and system components which can be operated locally shall be located and/or arranged as follows:

1. Valves with remote controllable operators, other than root valves on instruments and branch lines which are only operated to close off a pipeline leak, shall be located and oriented for manual operation within the normal reach of operating personnel from grade, walkways, or permanent platforms.

2. Manual operated valves for plant operation shall be located and oriented for manual operation within the normal reach of operating personnel from grade, walkways, or permanent platforms. Permanent extension operators of a conventional design may be used on a case-by-case basis only as approved by Owner.

3. Remote reading (such as DCS connected) devices shall be located where they will be accessible from grade, walkways, or permanent platforms. All instruments other than temperature gauges which are connected on thermowells on pipe shall be located where they will be accessible from platforms or grade.

4. All instrumentation with local indication or indication of the position or status of equipment shall be clearly visible, readable and/or accessible to operating personnel from grade, walkways, or permanent platforms.

5. Local control panels shall be located within reach of operating personnel from grade, walkways, or permanent platforms and shall place the operating person in a position to observe the equipment and the instrumentation critical to its starting or stopping.

6. Test ports shall be located in a position accessible to the operating or testing personnel and oriented where the equipment and instrumentation critical to its testing can be observed. Electrical cabinets shall be installed on a maintenance pad. Cabinet doors shall open freely upon installation.

2.2.2.9 Portions of equipment requiring visual inspection, lubrication and tending activities shall be safely accessible and adequately lighted to assure proper operation and servicing.

2.2.2.10 Cable trays and conduit shall be installed with a minimum 7'-0" headroom over walkways and a minimum 8'-6" over aisle ways. Routing shall be selected to avoid interference with locations of structural steel, equipment maintenance, pull spaces, door swings, electrical trays, rack ways, conduits, aisles designated for forklift access, and

areas reserved for future expansion. Deviations from this requirement shall be reviewed and approved by Owner.

2.2.2.11 Sufficient clearances shall be provided under and/or around hatchways, galleries, monorails, removable slabs, temporary end walls, etc., and sufficient clearances shall be provided for access to equipment, valves, etc., for maintenance, operation and inspection.

2.2.2.12 Piping flanges, screwed connections, valves, or other potential leak sources shall not be located over electrical panels, cabinets, MCCs, switchgear. A horizontal clearance of 3 ft shall be maintained. Deviations from this requirement shall be reviewed and approved by Owner.

2.2.2.13 Instrumentation access shall be approved by the Owner. Operating access requiring the use of scaffolding is not permitted.

### 2.2.3 Maintainability

The equipment shall be designed and constructed to minimize the complexity and time required for inspection and maintenance. The following general criteria shall be followed to achieve this objective:

#### 2.2.3.1 Access Design

2.2.3.2 Plant equipment shall be of a low maintenance and current design and shall be easily maintainable.

2.2.3.3 Plant equipment shall be designed to be maintained in place with minimum disassembly of surrounding equipment and minimize use of temporary scaffolding and handling equipment.

2.2.3.4 Permanent platforms shall be provided where equipment checks or lubrication are required.

2.2.3.5 Equipment arrangements, pipe routings and cable tray locations shall be designed for maximum equipment accessibility and to allow the following types of access:

1. Space shall be provided to allow plant personnel easy access and clearance to all equipment and instrumentation, which may require maintenance.

2. Space shall be provided to allow unobstructed access for maintenance tools and equipment required for maintenance on permanently installed equipment.

3. Space shall be provided for applicable condition monitoring technologies and equipment such as but not limited to vibration analysis, oil analysis, motor circuit analysis, infrared analysis, transducers and ultrasound.

4. Space shall be provided to motor-operated equipment areas for work carts.

5. Ample space shall be provided to allow removal and laydown of any equipment that cannot be maintained in place or may require disassembly or replacement.

6. Lifting eyes shall be provided on equipment to facilitate installation and removal for maintenance.

7. Strategically positioned pad-eyes shall be included to facilitate equipment removal and installation.

8. Plant batteries shall be installed to allow visible inspection of each bottle, with adequate space from the wall to allow both front and rear walking access.

9. Sufficient isolation valves shall be provided to isolate equipment for maintenance.

2.2.3.6 Beams and trolleys shall be provided where necessary for maintenance, including removal, of all major pieces of equipment. The design shall provide for the use of lifting equipment to disassemble and reassemble heavy components. Outdoor equipment shall be designed to be maintained and removed with portable lifting equipment. For indoor equipment, portable lifting equipment may be used only as approved in writing by Owner in some cases to serve multiple plant equipment. All beams, trolleys and lifting equipment shall be marked with capacity ratings per OSHA requirements. Beam trolley arrangements can be provided with common hoists where appropriate and approved by the Owner.

2.2.3.7 Techniques for minimizing corrosion of structures and equipment exposed to chemically or environmentally corrosive atmospheres shall be incorporated into the equipment design. Removable panels with lifting eyes on enclosures shall be provided where required.

2.2.3.8 Special attention shall be given to providing appropriate enclosures, trenches, curbs, drip guards and collection systems for fugitive water, hose spray water, chemicals and oils.

2.2.3.9 Adequate provisions shall be included for compressed air, service water, general purpose electrical outlets and welding receptacles to support maintenance activities.

2.2.3.10

2.2.3.11 Equipment removal paths shall be shown on drawings and these paths shall be maintained clear of obstructions and interferences.

2.2.3.12 Provisions shall be made to facilitate access and removal of rotating elements, including gearboxes, bearings, etc., for all major equipment, as specified in

Appendix G2 Attachment 01 Exhibit 01 Wind Plant Specifications and Appendix G3 Attachment 01 Exhibit 01 Solar Photovoltaic Plant Specifications.

2.2.3.13 Access doors shall be provided in buildings to accommodate maintenance of major plant equipment.

### 2.2.3.14 Standardization of Components

Where feasible, similar equipment shall be provided by the same supplier to minimize spare parts inventories and to minimize the number of different suppliers' equipment that plant personnel must be capable of maintaining.

Components shall be standardized to ensure that spares are:

1. Optimized to reduce the number of component types and manufacturers

2. Readily available with associated lead times

### 2.2.3.15 Adjustment and Tuning

Methods and specifications shall be described in associated start up / maintenance and operating manuals.

Systems to facilitate alignment, leveling and tensioning shall be provided. Where appropriate, such equipment as "jack bolts" and tensioning devices shall be provided.

### 2.2.3.16 Accessible Monitoring Systems

Major plant equipment shall include sensors to remotely monitor equipment condition(s). Other plant equipment shall be designed for safe, easily local inspection when not designed and installed to remotely monitored.

Interfaces locations include:

1. At the piece of generation equipment: Preferred interface is a hand-held unit that connects to the OEM processor and presents the same information as the SCADA HMI

2. At the control room: Preferred interface is SCADA HMI which provides ALL tags (not just the ones the OEM chooses to share)

Methods shall be provided, where appropriate, to facilitate and ensure status and operation via:

1. Gauges with ranges identified and purpose properly labeled.

2. Fluid level sights with ranges identified and purpose properly labeled.

3. Logical status indicators which depict the asset's current state of operation.

4. Internal monitoring, where appropriate which depicts status relative to baseline and alarm or fault. For example, vibration levels associated with high speed equipment.

5. Sights which allow personnel to view equipment status such as; electrical contacts, drive belts and timing locations.

For instrumentation requirements for the Plant's Control System see Appendix G1-01-04-01 for the list of assets and the associated list of instruments.

### 2.2.3.17 Predictive Maintenance

a. Oil Sampling and Lubrication

The following equipment shall include provisions for oil and lubrication analysis sampling:

1. Crane hoist, bridge, and trolley gearboxes

2. Centrifugal pumps

3. Gearboxes

4. Hydraulic Systems

5. Yaw systems

6. Main rotor bearings

7. Centrifugal Air Compressors

8. Rotary Screw Air Compressors

9. Blowers

10. Multi-shaft, base-mounted, gear reducers

11. Closed-Loop Heating/Cooling Systems.

12. Oil Reservoirs

13. Other systems not listed here but that may be high criticality and/or have lubricant volumes greater than two (2) gallons.

b. Oil Lubricant and Lubrication

1. Lubricant sumps shall be labeled with capacity (liters or gallons)

2. Dip sticks are not allowed; instead sight glasses that are positioned to be easily visible by plant personal will be used. Site glasses shall contain a water drain and an extra port which can be used with a sample port.

3. The sight glass is to be marked with the maximum and minimum lubricant levels. In the case of hydraulic systems, determination of the proper oil operating level depends on the position the cylinders when the level is checked. If necessary, the label shall indicate what state the equipment must be in to obtain an accurate reading. (i.e., start-of-cycle, cylinders retracted or extended, platen in the lowest position, etc.)

4. Centralized systems shall include provisions to allow refilling the reservoir using Zerk-type grease fitting without opening or uncovering the reservoir.

5. Centralized grease systems shall have min and max levels clearly marked on the reservoir.

6. The reservoir shall be labeled with the capacity, and the lubrication type printed on a label of specific color as designated by Owner

   Loss of one metering element shall not prevent the flow of grease to any other lube point.

C Labeling

1. Each grease lubrication point shall be labeled with the lubrication frequency, amount (in gr), and the lubrication type on a label of specific color

2. Each oil lubrication point or fill port shall be labeled with the, capacity (in gallons or liters), and the lubrication type printed on a label of specific color Drain ports shall be labeled “Drain”.

3. Labels are to be engraved or stamped, and must be permanently affixed.

d. Sampling Provisions

1. Locate ports and adjust tube length to pull a representative sample from a central location within the tank, reservoir, or reducer (not a ‘dead’ zone), not less than 25 mm and not more than 50 mm above the sump floor.

2. If possible, the pitot tube entrance will be positioned ‘face down’.

3. The location for drawing an oil sample from a sump or reservoir shall be as close to the return line, gear set or bearing as possible

4. The sample port for the gearbox shall be located so that the oil sample is withdrawn at a point that is halfway between the normal running level and the sump bottom (50% oil level)

5. The sampling port location shall be located so that a sample may be taken without removing covers, guards, or moving anything.

6. The sampling port may be located on the top of the unit if it meets all of the other requirements

e. Drain/Fill/Filter Provisions

1. To facilitate fluid fill, drain, and filtration each reducer (25gal and larger), reservoir, or tank shall include flat-face hydraulic fittings for filling and draining.

2. The fill fitting shall be located on the ‘clean’ side of the tank baffle, or in the case of reducers, at a location away from the drain fitting.

3. The drain fitting shall be located on the ‘dirty’ or ‘return’ side of the tank baffle or, in the case of reducers, at the manufacturer’s designated drain point.

4. Fill/supply ports shall be fitted with quick disconnect nipples and dust caps.

5. Drain/return ports shall be fitted with female couplers and shall be supplied with a dust cap.

6. Hydraulic oils shall be filtered through filter material with a ß5=100 rating before being introduced into the equipment.

7. Gearbox, transmission, and reducer oils shall be filtered through filter material with a ß12=100 rating before being introduced into the equipment.

8. Recirculating lubrication systems shall be provided with appropriate filtration. Unless otherwise specified, this filtration shall be sized to provide ISO cleanliness of 17/16/13 or better.

9. All fill and sampling ports shall be easily and safely accessible.

10. For padmount transformers a combination drain valve with oil sampling port shall be located externally within lockable cabinet.

f. Grease Fittings

1. In grease applications for bearings and motors requiring drains, ensure that pressure relief fittings are installed in the drain port.

2. Use hydraulic grease fittings (Zerk), not button-head fittings.

3. Grease lines to remote lubrication points shall be steel tubing routed neatly to follow machine contours.

g. Vibration Monitoring

1. Monitoring surfaces shall be provided where applicable. Where vibration route data collection points are accessible, the data collection points shall be clearly marked and labeled. Where access for vibration route data collection is restricted, permanent accelerometers shall be installed and connected to a break-out box for data collection.

2. The technical data supplied with the equipment and included in the Maintenance Manuals shall provide the following information related to equipment vibration monitoring:

3. Location of the recommended vibration sampling points that will provide horizontal, vertical and radial vibration readings.

4. Recommended vibration sampling frequency, i.e.: continually, weekly, monthly, quarterly, etc.

5. For each sampling position, this vendor shall provide a recommended “Warning” and “maximum allowable” acceleration levels.

h. Infrared (IR)

1. For switchgear, motor control centers, padmount transformers, and inverters with exposed bus and bolted connections; doors shall have view ports to allow IR inspection without opening the door.

i. Ultrasound Thickness (UT)

1. For pressure piping or vessels the original wall or shell thicknesses shall be shown on the arrangement drawings.

2. For storage tanks (fuel oil, chemical storage, dual-media, etc.) the original shell thicknesses shall be called out on arrangement drawings.

3. For tanks with multiple wall thicknesses the drawing shall also indicate the height above the floor where the thickness changes along with the shell thickness.

4. Insulated tanks shall include access plugs to allow thickness testing in accordance with applicable government and consensus standards.

j. Strobe Light

1. Belt drive guarding shall be labeled adjacent to the drive and driven sheaves with the design RPM.

k. Motor Circuit Analysis (MCA)

1. Special plugs shall be installed for MCA in switchgear and motor control center doors for critical assets.

l. Borescope

1. For large, complex, or critical equipment that is difficult to remove or disassemble for inspection, sufficient ports and plugs shall be installed to allow borescope inspection of critical and high-wear components.

m. Guarding/Access

1. Guarding shall be designed to allow vibration analysis using a 25 mm diameter hand-held accelerometer without removing guards.

2. Guarding shall be designed to allow infrared or strobe light inspection without removing guards or exposing operators to moving parts.

3. If mesh is used to allow visible access to working parts, the mesh portion of the guarding shall be painted flat black.

### 2.2.3.18 Failure Modes and Effects Analysis

Failure Modes Effects Analysis (FMEA) shall be provided for critical supplied systems and assets. The intent, based on history of similar systems' operations is to itemize or list:

1. Known / common failure modes

2. Potential failure modes and historical/expected mean time between failures

3. Severity on operation relative to the system provided

4. Methods of detection based on vendor supplied Preventive Maintenance (PM) or Predictive Maintenance (PdM) Procedures

5. Improvements due to design modifications, additional PM or PdM measures or optional equipment.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 04**
**ANNEX 01**

# EQUIPMENT NUMBERING

**PORTLAND GENERAL ELECTRIC**

**2018**

**REQUEST FOR PROPOSAL**

# 1 Purpose

This document details the equipment numbering system for existing and new PGE power plant assets.

## 1.1 Scope

This standard prescribes the equipment numbering system including numbering for mechanical, instrument and electrical equipment.

# 2 Responsibilities

## 2.1 Site Personnel

2.1.1 Assign the equipment numbers for new equipment for existing plants.

2.1.2 Provide new equipment numbers to the Planner/Scheduler and Project Manager or Engineer

2.1.3 Enter new assets and the equipment numbers into CMMS

2.1.4 Review the project submittals to validate equipment number assignment and format.

## 2.2 PSES Project Engineers and Managers

2.2.1 Require the Contractor or Vendor to use the plant equipment numbering system of an existing site on all equipment, drawings and documents.

2.2.2 Require the Contractor or Vendor to use the PGE Power Generation equipment numbering system for new power plants.

2.2.3 For new power plants require the Contractor or Vendor to use PGE equipment numbering system on all equipment, drawings and documents.

2.2.4 Acquire the list of equipment numbers from designated plant personnel for new equipment at existing sites.

2.2.5 Verify that the Contractor or Vendor has used the correct equipment number nomenclature.

2.2.6 Review the project submittals to validate equipment number assignment and format.

### 2.3 Contractor

2.3.1 For new power plants, assign equipment numbers to the assets in accordance with PGE's equipment numbering nomenclature.

### 2.4 Site Management

2.4.1 Assign site personnel to project teams when required

2.4.2 Ensure applicable site personnel have been training on the standard

### 2.5 Document Owner

2.5.1 Assigns resources to implement the procedure.

2.5.2 Maintains the procedure and coordinates revisions with Site Management and Program Owner.

2.5.3 Updates the procedure to reflect protocol changes.

### 2.6 Program Owner

2.6.1 Assigns resources to manage the program.

2.6.2 Oversees and reviews the program to ensure it is compliant and effective.

2.6.3 Provides business unit leaders and executive management with management system reports that reflect program compliance and effectiveness.

2.6.4 Provides updates to the procedure to be consistent and compliant with regulatory requirements, and available tools and technology.

## 3 Definitions and Acronyms

### 3.1 Definitions

3.1.1 Equipment Number**:** The unique identifier assigned to assets and used on drawings and documents.

3.1.2 Equipment ID Tag: A label affixed to the equipment that identifies the equipment number.

3.1.3 Subsystem Code: The subsystem designation used for the subsystem category in the CMMS.

3.1.4 Equipment Type Code: An acronym used to represent an equipment name or description.

3.1.5 Equipment Sequential Number: A three or four digit number assigned to site equipment

### 3.2 Acronyms

3.2.1 CMMS: Computerized Maintenance Management System (Maximo)

3.2.2 EQPN: Equipment Number (is a CMMS data field)

3.2.3 ISA: Instrument Society of America

3.2.4 PGE: Portland General Electric

3.2.5 P&ID: Piping and Instrumentation Diagram

3.2.6 PFD: Process Flow Diagram

3.2.7 PSES: Power Supply Engineering Services

## 4 Precautions and Limitations

**NONE**

## 5 Procedure

### 5.1 Prerequisite Actions

5.1.1 The equipment numbering format for each existing plant site is different and is detailed in Sections 6-9 below. The Project Manager or Engineer will review the equipment numbering system for each site to ensure the correct system is included in the project requirements and specifications.

5.1.2 The ISA (Instrument Society of America) nomenclature shall be used for instrument numbering.

5.1.3 The Project Manager or Project Engineer along with Project Team will identify documents and drawings that require PGE equipment numbering, such as P&IDs.

5.1.4 The Project Manager or Engineer will identify the new equipment.

5.1.5 Require Contractor and Vendor to use the PGE numbering system for all documents, drawings, and other applicable submittals.

5.1.6 Equipment numbers shall be assigned to process equipment, package units, tanks, buildings, structures, electrical equipment, rotating equipment, instruments, piping, etc., including their auxiliaries as detailed as practical to secure a uniform identification of the equipment throughout the project.

5.1.6.1 Application of Equipment Numbering

A) Documents and Drawings

B) Operating and Maintenance Procedures

C) Equipment number shall be used in engineering documents and drawings such as Process Flow Diagrams, Plot Plan, Piping and Instrumentation Diagrams, Equipment Data Sheets, Instrument Data Sheets, etc.

D) Vendor's documents including drawings, data sheets, etc., shall display the PGE equipment number.

E) Equipment Nameplates

F) CMMS

## 5.2 Procedure

5.2.1 In the project specifications the Project Manager or Engineer will require the Contractor or Vendor to use the PGE numbering system for the project equipment for the applicable site.

5.2.2 For new power plants the Project Manager will require the Contractor and Vendors to use the PGE numbering system on all applicable documents and drawings.

5.2.2.1 The Contractor will assign the equipment numbers based on the PGE equipment nomenclature.

5.2.2.2 The Project Manager and Project Team will review project submittals for correct application of the equipment numbering.

5.2.3 The Project Manager and Engineer will submit the draft list of equipment to the plant project team member and request a list of equipment numbers to be used for this project.

5.2.4 At the final design, the Project Manager or Engineer will send the equipment list to the designated plant lead and request a list of equipment numbers for the new equipment.

5.2.5 The Project Manager or Engineer will return the list of equipment numbers to the contractor or vendor for inclusion in project documents and drawings.

5.2.6 The Project Manager or Engineer and designated Site Personnel will review the updated project documents to ensure the equipment numbers are correct.

5.2.7 If equipment is added after the final design stage, the Project Manager or Engineer will send the new information to the designated Site Personnel for assignment of new equipment numbers. This step will be repeated throughout the life of the project as required.

5.2.8 The plant lead will facilitate entry of the new equipment and equipment numbers into the CMMS.

5.2.9 At Substantial Completion or Project Turnover the contractor will supply an as-built list of assets.

# 6 Carty, Coyote Springs, Port Westward Generating Plants

## 6.1 Equipment Numbering Format

6.1.1 Equipment and Modular Units at Carty, Coyote Springs and Port Westward Equipment shall be numbered in the following manner:

**SUBSYSTEM CODE – EQUIPMENT TYPE CODE – EQUIPMENT SEQUENTIAL NUMBER – PARALLEL OR DUPLICATE EQUIPMENT**

→FGA → P → 0001(or 001) → A

**Table 1 - Carty Subsystem Codes**

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| ACU | FACILITY AIR CONDITIONING | CME | SITE SECURITY | LTA | PLANT LIGHTING | TGI | CT GENERATOR |
| APA | AC POWER SUPPLY 120/240 | CMG | CARTY WIRELESS | LTB | FAA LIGHTING | TGM | CT GENERATOR COOLING AND PURGE |
| APB | AC POWER SUPPLY 208/120 | COA | DISTRIBUTED CONTROL SYSTEM | MOB | MOBILE EQUIPMENT | TGN | CT CONTOL AND INSTRUMENTATION |
| APC | AC POWER SUPPLY 480 | COC | UNIT PROTECTION | MXB | MIXED BED SYSTEM | TGO | CT OFF BASE AUXILARIES |
| APCMCC17 | MOTOR CONTROL CENTER 0017 | COE | INSTRUMENT FREEZE PROTECTION | PMB | SHUTDOWN CORROSION PROTECTION | TGU | CR DATA LINK INFORMATION |
| APCSUS11 | SECONDAY UNIT SUBSTATION 0011 | CPU | CATHODIC PROTECTION | PPA | | TOL | TOOL ASSETS |
| APCSUS12 | SECONDAY UNIT SUBSTATION 0012 | CTL | WATER TREATMENT CONTROL SYSTEM | PSA | AUXILIARY STEAM | WSA | SURFACE WATER |
| APCSUS13 | SECONDAY UNIT SUBSTATION 0013 | ECB | CLOSED CYCLE COOLING WATER | PSE | CT COOLING STEAM SUPPLY | WSC | SERVICE WATER |
| APCSUS14 | SECONDAY UNIT SUBSTATION 0014 | EDI | ELECTRO DE-IONIZATION | PSF | CT COOLING STEAM RETURN | WSD | POTABLE WATER |
| APCSUS15 | SECONDAY UNIT SUBSTATION 0015 | EEA | ELECTRICAL HEAT TRACING | PWME | PORT WESTWARD MOBILE EQUIPMENT | WSE | FP WATER SUPPLY AND STORAGE |
| APCSUS16 | SECONDAY UNIT SUBSTATION 0016 | EEA | HEAT TRACING | ROS | REVERSE OSMOSIS | WSH | DEMINERALIZED WATER |
| APCSUS17 | SECONDAY UNIT SUBSTATION 0017 | EEB | SITE GROUNDING | RW | RAW WATER | WTB | SERVICE WATER TREATMENT |
| APCSUS18 | SECONDAY UNIT SUBSTATION 0018 | EEC | DUCT BANKS AND RACEWAYS | SAA | CONTINUOUS EMISSION MONITORING | WTR | WATER SYSTEM |
| APD | AC POWER SUPPLY 4160 | EQP | SPARE EQUIPMENT | SAC | STEAM CYCLE SAMPLING- ANALYSIS | WWB | SANITARY DRAINAGE |
| APDSWG01 | 13.8KV SWITCHGEAR 0001 | FGA | FUEL GAS SUPPLY | SCA | GB HEATING AND VENT | WWC | WASTEWATER COLLECTION |
| APE | AC POWER SUPPLY 13.8 UNIT 2 | FPA | FIRE PROTECTION | SCC | SPACE CONDITIONING | WWD | OIL SPILL PREVENTION |
| APF | AC POWER SUPPLY 13.8 | FWA | BOILER FEED WATER | SCG | GCB HEATING AND VENT | | |
| APH | DC POWER SUPPLY 125 | FWC | CONDENSATE | SCH | CFB HEATING AND VENT | | |
| API | ESSENTIAL SERVICE AC POWER | FWE | CYCLE CHEMICAL FEED | SCS | SB HEATING AND VENT | | |
| BLD | PROJECT BUILDINGS | FWF | CYCLE MAKEUP AND STORAGE | SCZ | BFB HEATING AND VENT | | |
| BSA | GB CRANE HOISTS & ROLL UP DOOR | GRLD | | SGA | HEAT RECOVERY STEAM GENERATOR | | |
| BSF | PSB HOISTS & ROLL UP DOOR | GTA | ST GENERATOR ISOPHASE BUS DUCT | SGB | STEAM GENERATOR BLASTER | | |
| BSG | GCB CRANE HOISTS-ROLL UP DOOR | GTC | ST GENERATOR SURGE PROTECTION | SGF | BOILER VENTS AND DRAINS | | |
| BSU | CFB HOISTS & ROLL UP DOOR | GTD | ST GENERATOR NEUTRAL | SGG | HIGH PRESSURE STEAM | | |
| BSZ | BFB HOISTS & ROLL UP DOOR | GTE | GENERATOR CIRCUIT BREAKER ST | SGH | LOW PRESSURE STEAM | | |
| CAB | CONTROL AIR | GTK | CT GENERATOR ISOPHASE BUS DUCT | SGJ | HOT REHEAT STEAM | | |
| CAC | STARTING AIR | GTM | CT GENERATOR SURGE PROTECTION | SGK | COLD REHEAT STEAM | | |
| CCF | CEMS DESIGNATION | GTN | CT GENERATOR NEUTRAL GROUND | STG | SITE FIRE PROTECTION | | |
| CF | CHEMICAL INJECTION | GTO | GENERATOR CIRCUIT BREAKER CT | TGA | STEAM TURBINE | | |
| CGE | AMMONIA STORAGE AND DIST | GTU | | TGB | ST GENERATOR | | |
| CIP | CLEANING IN PLACE | HRB | CONDENSER AIR EXTRACTION | TGC | STEAM TURBINE SEALS AND DRAINS | | |
| CMB | Plant Paging System | HRC | CIRCULATING WATER | TGD | STEAM TURBINE LUBE OIL | | |
| CMD | PLANT COMMUNICATIONS | HRE | CIRC WATER CHEMICAL FEED | TGF | ST INSTRUMENTATION & CONTROL | | |
| | | | | TGH | COMBUSTION TURBINE | | |
| | | | | | | | |

**Table 2 - Carty Equipment Type Codes**

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| VNT | Valve, Air Release | ACC | Accumulator | Use ISA for instrument designations unless other information is in table | | BKR | Breaker | ANZ | Analyzer |
| V | Valve, Ball | AC | Air Conditioner | VA | Accelerometer, Linear | CB | Circuit Breaker | BTRY | Battery |
| V | Valve, Butterfly | AD | Air Dryer | FE | Element, Flow | JBX | Junction Box | BC | Battery Charger |
| V | Valve, Check | AHU | Air Handling Unit | LE | Element, Level | MCC | Motor Control Center | CAB | Cabinet |
| CV | Valve, Control | CMP | Compressor | TE | Element, Temperature | NBD | Non-Seg Bus Duct | CAM | Camera |
| ABV | Valve, Diaphragm | COCAT | CO Catalyst | LI | Indicator, Level | PPL | Panel, Electrical | F | Coalescer |
| FCV | Valve, Flow Control | A | Condenser | PI | Indicator, Pressure | DS | Switch, Disconnect | CPL | Controller |
| V | Valve, Gate | CU | Condensing Unit | PDI | Indicator, Pressure Differential | SWG | Switchgear | AT | Detector, Leak |
| V | Valve, Globe | A | Cooler | TI | Indicator, Temperature | UPS | Uninterruptible Power Supply | SDT | Detector, Smoke |
| LCV | Valve, Level Control | CTW | Cooling Tower | FS | Switch, Flow | VFD | Variable Frequency Drive | DIF | Diffuser |
| MV | Valve, Metering | CRA | Crane | LS | Switch, Level | XF | Transformer | SRV | Disc, Rupture |
| MOV | Valve, Motor Operated | Y | Damper, Stack | VE | Sensor, Proximity | | | LTA | Exit Sign |
| V | Valve, Needle | DEA | Deaerator | SE | Sensor, Speed Pickup | | | EXJ | Expansion Joint |
| PCV | Valve, Pressure Control | DSH | Desuperheater | TS | Sensor, Temperature | | | FLT | Filter |
| RV | Valve, Relief | | | LSH | Switch, Level High | | | HT | Heater |
| SRV | Valve, Safety Relief | | | LSHH | Switch, Level High High | | | FHS | Hose, Fire Station |
| SV | Valve, Solenoid | | | LSLL | Switch, Level Low Low | | | HYD | Hydrant |
| TCV | Valve, Temperature Control | DRM | Drum, Steam | PS | Switch, Pressure | | | ORF | Orifice |
| | | DB | Duct Burner | ZS | Switch, Pressure | | | PRN | Printer |
| | | FN | Fan | PDS | Switch, Pressure Differential | | | CPU | Server (Computer) |
| | | GB | Gearbox | PSHH | Switch, Pressure High High | | | STR | Strainer |
| | | GEN | Generator | PSL | Switch, Pressure Low | | | TRP | Trap |
| | | A | Heat Exchanger | TS | Switch, Temperature | | | S | Safety Shower |
| | | MOT/MTR | Motor | VS | Switch, Vibration | | | | |
| | | MXR | Mixer | TW | Thermowell, Instrument | | | | |
| | | MOT/MTR | Motor | AIT | Transmitter, Analyzer | | | | |
| | | OWS | Oil Water Separator | CT | Transmitter, Conductivity | | | | |
| | | P | Pump | FT | Transmitter, Flow | | | | |
| | | RCV | Receiver, Air | FIT | Transmitter, Indicator, Flow | | | | |
| | | RH | Reheater | LIT | Transmitter,Indicator, Level | | | | |
| | | SEP | Separator | PIT | Transmitter, Indicator, Pressure | | | | |
| | | T | Tank | PDIT | Transmitter, Indicator, Pressure Differential | | | | |

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| | | T (TUR) | Turbine | LT | Transmitter, Level | | | | |
| | | TGR | Turning Gear | FZT | Transmitter, Position | | | | |
| | | | | LZT | Transmitter, Position | | | | |
| | | | | TZT | Transmitter, Position | | | | |
| | | | | PT | Transmitter, Pressure | | | | |
| | | | | PDT | Transmitter, Pressure Differential | | | | |
| | | | | TT | Transmitter, Temperature | | | | |
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**Table 3 - Coyote Springs Subsystem Codes**

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| AA | ATOMIZING AIR | DB | DUCT BURNER | GH | GENERATOR HYDROGEN AND CO2 | MD | MISCELLANEOUS STEAM DRAINS |
| AB | AUX BOILER | DCS | DISTRIBUTED CONTROL SYSTEM | GL | GAS TURBINE LUBE OIL | MOB | MOBILE EQUIPMENT |
| AE | AIR EJECTION | DW | DEMINERALIZED WATER | GS | GLAND SEALING | NH | AMMONIA SYSTEM |
| AI | ACID INJECTION | ED | 125V DC SYSTEM | GT | GAS TURBINE/PACKAGE | NH | AMMONIA SYSTEM |
| BAR | BARRIERS AND FENCES | EG | EXHAUST GAS | GW | GAS TURBINE WATER INJECTION | NS | NITROGEN SUPPLY TO HRSG |
| BD | BOILER BLOWDOWN | EH | ELECTRO-HYDRAULIC CONTROL | HO | HYDRAULIC AND TRIP OIL | PAS | PASSENGER VEHICLES |
| BF | BOILER FEED | EL | 480V LC/MCC | HP | HIGH PRESSURE STEAM | PS | PROCESS STEAM |
| BLD | BUILDINGS | EM | MEDIUM VOLTAGE AC (4.16 - 18KV) | HRH | HOT REHEAT | PW | POTABLE WATER |
| CC | COMPONENT COOLING WATER | EQP | SPARE EQUIPMENT | HT | HEAT TRACE | RAD | RADIO SYSTEMS |
| CD | CONDENSATE | ES | EXTRACTION STEAM | HV | HVAC SYSTEM | RW | RAW WATER |
| CF | CHEMICAL FEED | EU | 120/240 VITAL AC AND UPS | HY | HYDRAULIC OIL | SA | SERVICE AIR |
| CH | CRANES AND HOISTS | EV | 500KV SYSTEM | IA | INSTRUMENT AIR | SG | STEAM GENERATOR |
| CM | CONTINUOUS EMISSION MONITORING | FG | FUEL GAS | IC | INLET COOLING | SS | SAMPLING SYSTEM |
| CP | CATHODIC PROTECTION | FO | FUEL OIL | IP | INTERMEDIATE PRESSURE STEAM | ST | STEAM TURBINE/PACKAGE |
| CR | PROCESS CONDENSATE RETURN | FP | FIRE PROTECTION | IA | INSTRUMENT AIR | SV | SANITARY WATER |
| CRH | COLD REHEAT | GE | GENERATOR EXCITER | IC | INLET COOLING | SW | SERVICE WATER |
| CTMU | COOLING TOWER MAKEUP | GEN | MAIN GENERATOR | IP | INTERMEDIATE PRESSURE STEAM | TA | GAS TURBINE AIR |
| CW | CIRCULATING WATER | | | LC | LCI AND STATIC START | TOL | TOOL ASSETS |
| | | | | LI | LIGHTING | WA | WATER WASH |
| | | | | LO | STG LUBE OIL | WW | WASTE WATER |
| | | | | LP | LOW PRESSURE STEAM | | |
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**Table 4 - Coyote Springs Equipment Type Codes**

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| BP | Valve, Backpressure | ACC | Accumulator | Use ISA for instrument designations unless other information is in table | | MCC | Motor Control Center | AIT | Analyzer, Indicator |
| BL | Valve, Ball | AC | Air Conditioner | LC | Controller, Level | PNL | Panel | PA | Analyzer, Purity |
| HV | Valve, Block | AD | Air Dryer | LIC | Controller, Indicating Level | NGT | Transformer, Neutral Grounding | BATT | Battery |
| BF | Valve, Butterfly | CAN | Combustion Can | PIC | Controller, Indicating Pressure | XFMR | Transformer | CHGR | Battery Charge |
| CV | Valve, Check | ACC | Compressor | AE | Element, Analyzer | SS-XFMR | Transformer, Station Service | BATT | Battery Charger |
| DP | Valve, Diaphragm | GS-SC | Condenser, Gland Steam | CE | Element, Conductivity | MT | Transformer, Main | BD | Disconnect, Battery |
| KV | Valve, Diaphragm | COND | Condenser | FE | Element, Flow | UPS | Uninterruptible Power Supply | EG-J | Expansion Joint |
| FV | Valve, Flow | HX | Cooler | LE | Element, Level | VFD | Variable Frequency Drive | F | Filter |
| FCV | Valve, Flow Control | CRN | Crane | TE | Element, Temperature | | | FH | Filter, Hydraulic |
| GT | Valve, Gate | DMP | Damper | VE | Element, Vibration | | | EUH | Heater, Electric Unit |
| GA | Valve, Globe Angled | DA | Deaerator | LG | Gauge, Level | | | HTR | Heater |
| GL | Valve, Globe | DS | Desuperheater | PSL | Gauge, Pressure Low | | | HST | Hoist |
| LV | Valve, Level | HX | Cooler | SG | Glass, Sight | | | FH | Hose, Flexible |
| HV | Valve, Motor Operated | DR | Drum, Steam | FI | Indicator, Flow (Local) | | | EM | Light, Emergency Exit |
| MOV | Valve, Motor Operated | BRN | Duct Burner | FIT | Indicator, Flow Transmitter | | | FM | Manifold, Valve |
| ND | Valve, Needle | FN | Fan | LI | Indicator, Level | | | RO | Orifice, Restricting |
| PV | Valve, Pressure | GB | Gearbox | PI | Indicator, Pressure | | | PRN | Printer |
| PCV | Valve, Pressure Control | GEN | Generator | PDI | Indicator, Pressure Differential | | | SCR | SCR Element |
| RV | Valve, Relief | HX | Heat Exchanger | TI | Indicator, Temperature | | | SL | Silencer |
| SV | Valve, Solenoid | MX | Mixer | VX | Proximitor, VB Probe | | | ST | Strainer |
| SOV | Valve, Solenoid, Operated | M | Motor | LY | Relay, Level | | | T | Trap |
| FY | Valve, Flow, Solenoid | P | Pump | DT | RTD | | | | |
| HY | Valve, Flow, Solenoid | TK | Tank | ST | Sensor, Speed | | | | |
| TV | Valve, Temperature | | | FS | Switch, Flow | | | | |
| | | | | FSH | Switch, Flow High | | | | |
| | | | | LS | Switch, Level | | | | |
| | | | | LSH | Switch, Level High | | | | |
| | | | | LSHL | Switch, Level High Low | | | | |
| | | | | LSHH | Switch, Level High High | | | | |
| | | | | LSL | Switch, Level Low | | | | |
| | | | | LSLL | Switch, Level Low Low | | | | |
| | | | | ZSC | Switch, Position | | | | |
| | | | | ZDO | Switch, Position | | | | |
| | | | | PSL | Switch, Pressure Low | | | | |
| | | | | PS | Switch, Pressure | | | | |
| | | | | TS | Switch, Temperature | | | | |

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| | | | | VSH | Switch, Vibration | | | | |
| | | | | TW | Thermowell, Instrument | | | | |
| | | | | AIT | Transmitter, Indicating, Analyzer | | | | |
| | | | | CIT | Transmitter, Indicating, Conductivity | | | | |
| | | | | FT | Transmitter, Flow | | | | |
| | | | | FIT | Transmitter, Indicating Flow | | | | |
| | | | | LT | Transmitter, Level | | | | |
| | | | | LIT | Transmitter, Indicating Level | | | | |
| | | | | TIT | Transmitter, Indicating Temperature | | | | |
| | | | | ZT | Transmitter, Position | | | | |
| | | | | PT | Transmitter, Position | | | | |
| | | | | ZT | Transmitter, Pressure | | | | |
| | | | | PIT | Transmitter, indicating Pressure | | | | |
| | | | | PDT | Transmitter, Pressure Differential | | | | |
| | | | | TT | Transmitter, Temperature | | | | |
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**Table 5 - Port Westward Subsystem Codes**

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| ACU | FACILITY AIR CONDITIONING | CCF | CEMS DESIGNATION | ENG01 | ENGINE 01 SUBSYSTEM | FWF | CYCLE MAKEUP AND STORAGE |
| APA | AC POWER SUPPLY 120/240 | CGE | AMMONIA STORAGE AND DIST | ENG02 | ENGINE 02 SUBSYSTEM | GTA | ST GENERATOR ISOPHASE BUS DUCT |
| APB | AC POWER SUPPLY 208/120 | CGR | COMPACT GAS RAMP | ENG03 | ENGINE 03 SUBSYSTEM | GTC | ST GENERATOR SURGE PROTECTION |
| APC | AC POWER SUPPLY 480 | CMB | PLANT PAGING SYSTEM | ENG04 | ENGINE 04 SUBSYSTEM | GTD | ST GENERATOR NEUTRAL |
| APD | AC POWER SUPPLY 4160 | CMD | PLANT COMMUNICATIONS | ENG05 | ENGINE 05 SUBSYSTEM | GTE | GENERATOR CIRCUIT BREAKER ST |
| APE | AC POWER SUPPLY 13.8 UNIT 2 | CME | SITE SECURITY | ENG06 | ENGINE 06 SUBSYSTEM | GTK | CT GENERATOR ISOPHASE BUS DUCT |
| APF | AC POWER SUPPLY 13.8 | CMG | PORT WESTWARD WIRELESS | ENG07 | ENGINE 07 SUBSYSTEM | GTM | CT GENERATOR SURGE PROTECTION |
| APH | DC POWER SUPPLY 125 | COA | DISTRIBUTED CONTROL SYSTEM | ENG08 | ENGINE 08 SUBSYSTEM | GTN | CT GENERATOR NEUTRAL GROUND |
| API | ESSENTIAL SERVICE AC POWER | COC | UNIT PROTECTION | ENG09 | ENGINE 09 SUBSYSTEM | GTO | GENERATOR CIRCUIT BREAKER CT |
| BLD | PROJECT BUILDINGS | COE | INSTRUMENT FREEZE PROTECTION | ENG10 | ENGINE 10 SUBSYSTEM | GTU | GENERATOR STEPUP TRANSFORMER |
| BSA | GB CRANE HOISTS & ROLL UP DOOR | CPU | CATHODIC PROTECTION | ENG11 | ENGINE 1 SUBSYSTEM | HRB | CONDENSER AIR EXTRACTION |
| BSA | GB CRANE HOISTS & ROLL UP DOOR | EAM | ENGINE AUXILIARY MODULE | ENG12 | ENGINE 12 SUBSYSTEM | HRE | CIRCULATING WATER |
| BSF | PSB HOISTS & ROLL UP DOOR | ECB | CLOSED CYCLE COOLING WATER | EQP | SPARE EQUIPMENT | LTA | PLANT LIGHTING |
| BSG | GCB CRANE HOISTS-ROLL UP DOOR | EEA | ELECTRICAL HEAT TRACING | FGA | FUEL GAS SUPPLY | LTB | FAA LIGHTING |
| BSU | CFB HOISTS & ROLL UP DOOR | EEA | HEAT TRACING | FPA | FIRE PROTECTION | PMB | SHUTDOWN CORROSION PROTECTION |
| BSZ | BFB HOISTS & ROLL UP DOOR | EEB | SITE GROUNDING | FWA | BOILER FEED WATER | PPA | SUBSTATION |
| CAB | CONTROL AIR | EEC | DUCT BANKS AND RACEWAYS | FWC | CONDENSATE | PSA | AUXILIARY STEAM |
| CAC | STARTING AIR | EGM | EXHAUST GAS MODULE | FWE | CYCLE CHEMICAL FEED | PSE | CT COOLING STEAM SUPPLY |
| CCE | CHARGE AIR | EGS | EXHAUST GAS SYSTEM | | | PSF | CT COOLING STEAM RETURN |

**Table 3 - Port Westward Subsystem Codes**

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| PWME | PORT WESTWARD MOBILE EQUIPMENT | SGH | LOW PRESSURE STEAM | | | | |
| RED | LUBE OIL DESIGNATION | SGJ | HOT REHEAT STEAM | | | | |
| SAA | CONTINUOUS EMISSION MONITORING | SGK | COLD REHEAT STEAM | | | | |
| SAC | STEAM CYCLE SAMPLING-ANALYSIS | STG | SITE FIRE PROTECTION | | | | |
| SCA | GB HEATING AND VENT | TGA | STEAM TURBINE | | | | |
| SCC | SPACE CONDITIONING | TGB | ST GENERATOR | | | | |
| SCG | GCB HEATING AND VENT | TGC | STEAM TURBINE SEALS AND DRAINS | | | | |
| SCH | CFB HEATING AND VENT | TGD | STEAM TURBINE LUBE OIL | | | | |
| SCS | SB HEATING AND VENT | TGF | ST INSTRUMENTATION & CONTROL | | | | |
| SCZ | BFB HEATING AND VENT | TGH | COMBUSTION TURBINE | | | | |
| SGA | HEAT RECOVERY STEAM GENERATOR | TGI | CT GENERATOR | | | | |
| SGB | STEAM GENERATOR BLASTER | TGM | CT GENERATOR COOLING AND PURGE | | | | |
| SGF | BOILER VENTS AND DRAINS | SGH | LOW PRESSURE STEAM | | | | |
| SGG | HIGH PRESSURE STEAM | | | | | | |
| SGH | LOW PRESSURE STEAM | | | | | | |
| SGJ | HOT REHEAT STEAM | | | | | | |
| SGK | COLD REHEAT STEAM | | | | | | |
| STG | SITE FIRE PROTECTION | | | | | | |
| TGA | STEAM TURBINE | | | | | | |
| TGB | ST GENERATOR | | | | | | |
| TGC | STEAM TURBINE SEALS AND DRAINS | | | | | | |
| TGD | STEAM TURBINE LUBE OIL | | | | | | |
| TGF | ST INSTRUMENTATION & CONTROL | | | | | | |
| TGH | COMBUSTION TURBINE | | | | | | |
| TGI | CT GENERATOR | | | | | | |
| TGM | CT GENERATOR COOLING AND PURGE | | | | | | |
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**Table 6 - Port Westward Equipment Type Codes**

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| BV | Valve, Ball | ACC | Accumulator | Use ISA for instrument designations unless other information is in table | | BKR | Breaker | ANZ | Analyzer |
| BV | Valve, Butterfly | AC | Air Conditioner | VA | Accelerometer, Linear | MCC | Motor Control Center | BTRY | Battery |
| BV | Valve, Gate | AD | Air Dryer | PHE | Element | MOS | Motor Starter | BYC | Battery Charger |
| BV | Valve, Globe | AHU | Air Handling Unit | FE | Element, Flow | NBS | Non-Seg Bus Duct | BTRYRM | Battery Room |
| GL | Valve, Ball | CMP | Compressor | LE | Element, Level | IRK | Rack, Instrument | CAB | Cabinet |
| RV | Valve, Butterfly | COCAT | CO Catalyst | TE | Element, Temperature | DS | Switch, Disconnect | CAM | Camera |
| CHV | Valve, Check | CDU | Condensing Unit | DPG | Gauge, Differential Pressure | XF | Transformer | CARDR | Card Reader |
| UV | Valve, Check | CLR | Cooler | GG | Gauge, Glass | PPL | Circuit Breaker | XS | Detector, Leak |
| CV | Valve, Control | CTW | Cooling Tower | PG | Gauge, Pressure | PL | Panel | SDT | Detector, Smoke |
| HCV | Valve, Control | CRN | Crane | LI | Indicator, Level | KXX | Panel, Electrical | DIF | Diffuser |
| PAV | Valve, Control Purge Adjusting | DEA | Deaerator | PIJ | Indicator, Monolithic Joint | PPL | Panel, Electrical | RPD | Disc, Rupture |
| ABV | Valve, Diaphragm | DSH | Desuperheater | PI | Indicator, Pressure | LPL | Panel, Lighting | LTA | Exit Sign |
| FIV | Valve, Flow Indicator | DRUM | Drum, Steam | PIT | Indicator, Pressure | RPL | Panel, Protective Relay | EXJ | Expansion Joint |
| IV | Valve, Isolation | DB | Duct Burner | TI | Indicator, Temperature | TCPL | Panel, Temperature Control | XJ | Expansion Joint |
| PIV | Valve, Position Indicating | EFAN | Exhaust Fan | IEN | Instrument Freeze Protection Enclosure | | | FLT | Filter |
| PV | Valve, Purge | FAN | Fan | WPHE | Instrument, Water PH | | | FTR | Filter |
| HBV | Valve, Reheat Stop | GB | Gearbox | PRB | Probe | | | FL | Filter Element |
| SBV | Valve, Solenoid | GEN | Generator | SV | Probe | | | PAF | Filter, Pilot Air |
| SS | Valve, Switching | HX | Heat Exchanger | AE | Sensor | | | SLIDG | Gate, Slider |
| | | HPECON | HP Economizer | PE | Sensor, Pressure Fluctuation | | | SWG | Gate, Swing |
| | | HPEVAP | HP Evaporator | SE | Sensor, Speed Pickup | | | GRV | Grav Roof Ventilator |
| | | HPSUPERHTR | HP Superheater | TS | Sensor, Temperature | | | HTPMP | Heat Pump |
| | | BAY | HRSG Bay | FS | Switch, Flow | | | DHT | Heater |
| | | DUCT | HRSG Duct | LS | Switch, Level | | | HT | Heater |
| | | IPECON | IP Economizer | LPS | Switch, Low Pressure | | | DHT | Heater, Duct |
| | | IPEVAP | IP Evaporator | PS | Switch, Pressure | | | HRN | Horn |
| | | IPSUPERHTR | IP Superheater | STR | Switch, Speed | | | HSS | Hose |
| | | MIX | Mixer | VS | Switch, Vibration | | | FHOS | Hose, Flexible |
| | | MOT | Motor | XT | Switch, Vibration | | | HYD | Hydrant |
| | | ODS | Oil Water Separator | DBT | Thermostat | | | ORF | Orifice |
| | | P | Pump | OTT | Thermostat | | | PO | Orifice, Purge |
| | | HTPMP | Pump, High Temp Water | HCT | Thermostat, Heater Control | | | PW | Powerwave |
| | | LTPMP | Pump, Low Temp Water | TW | Thermowell, Instrument | | | PRN | Printer |
| | | LOPMP | Pump, Lube Oil | AT | Transmitter, Analyzer | | | BX | Pull Box |

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| | | RCV | Receiver, Air | CT | Transmitter, Conductivity | | | SEP | Separator |
| | | REHTR | Reheater | FT | Transmitter, Flow | | | CPU | Server (Computer) |
| | | SEP | Separator | LT | Transmitter, Level | | | SG | Sight Glass |
| | | SFAN | Supply Fan | ZE | Transmitter, Position | | | SIL | Silencer |
| | | TNK | Tank | PT | Transmitter, Pressure | | | STR | Strainer |
| | | LPV | Tank, Pressure Vessel | PDIT | Transmitter, Pressure Differential | | | SPN | Syphon |
| | | TRB | Turbine | PDT | Transmitter, Pressure Differential | | | TRP | Trap |
| | | TGR | Turning Gear | MPX | Transmitter, Temperature | | | VAV | Variable Air Volume Box |
| | | | | VT | Transmitter, Vibration | | | UHT | Unit Heater |
| | | | | VE | Velomiter | | | KXX | Vibration Monitor |
| | | | | KXX | Vibration Monitor | | | | |
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# 7 Beaver Generating Plant

## 7.1 Equipment Numbering Format

7.1.1 Equipment and Modular Units at Beaver Generating Plant shall be numbered in the following format:

**EQUIPMENT TYPE CODE – SEQUENTIAL NUMBER - PARALLEL OR DUPLICATE EQUIPMENT**

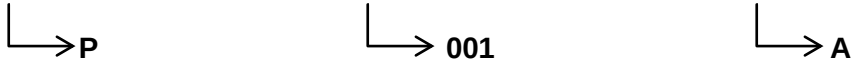

**Table 7 - Beaver Equipment Type Code**

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| BV | Valve, Ball | AC | Air Compressor | Use ISA for instrument designations unless other information is in table | | DC | Battery | AIT | Analyzer |
| BFV | Valve, Butterfly | SBLK | Block, Shroud | SLC | Controller | LC | Breaker, Circuit | CB | Cabinet |
| CHV | Valve, Check | BUCK | Bucket, Turbine | PS | Controller, Pressure | SLC | Controller | TC | Converter, Torque |
| CBV | Valve, Compressor Bleed | TC | Converter, Torque | PC | Controller, Pressure | PS | Controller, Pressure | XJ | Expansion Joint |
| CV | Valve, Control | CRN | Crane | TC | Controller, Temperature | PC | Controller, Pressure | ESW | Eyewash Station |
| FCV | Valve, Flow Control | IXC | Exchanger, Ion | FE | Element, Flow | TC | Controller, Temperature | F | Filter |
| GV | Valve, Gate | EF | Exhaust Fan | TE | Element, Temperature | MCC | Motor Control Center | FD | Fire Detector |
| GLV | Valve, Globe | FN | Fan | FG | Gauge, Flow | PDP | Panel, Electrical (Distribution) | FHS | Fire Hose Station |
| LCV | Valve, Level Control | GT | Gas Turbine | LG | Gauge, Level | LP | Panel, Lighting | AE | Gas Detector |
| MOV | Valve, Motor Operated | ACC | Gearbox, Accessory | DPI | Indicator, Differential Pressure | CB | Potential Transformer | WH | Heater, Hot Water |
| PCV | Valve, Pressure Control | HX | Heat Exchanger/Cooler | FI | Indicator, Flow | PLC | Programmable Logic Controller | H | Hydrant |
| PSV | Valve, Pressure Relief | CL | Liner, Combustion | LI | Indicator, Level | NX | Transformer | YIT | Monitor, Vibration |
| SRV | Valve, Safety Relief | ML | Mixer | LIS | Indicator, Level | RN | Transformer | FO | Orifice, Flow |
| PN | Valve, Solenoid | MOT | Motor | FQ | Integrator, Flow | RX | Transformer | PNL | Panel |
| FV | Valve, Solenoid | DFNOZ | Nozzle, Dual Fuel | DPIS | Switch, Differential Pressure | VFD | Variable Frequency Drive | SH | Space Heater |
| TC | Valve, Temperature Control | NOZ | Nozzle, Turbine | DPS | Switch, Differential Pressure | VSD | Variable Speed Drive | ST | Steam Trap |
| TCV | Valve, Temperature Control | PU | Pump | R | Switch, Disconnect | | | YS | Y-Strainer |
| | | VPR | Regulator, Pressure | FS | Switch, Flow | | | TS | Thermostat |
| | | VTR | Regulator, Temperature | LS | Switch, Level | | | | |
| | | ML | Reservoir | ZS | Switch, Limit | | | | |
| | | ST | Steam Turbine | PS | Switch, Pressure | | | | |
| | | SUP | Support Ring Assembly | TS | Switch, Temperature | | | | |
| | | TK | Tank | YE | Switch, Vibration | | | | |
| | | JG | Turning Gear | CIT | Transmitter, Conductivity | | | | |
| | | | | FT | Transmitter, Flow | | | | |
| | | | | FIT | Transmitter, Flow Indicator | | | | |
| | | | | LX | Transmitter, Level | | | | |
| | | | | PT | Transmitter, Pressure | | | | |
| | | | | TT | Transmitter, Temperature | | | | |

# 8 Westside Hydro

## 8.1 Equipment Numbering Format

**UNIT – SUBSYSTEM - EQUIPMENT TYPE – SEQUENTIAL NUMBER – PARALLEL OR DUPLICATE EQUIPMENT**

**NFP1 HO BV 0001 A**

Table 8 - WSH Unit Designations

| Plant Designation – Plant Name | Plant Designation – Plant Name | Plant Designation – Plant Name |
|---|---|---|
| FY1 – Faraday Unit 1 | RM1 – Rivermill Unit 1 | SN1 – Sullivan Unit 1 |
| FY2 - Faraday Unit 2 | RM2 - Rivermill Unit 2 | SN2 – Sullivan Unit 2 |
| FY3 - Faraday Unit 3 | RM3 - Rivermill Unit 3 | SN3 – Sullivan Unit 3 |
| FY4 - Faraday Unit 4 | RM4 - Rivermill Unit 4 | SN4 – Sullivan Unit 4 |
| FY5 - Faraday Unit 5 | RM5 - Rivermill Unit 5 | SN5 – Sullivan Unit 5 |
| FY6 - Faraday Unit 6 | RM6 - Rivermill Unit 6 | SN6 – Sullivan Unit 6 |
| FYCM – Faraday Common | | SN7 – Sullivan Unit 7 |
| HL – Harriet Lake | | SN8 – Sullivan Unit 8 |
| NF1 – North Fork Unit 1 | | SN9 – Sullivan Unit 9 |
| NF2 – North Fork Unit 2 | | SN10 – Sullivan Unit 10 |
| OG1 – Oak Grove Unit 1 | | SN11 – Sullivan Unit 11 |
| OG2 – Oak Grove Unit 2 | | SN12 – Sullivan Unit 12 |
| SC – Stone Creek | | SN13 – Sullivan Unit 13 |
| | | TL – Timothy Lake |

**Table 9 - WSH Subsystem Codes**

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 11KV | 11 KV Systems | FTRANS | Fingerling Transportation | LA | Low Pressure Air | SPARE | Spare |
| 13KV | 12.5 - 13 KV Systems | FD | Fire Detection | LO | Lubricating Oil Systems | SUBSC | Stone Creek Substation |
| 4160V | 4.16 KV | FP | Fire Protection Systems | TURB | Main Turbine Systems | STORE | Store Rooms |
| 7KV | 7.2 KV Systems | FCCS | Fish Collection Channel Systems | MLWR | Millwater Turbine Bearing Cooling Water | PERM | Stores |
| ACSS | AC Power Systems | FF | Fish Facilities | MINFLOW | Minimum Flow Systems | SS | Structural Systems |
| GATE | Access Gates | FHCS | Fish Handing and Counting Station System | MON | Monitoring Systems | SUBSN | Sullivan Substation |
| AFM | Adult Fish Migration | FLAS | Fish Ladder Air Systems | WATCH | Monitoring Systems | SU | Sump System |
| ASF | Adult Sorting Facility Systems | INST | FIsh Ladder Instrumentation | NORM | Normal | SFLOW | Supplemental Flow Systems |
| AUXB | Auxiliary Buildings | FFFL | Fish Ladder Systems | SUBNF | North Fork Substation | TEL | Telecomms |
| AVDT | Aviant Deterrant | FSHTP | Fish Transport Pipe | SUBOG11 | OG 11 KV Substation | TSS | Tertiary Screen Structure |
| BWATER | Backwash Water | TRAP | Fish Trap | SUBOG115 | OG 115 KV Substation | 3SAB | Tertiary Screens and Baffles |
| BATANK | Ballast Tanks | WSUPLY | Floating Collector Water Supply | PARK | Park Facilities | TST | Testing Equipment |
| BLTANK | Belly Tanks | FSCGN | Floating Surface Collector Guide Net | PLOT | Parking Areas | SUBTL | Timothy Lake Substation |
| BRDG | Bridges | FLFL | Flow line Systems | PN | Penstock Water Systems | TLV | Timothy Lake Valve |
| BBLRS | Bubbler | FBAY | Forebay | DAM | Permanent Dam Structures | TOOL | Tools |
| BLD | Buildings | FORE | Forebays | PRM | Permanent Equipment | TRAILER | Trailers |
| CAMP | Camp Grounds | FUEL | Fuel Station | PLAY | Play Grounds | TRAILS | Trails |
| CO2 | CO2 Fire Suppression System | SUBFY11 | FY 11 KV Substation | PAIR | Pneumatic Systems | TRAR | Trash Racks & Rakes |
| CWATER | Cold Water Make-Up | SUBFY115 | FY 115 KV Substation | POR | Portable Equipment | BWASH | Travelling Screen Backwash |
| COMM | Communications Systems | SUBFY13 | FY 13 KV Substation | PW | Potable Water | TMTANK | Trim Tanks |
| CTL | Control Comms | GARAGE | Garage | PWTR | Potable Water Systems | EMG | TSS Emergency Fish Release |
| CONT | Control Systems | GAS | Gas Storage | 1SAB | Primary Screens & Baffles | TINTK | Tunnel Intake |
| CD | Cooling Water Drains | GAGE | Gauging Stations | PAGD | Property & Grounds | TURB | Turbine |
| CRN | Crane and Hoists | GEN | Generator | RES | Reservoir | TAIR | Turbine Air |
| DAM | Dam | GOV | Governor | SUBRM | Rivermill Substation | TGV | Turbine Guard Valve System |
| DCSS | DC Power Systems | GAIR | Governor Air System | RD | Roads | TGBO | Turbine Guide Bearing Oil System |
| CAP | Debris Capture | GUGO | Governor Oil Systems | ROAD | Roadways | UWSU | Unwatering Systems |
| RML | Debris Removal | GL | Grease Lubrication Systems | ROT | Rotable Spares | UWATER | Utility Water Systems |
| DWSU | Dewatering Systems | GRND | Grounding | JACK | Rotor Braking and Jacking System | VCMPS | Vacuum Priming |
| DW | Domestic Water | GRNS | Grounds | SAFE | Safety | FLVH | Valve Houses |
| DMFP | Downstream Migrant Fish Pipe | HABITAT | Habitat Improvement | SCA | Scada | VEH | Vehicles |
| DRAIN | Drainage & Waste Systems | SUBHL | Harriet Lake Substation | CAR | Screen Hoist and Cariages | WALK | Walkways |
| ELEV | Elevators | HAC | Heating and Cooling | SAB | Screens and Baffles | WS | Waste Systems |
| EMERG | Emergency | HA | High Pressure Air | 2SAB | Secondary Screens and Baffles | DISC | Water Discharge |
| FUEL | Engine Generator Fueling System | HVAC | HVAC Systems | SEC | Security | INTK | Water Intake |
| EP | Environmental Protection | HO | Hydraulic Oil Systems | SWR | Septic Waste | WSUPLY | Water Supply Systems |
| EXC | Excavation | HP | Hydraulic Power | SA | Service Air Systems | WSUPPLY | Water Supply Systems |
| EXNS | Exclusion Net System | INLT | Inlet | SW | Service Water | WCRAFT | Watercraft |
| FENCE | Fences | LAKE | Lake | SEWER | Sewage & Waste Systems | WPHO | West Portal Hydraulic Oil |
| FW | Filtered Water | LITE | Lighting Systems | SITE | Site | WPWP | West Portal System |
| | | | | | | | |

**Table 10 - WSH Equipment Type Code**

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| ACV | Actuated Control Valve | ACC | Accumulator | Use ISA for instrument designations unless other information is in table | | BKR | Breaker | ACT | Actuator |
| AV | Auxiliary Valve | AC | Air Conditioner | AIT | Transmitter, Analyzer Indicator | DS | Disconnect Switch | ANZ | Analyzer |
| BV | Ball Valve | DRY | Air Dryer | FE | Element, Flow | EXC | Exciter | BH | Ball Head |
| BFV | Butterfly Valve | AHU | Air Handling Unit | TE | Element, Temperature | IVT | Inverter | BTRY | Battery Bank |
| CV | Check Valve | BRG | Bearing | LI | Indicator, Level | JBX | Junction Box | BYC | Battery Charger |
| GV | Gate Valve | CMP | Compressor | LI | Indicator, Level | LXF | Lighting Transformer | BLD | Building |
| GLV | Globe Valve | CNTL | Controller | PI | Indicator, Pressure | MCC | Motor Control Center | CHN | Chain |
| MV | Main Valve | CLR | Cooler | TI | Indicator, Temperature | NBS | Non-Seg Bus Duct | CPL | Coupling |
| NDV | Needle Valve | CRN | Crane/Hoist | LG | Level Gauge | PNL | Panel | CYL | Cylinder |
| PV | Pilot Valve | DSH | Dash Pot | LVDT | Linear Voltage Differential Transmitter | PLC | Programmable Logic Controller | ENC | Enclosure |
| PGV | Plug Valve | EG | Emergency Generator | LS | Switch, Level | SUS | Secondary Unit Substation | EXJ | Expansion Joint |
| RV | Relief Valve | FN | Fan | PS | Switch, Pressure | SWG | Switchgear | F | Filter |
| SV | Solenoid Valve | GLA | Gate Limit Assembly | TS | Switch, Temperature | XF | Transformer | EXT | Fire Extinguisher |
| TV | Transfer Valve | GBX | Gearbox | TS | Switch, Temperature | UPS | Uninterruptible Power Supply | FH | Flexible Hose |
| TGV | Turbine Guard Valve | GEN | Generator | FT | Transmitter, Flow | | | GBK | Generator Brakes |
| TSV | Turbine Stop Valve | GOV | Governor | FIT | Transmitter, Flow Indicator | | | HT | Heater |
| | | HGT | Headgate | LIT | Trasmitter, Level Indicator | | | MON | Monitor |
| | | HX | Heat Exchanger | PDIT | Transmitter, Pressure Diff Indicator | | | SCRN | Screens |
| | | M | Motor | PDT | Transmitter, Pressure Differential | | | SEP | Separator |
| | | OMV | Oil Motor Vibrator | PT | Trasmitter, Pressure | | | SG | Sight Glass |
| | | OWS | Oil Water Separator | PIT | Transmitter, Pressure Indicator | | | ST | Strainer |
| | | PEN | Penstock | TT | Transmitter, Temperature | | | SMP | Sump |
| | | PMG | Permanent Magnet Generator | | | | | WR | Weir |
| | | P | Pump | | | | | WRG | Weir Gate |
| | | RCV | Receiver | | | | | | |
| | | RSA | Restoring Assembly | | | | | | |
| | | ROT | Rotor | | | | | | |
| | | RUN | Runner | | | | | | |
| | | SVM | Servomotor | | | | | | |
| | | SGT | Spillway Gate | | | | | | |
| | | STA | Stator | | | | | | |
| | | TNK | Tank | | | | | | |
| | | RCK | Trash Racks | | | | | | |
| | | TRR | Trash Rakes | | | | | | |

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** | **IDENTIFIER** | **LEGEND** |
| | | TUR | Turbine | | | | | | |
| | | VFD | Variable Frequency Drive | | | | | | |
| | | WG | Wicket Gate | | | | | | |
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# 9 Biglow and Tucannon

## 9.1 Equipment Numbering Format

**TOWER NUMBER - SUBSYSTEM CODE - EQUIPMENT TYPE CODE - SEQUENTIAL NUMBER**

| | | | | |
|---|---|---|---|---|
| **T001** | **HO** | **BV** | **0001** | **A** |

| SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION | SUBSYSTEM CODE | SUBSYSTEM CODE DESCRIPTION |
|---|---|---|---|---|---|
| ALM | ALARMS | HYD | HYDRAULIC SYSTEMS | TOL | TOOL ASSETS |
| BLD | BUILDINGS | IN | INSIDE SWITCHYARD FENCE | TRAN | TRANSMISSION |
| CAM | CAMERAS | LBC | LAND BASED | TRANP | TRANSFORMER PROTECTION |
| COL | COLLECTOR | LUBE | LUBRICATION | TRNL | TRANSMISSION LINES |
| COM | COMM TOWERS | LV | LOW VOLTAGE | TWR | WIND TOWER STRUCTURE |
| COOL | COOLING SYSTEMS | MET | MET TOWERS | UCNTL | UNIT CONTROL |
| DC | DC POWER | MOB | MOBILE EQUIPMENT | UPS | UNINTERRUPTIBLE POWER SUPPLY |
| DCS | DISTRIBUTED CONTROL SYSTEM | MV | MEDIUM VOLTAGE | WIRE | WIRELESS |
| DET | FIRE DETECTION | OUT | OUTSIDE SWITCHYARD FENCE | YAW | YAW SYSTEMS |
| DW | DOMESTIC WATER | OW S | OILY WASTE | | |
| ELE | COLLECTION | PAS | PASSENGER VEHICLES | | |
| EQP | SPRARE EQUIPMENT | PC | POWER CONDITIONING | | |
| EV | 230KV SYSTEM | PRT | PROTECTION SYSTEM | | |
| FIBER | FIBER OPTIC | ROADS | ROADS | | |
| FPA | FIRE WATER SUPPLY | SCADA | SCADA SYSTEMS | | |
| FPB | FIRE SUPPRESSION SYSTEMS | SCU | SPACE CONDITIONING UNITS | | |
| FUEL | FUEL STATION | SEW | SANITARY WASTE SYSTEMS | | |
| GEN | GENERATION | STR | STRUCTURES | | |
| GENP | GENERATOR PROTECTION | SUPP | FIRE SUPPRESSION | | |
| GSU | GSU TRANSFORMERS | SWG | SWITCHGEAR EQUIPMENT | | |
| HV | HIGH VOLTAGE | TDEV | TRANSMISSION PROTECTION | | |
| HVAC | HEATING, VENTILATION & AIR CONDITIONING | TG | TURBINE GENERATOR | | |
| | | | | | |

| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND |
| BV | Ball Valve | AC | Air Conditioner | Use ISA for instrument designations unless other information is in table | | BKR | Breaker | ACT | Actuator |
| BV | Block Valve | ACC | Accumulator | AIT | Transmitter, Analyzer Indicator | BUS | Bus Work | ANZ | Analyzer |
| BFV | Butterfly Valve | AHU | Air Handling Unit | FIT | Transmitter, Flow Indicator | CAP | Capacitor | BRK | Brakes |
| CV | Check Valve | BRG | Bearing | FSR | Sensor, Flow | CON | Contactor | BRT | Breather |
| DCV | Directional Control Valve | BRSH | Brush | LIT | Transmitter, Level Indicator | COND | Conductor | BTRY | Battery Bank |
| GT | Gate Valve | CLR | Cooler | LS | Switch, Level | DS | Disconnect Switch | BYC | Battery Charger |
| GL | Globe Valve | CMP | Compressor | MAN | Manometer | EXC | Exciter | CAB | Cabinet |
| RV | Relief Valve | CNTL | Controller | PRB | Probe | GRD | Grounding Grid | CBL | Cables |
| NDV | Needle Valve | CRN | Crane/Hoist | PS | Switch, Pressure | IND | Inductor | CHN | Chain |
| PG | Plug Valve | CTRL | Yaw Pendant Controller | PSR | Sensor, Position | JBX | Junction Box | CLA | Climb Assist |
| ACV | Actuated Control Valve | DRY | Air Dryer | PTD | Transducer, Pressure | LXF | Lighting Transformer | CPLG | Coupling |
| SV | Solenoid Valve | EDG | Emergency Diesel Generator | RTD | Transmitter, Pressure | MCC | Motor Control Center | CYL | Cylinder |
| AV | Auxiliary Valve | FN | Fan | TE | Temperature Element | NBS | Non-Seg Bus Duct | DSC | Disc |
| PV | Pilot Valve | GBX | Gearbox | TT | Transmitter, Temperature | PNL | Panel | ENC | Enclosure |
| PV | Poppet Valve | GEN | Generator | VS | Sensor, Vibration | SUS | Secondary Unit Substation | EXJ | Expansion Joint |
| | | HUB | Bhub | | | SWG | Switchgear | EXT | Fire Extinguisher |
| | | HX | Heat Exchanger | | | UPS | Uninterruptible Power Supply | F | Filter |
| | | M | Motor | | | XF | Transformer | FH | Flexible Hose |
| | | P | Pump | | | | | GRD | Guard |
| | | RCV | Receiver | | | | | HT | Heater |
| | | RG | Ring Gear | | | | | LCOL | Locking Collar |
| | | ROT | Rotor | | | | | LGT | Lighting |
| | | SLR | Slip Ring | | | | | MON | Monitor |
| | | SVM | Servomotor | | | | | ORF | Orifice |
| | | TNK | Tank | | | | | RAD | Radiator |
| | | TUR | Turbine | | | | | SCRN | Screens |
| | | VFD | Variable Frequency Drive | | | | | SD | Smoke Detector |
| | | VMAN | Valve Manifold | | | | | SEP | Separator |
| | | WS | Weather Station | | | | | SMP | Sump |
| | | | | | | | | ST | Strainer |
| | | | | | | | | | |
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| VALVES | | EQUIPMENT | | INSTRUMENTS | | ELECTRICAL | | OTHER | |
|---|---|---|---|---|---|---|---|---|---|
| IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND | IDENTIFIER | LEGEND |
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### 9.2 Acceptance Criteria

9.2.1 Project Manager or Engineer has followed process to obtain equipment number for existing sites.

9.2.2 Contractor has included equipment numbers on drawings and documents as required.

### 9.3 Post-Performance Activity

9.3.1 Review information that has been loaded into the CMMS for errors and make corrections

## 10 References and Source Requirements

### 10.1 References

10.1.1 GEN-00ENG-EDP-0007 Asset Addition and Retirement

### 10.2 Sources

## 11 Forms and Records

NONE

## 12 Appendix

NONE

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 04**
**ANNEX 02**

# PROCESS DATA FOR PATTERN RECOGNITION

**PORTLAND GENERAL ELECTRIC**

**2018**

**REQUEST FOR PROPOSAL**

## Process Data for Pattern Recognition

Instrumentation will be installed and the process data available in the Plant's Control System for following systems and equipment:

### Hydro Turbine

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

### Wind Turbines

1. Blade - Lightening Strike
2. Pitch - Blade A/B/C Pitch Motor Current
3. Pitch - Blade A/B/C Pitch Motor Voltage
4. Pitch - Blade A/B/C Pitch Position
5. Pitch - Blade A/B/C Hydraulic Oil Accumulator Pressure
6. Pitch - Pitch Pressure Output From Hydraulic Power Unit
7. Pitch - Pitch Oil Temperature - Outlet Hydraulic Power Unit
8. Pitch - Pitch Oil Accumulator Temperature
9. Pitch - Pitch Controller Panel Temperature
10. Pitch - Pitch Bearing A/B/C Trangential Vibration
11. Hub - Hub Temperature
12. Hub - Ice Detection System
13. Main Bearing(S) - Main Bearing Temperature
14. Main Bearing(S) - Main Bearing Tangential Vibration
15. Main Bearing(S) - Main Bearing Axial Vibration
16. Main Bearing(S) Oil Lubrication System - In Line Metal Particle Counter
17. Main Bearing(S) Oil Lubrication System - Oil Filter Differential Pressure
18. Main Bearing(S) Oil Lubrication System - Oil Pump Amps
19. Main Bearing(S) Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
20. Main Shaft - Main Shaft Brake Pressure
21. Main Shaft - Main Shaft Brake Accumulator Pressure
22. Gearbox - Speed Of High Speed Shaft
23. Gearbox - Bearing Temperatures (Except Planetary Bearings)

24. Gearbox - Gearbox Lube Oil Pressure
25. Gearbox - Axial Vibration
26. Gearbox - Planetary Ring/Plants Tangential Vibration
27. Gearbox - High Speed Shaft Tangential Vibration
28. Gearbox - Intermediate Speed Shaft Tangential Vibration
29. Gearbox - Low Speed Shaft Tangential Vibration
30. Gearbox - Oil Temperature - Gearbox Sump
31. Gearbox Oil Lubrication System - In Line Metal Particle Counter
32. Gearbox Oil Lubrication System - Oil Filter Differential Pressure
33. Gearbox Oil Lubrication System - Oil Pump Amps
34. Gearbox Oil Lubrication System - Oil Temperatures - Inlet/Outlet Heat Exchanger
35. Generator - Winding Temperature 1/2/3
36. Generator - Generator Drive End Bearing Temperature
37. Generator - Generator Non-Drive End Bearing Temperature
38. Generator - Generator Drive End Bearing Tangential Vibration
39. Generator - Generator Non-Drive End Bearing Tangential Vibration
40. Generator - Generator Non-Drive End Bearing Axial Vibration
41. Generator - Phase A/B/C Voltage
42. Generator - Phase A/B/C Current
43. Generator - Power Factor
44. Generator - Heat Exchanger Water Inlet/Outlet Temperatures
45. Yaw - Yaw Position
46. Yaw - Yaw Brake Accumulator Pressure
47. Yaw - Yaw Brake Pressure
48. Tower - Wind Speed Primary
49. Tower - Wind Speed Secondary
50. Tower - Wind Direction
51. Tower - Nacelle Temperature
52. Tower - Tower Base Temperature
53. Tower - Control Panel(S) Temperature
54. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Cooling Media
55. Tower - Misc. Panel Cooling System - Inlet/Outlet Temperatures Of Panel Air At Cooler
56. Tower - Transformer Temperature
57. Tower - Ambient Temperature
58. Tower - Sway
59. Main Breaker - Status
60. Main Breaker - Faults
61. Main Breaker - Temperature
62. Main Breaker - Fan Ampere
63. Meteorological Station - Air Temperature
64. Meteorological Station - Cell Temperature
65. Meteorological Station - Relative Humidity
66. Meteorological Station - Wind Speeds At 10 meter, 1/2 Hub Height, and Hub Height
67. Meteorological Station - Barometric Pressure
68. Switchgear - Breaker Phase Currents
69. Switchgear - Breaker Phase Voltages
70. Switchgear - Breaker Status
71. Switchgear - Relay Fault Codes
72. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

**Solar Panels**

1. Combiner Box - DC Output Voltage
2. Combiner Box - DC Output Current
3. Combiner Box - DC Current per String
4. Combiner Box - Combiner Box Interior Temperature
5. Inverter - DC Input Voltage
6. Inverter - DC Input Current
7. Inverter - AC Output Voltage
8. Inverter - AC Output Current
9. Inverter - AC Power
10. Inverter - AC Frequency
11. Inverter - AC Reactive Power
12. Inverter - Energy Totalizer
13. Inverter - Inverter Temperatures
14. Inverter - Inverter Status
15. Inverter - Faults/Alarms
16. Inverter - Ground Current
17. Meteorological Station - Air Temperature
18. Meteorological Station - Cell Temperature
19. Meteorological Station - Relative Humidity
20. Meteorological Station - Wind Speed
21. Meteorological Station - Global Irradiance
22. Meteorological Station - Plane of Array Irradiance
23. Meteorological Station - Solar Module Back Panel Temperature(s) - 10% of Modules
24. Switchgear - Breaker Phase Currents
25. Switchgear - Breaker Phase Voltages
26. Switchgear - Breaker Status
27. Switchgear - Relay Fault Codes
28. Switchgear - Bolted Bus Connections Temperatures via Fiber Optics

**Generators**

1. Generator Load
2. Generator Reactive Power
3. Generator Field Current
4. Generator Field Voltage
5. Generator Field Temperature
6. Generator Cooler Gas Temperatures
7. Hydrogen Dryer Inlet Dew Point Temperature
8. Hydrogen Dryer Outlet Dew Point Temperature
9. Generator Exciter Radial Vibrations
10. Generator Exciter Axial Vibration
11. Generator Exciter Air Inlet Temperature
12. Generator Exciter Air Outlet Temperature
13. Ground Field Resistance
14. Generator Partial Discharge 1
15. Generator Partial Discharge 2
16. Generator Partial Discharge 3
17. Generator Shaft Grounding Current

18. Generator Line Current (by phase)
19. Generator Line Voltage (by phase)
20. Generator Seal Oil Pressure
21. Generator Seal Oil Supply Temperature
22. Generator Seal Oil Return Temperature
23. Gland Steam Seal Pressure
24. Generator Hydrogen Pressure
25. Generator Hydrogen Purity
26. Generator Hydrogen Makeup Flow
27. Cooling Water Inlet Temperature at Generator Hydrogen Cooler
28. Cooling Water Outlet Temperature at Generator Hydrogen Cooler
29. Air Cooler Inlet Temperature
30. Air Cooler Outlet Temperature
31. Hydrogen Inlet Temperature at Generator Hydrogen Cooler
32. Hydrogen Outlet Temperature at Generator Hydrogen Cooler
33. Keyphasor RPM
34. Air Gap Sensor 1
35. Air Gap Sensor 2
36. Air Gap Sensor 3
37. Stator Frame Vibration
38. Stator Temperature 1
39. Stator Temperature 2
40. Stator Temperature 3
41. Stator Temperature 4
42. Stator End Winding Vibration
43. Stator Slot Temperature 1
44. Stator Slot Temperature 2
45. Stator Slot Temperature 3
46. Thrust Bearing Position

**Oil Cooled Transformers**

1. Active Power
2. Reactive Power
3. High Side Amps (by phase)
4. High Side Voltage (by phase)
5. Ground Current
6. Low Side Voltage (by phase)
7. Control Voltage
8. Control Panel Temperature
9. LTC Tap Position
10. Oil Pump Amps
11. Oil Pump Discharge Pressure
12. Fan Bank Amps
13. LTC Tank Oil Temperature
14. Main Tank Oil Temperature
15. Top Oil Temperature
16. High Voltage Winding Temperature
17. Low Voltage Winding Temperature
18. Nitrogen Pressure

19. Local Ambient Temperature
20. Moisture Percentage
21. Gas Analyzer H2
22. Gas Analyzer O2
23. Gas Analyzer N2
24. Gas Analyzer CO
25. Gas Analyzer CO2
26. Gas Analyzer CH4
27. Gas Analyzer C2H6
28. Gas Analyzer C2H4
29. Gas Analyzer C2H2
30. Gas Analyzer H2O
31. Infrared Camera Temperatures

**Dry Transformers**

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

**Switchgear / Motor Control Centers**

1. Control Panel
    a. Control Panel Voltage
    b. Control Panel Temperature
2. 4160 VAC and Higher Bus
    a. Connected Joints Temperature Via Fiber Optic Infrared Measurement
3. MCC Bucket
    a. Load Amps
    b. Load Voltage
    c. Power Factor
    d. Bucket Temperature
    e. Cooling Fan Amps

**Process Filters Differential Pressure**

### Heat Exchangers

1. Inlet/Outlet Temperatures
2. Process Flows

### Pump / Fan Motors Greater than 100 HP

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

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 05**

# PROJECT MANAGEMENT AND CONTROLS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 11Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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# 1.0 PROJECT CONTROLS

## 1.1 GENERAL

The Contractor shall provide a project management plan, detailed project schedule, milestone or progress payment schedule, progress reports, and other information necessary for the completion of the facility on time and within budget. The scope of this shall include all work in all phases of the project for which the Contractor is responsible.

## 1.2 KICK OFF MEETING

As a first step, Contractor shall organize a kick-off meeting with Owner and subcontractors, with the following objectives:

1. Learn about the Project, update timeline, and short-term and medium term priorities and discuss other key points and expectations
2. Introduce the team that will be working on the project and their roles and responsibilities
3. Establish document control method (see Section 1.3)
4. Identify time and frequency of conference call
5. Identify main point(s) of contact and discuss communication protocols and timeframes for response
6. Discuss any risks to the project and potential mitigation measures
7. Discuss escalation procedures
8. Discuss contract administration

Contractor shall have project managers and any other representative in attendance during the kick-off meeting.

## 1.3 DOCUMENT CONTROL

Contractor and Owner shall discuss and agree upon a document control plan. The document control plan shall address how documents are transmitted, named, reviewed, tracked, and edited in compliance with the requirements in Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables. A data room shall be set up that Contractor and Owner can effectively use.

## 1.4 PROJECT MANAGEMENT PLAN

Contractor shall develop a project management plan for the management and execution of all phases of the Work within 30 days of contract execution, and shall address as a minimum:

1. Construction project manager and key team members (including curricula vitae)
2. Project organization diagram
3. Communication plan

4. Permits, licenses, certifications and agreements required
5. Procurement and sub-contracting plan
6. Project schedule and payment milestones
7. Resource loading plan
8. Environment, health and safety plan (initial draft or outline)
9. Quality Management System plan
10. Management of Owner and other external interfaces
11. Change control plan – including change order process
12. Escalation matrix – how and when to escalate issue for resolution

Contractor shall identify project manager(s), project scheduler, cost controller, risk matrix manager, and documentation manager for the Project.

## 1.5 SCHEDULE

The Contractor shall furnish a detailed, minimum level 3[1], Project Schedule, referred to as "Schedule", for its scope of work utilizing the Critical Path Method (CPM) 8 weeks after Notice to Proceed (NTP). The Schedule shall include, but not be limited to, the following:

1. Engineering activities
2. Procurement activities
3. Material and equipment deliveries
4. Construction activities
5. Tie-ins to existing plant systems
6. Equipment factory tests
7. Interfaces with Owner and other external interfaces
8. Major milestones
9. Milestone payments, if applicable
10. Startup and commissioning activities
11. Testing activities

Along with the detailed level 3 schedule, the Contractor shall furnish a Schedule Basis Memorandum. The Schedule Basis Memorandum shall include, but not be limited to, the following:

1. Project description

2. Project scope

    a. Provide work breakdown structure (WBS)

3. Schedule methodology

    a. Key milestones and interface milestones

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

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

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

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

e. Summary of activities on the critical path

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

4. Risk and opportunity analysis

   a. Summarize key risks that could delay the schedule

   b. Summarize strategies to mitigate key risk

5. Major constraints

   a. Key dates and constraints

6. Scheduling team

   a. Names and roles

The Schedule shall be resource loaded and be of sufficient detail to assure adequate planning and execution of the work, such that, in the judgment of Owner, it provides an adequate basis for monitoring and evaluating the progress of the work. This plan shall include and highlight all non-contractor interface points with the Owner, vendors or other external entities that could impact the Contractor's Schedule and execution plan. Owner will assume overall schedule integration to assure linkage of those non-contractor interfaces within the Schedule. After the Notice to Proceed, the Contractor shall update their project Schedule monthly as part of the monthly progress reporting. The Contractor shall also prepare, during construction, a rolling three-week Gantt chart schedule, updated weekly, for review at each progress and coordination meeting.

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

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

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

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

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

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

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

## 1.6 PROJECT STATUS REPORTING

The Contractor shall prepare and provide, at a minimum, a monthly and weekly progress report to the Owner. The monthly report content requirements are listed below. A weekly report template will be provided by the Owner and will include daily weather records and reporting major activities during the past week and those planned for the next three weeks. Weekly major activity reporting shall cover equipment delivery dates and status. An alternate template may be used upon Owner approval. The monthly report shall be issued to the Owner by the 10$^{th}$ day of the month following the month being reported, commencing upon notice to proceed. The weekly report shall be issued to the Owner by 4:00 pm, local time, every Friday, commencing upon notice to proceed.

The monthly report shall include, as a minimum, for that month:

1. Safety statistics, issues, and events
2. Summary of events including equipment delivery dates and status
3. Major activities accomplished during past month and those planned for the coming month
4. Project schedule update
5. Milestone payment schedule status
6. Earned Value Quantities Report (EVQR)

7. Contract progress S-curves
8. Contract overall man-hours S-curves
9. Contract overall staffing histograms
10. Contract overall craft histograms
11. Key quantity S-curves
12. Risks, delays, and quality concerns

The Contractor shall also prepare and submit to the Owner the Semi-Annual Construction Report as required by the applicable Site Certificate or state or local governmental siting process during the construction and commissioning phases only. Contractor shall prepare other permit required reports, as applicable.

### 1.6.1 EARNED VALUE QUANTITIES REPORT (EVQR)

This is a tabular report where contract quantities are reported showing quantities completed on monthly basis. This is the report that shows actual % complete, productivity, earned value, etc. on a monthly basis. Contractor is required to finalize the format and submit with contract quantity data within 4 weeks of award of contract/notice to proceed.

### 1.6.2 CONTRACT PROGRESS S-CURVES

This is a graph showing the cumulative and period plan, actual, and forecast progress on a weekly basis. The plan progress curves should be derived from the resource loaded Schedule and is to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual progress as derived from the EVQR should be plotted on the same graph against the plan. The Schedule is to be updated with the actual progress on a monthly basis. The forecast progress curve should be derived from the Schedule thus updated accordingly.

### 1.6.3 CONTRACT OVERALL MAN-HOURS S-CURVES

This is a graph showing the cumulative and period plan, actual, and forecast craft hours on a weekly basis. The plan craft hours curves should be derived from the craft hour loaded Schedule and are to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual craft hours spent as derived from the EVQR should be plotted on the same graph against the plan. The Schedule is to be updated with the actual craft hours on a monthly basis. The forecast craft hours curve should be derived from the Schedule thus updated.

### 1.6.4 CONTRACT OVERALL STAFFING HISTOGRAMS

This is a bar graph showing the overall weekly staffing (e.g. craft, home office team, management, etc.) planned, actually employed, and forecast (if different from plan). This should be derived from the resource loaded Schedule.

### 1.6.5 CONTRACT OVERALL CRAFT HISTOGRAMS

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

### 1.6.6 KEY QUANTITY S-CURVES

This is a graph showing the cumulative quantities plan, actual installed, and forecast to be installed on a weekly basis. Key quantities should be selected for this graph. Some of the key quantities (will differ from contract to contract) are excavation, back filling, concrete poured, structural steel, underground piping, aboveground piping, cable trays, cables, equipment to be installed, instruments, electrical terminations, etc. The plan curves should be derived from the quantity loaded Schedule and is to be submitted within 4 weeks of award of contract/notice to proceed. Thereafter when the work starts, the actual progress as derived from the EVQR report should be plotted on the same graph against the plan. The Schedule is to be updated with the actual progress on a monthly basis. The forecast progress curve should be derived from the Schedule thus updated. Since this process as mentioned above is required to continue on a monthly basis, Contractor is requested to plan the scheduling process in a way that the monthly updating of the Schedule with actual progress is managed well within the Contractor's capability.

### 1.6.7 CONTRACT DELIVERABLES LOG

This is a log of the required deliverables from the Contract. The deliverables log will be created by the Owner within 30 days of the notice to proceed, then tracked and updated by the Contractor on a monthly (or more frequent) basis.

## 1.7 ON-SITE STATUS & COORDINATION MEETINGS

During construction, startup and commissioning, the Contractor will hold a weekly on-site meeting that includes their key field personnel and the Owner project team. The purpose of these meetings is to review the weekly status report and to discuss current status, the three-week rolling schedule, coordination issues, and any significant concerns or problems that require action.

Commencing a month after project notice to proceed, Contractor will hold a monthly meeting that includes their key personnel and the Owner project team. The purpose of these meetings is to review the monthly progress report and to discuss current status, the Schedule, coordination issues, health and safety issues, and any significant concerns or problems that require action.

Additional project meetings to facilitate construction and communication may be required as well. Contractor shall hold a meeting prior to tower erection with Owner.

## 1.8 RISK ASSESSMENT

The Contractor shall furnish a Risk Assessment Analysis for their scope of work identifying major risks, probability of occurrence, possible impact, and actions that can be taken to mitigate any adverse effects. A Risk Matrix template is available from the Owner. The assessment shall be completed within 30 days of contract execution and updated monthly or more often as conditions or events warrant and submitted to the Owner. Specific risk items that were/are active during the previous month or next three months shall be included in the monthly report.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 06**

# SAFETY, HEALTH, AND ENVIRONMENT

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 11Dec17 | Issued for Implementation | DNV-GL | DS | CPA | Craig Armstrong |
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## 1. GENERAL

This Section covers the administrative and procedural requirements for the Contractor's Site Specific Safety and Health Plan (SSSHP) and Environment Management Plan (EMP) to be implemented under the Owner's Health, Safety, and Environment Program.

The intent of this Section is to present recommendations for the safety and environmental protection requirements and standards that shall be used while work is being performed on the project site. The Contractor is encouraged to exceed these requirements and standards as it prepares and executes its SSSHP and EMP.

All references to the Contractor in this Section include the Contractor and all its subcontractors. It follows that all requirements that apply to the Contractor also apply to its subcontractors. All records and reports maintained by the Contractor shall cover all on-site personnel, including those of subcontractors, vendor representatives, etc.

In the absence of an Owner-provided Safety Management Plan, the Contractor's SSSHP shall be recognized by all project participants and implemented as the governing Project Safety Program document.

The Owner or the Owner's authorized representative shall have full access to the Contractor's and its subcontractor's facilities for the purposes of reviewing conformance to the approved SSSHP and EMP, which includes Health, Safety and Environmental (HS&E) records, contractual requirements and cost control reports.

Surveillance, oversight and audits of the Contractor's SSSHP and EMP may be performed by the Owner or the Owner's authorized representative to verify compliance with contract requirements.

The Contractor shall be responsible for the creation and implementation of its own written SSSHP and EMP designed to ensure a safe and healthful workplace, and to prevent its employees and employees of its subcontractors from working under conditions which are unsanitary or dangerous to safety and health.

If the Contractor engages subcontractors to perform any portion of the Work at the project site, the Contractor shall require each subcontractor to create a SSSHP and EMP subject to the requirements of the Contractor's Contract for the Work, or to fully comply with and work under the Contractor's SSSHP and EMP.

The Contractor's and subcontractor's SSSHP shall conform to the requirements of the contract, meet the minimum applicable requirements of the Occupational Safety and Health Act of 1970 as amended, and conform to the Owner's Safety Management Plan. The Owner's Safety Management Plan, if available, will be provided to the Contractor prior to execution of the EPC Agreement.

Requirements for the Contractor to provide safety related actions may be supplemented by provisions of other Sections of the project specification. Other Sections of the Project Specification may contain safety activities specific to those work results.

## 2. HEALTH AND SAFETY

### 2.1 RESPONSIBILITIES

The Contractor shall be responsible for the safety and health of all persons and property affected by performance of the Work, including work performed by its subcontractors. This requirement shall apply continuously during the entire contract period.

The Contractor shall resolve any comments with respect to the implementation of the SSSHP to the Owner's satisfaction.

The Contractor shall be responsible for confirming compliance of its subcontractor's SSSHP with the Owner's Safety Management Plan.

The Contractor is responsible to assure that any activities subcontracted to lower-tier constructors or agencies are contractually "passed-down" and the Contractor shall assure that its sub-tier entities follow these requirements.

Each contractor shall designate not less than one qualified Safety Professional for each 50 employees (or portion thereof) that it has working at the project site. The Safety Professional shall meet, at a minimum, the following qualifications:

- Have a minimum of two (2) years' experience in construction safety
- Possess the OSHA 30-Hour Construction Safety Outreach Training certification.
- Hold a current certification in First Aid and CPR.
- Climb certification, and high- angle rescue, as required

The Safety Professional shall be responsible for the administration of the Contractor's SSSHP. Similarly, a Safety Professional shall be assigned for major subcontractors and be responsible for the subcontractor's SSSHP.

The Contractor's Safety Professional shall be on-site on a full-time basis from the time of mobilization through the completion of the final punch list. The subcontractor's Safety Professional shall be on-site on a full-time basis from the time of the subcontractor's mobilization through completion. This person may hold no other duties unless prior approval from the Owner or the Owner's authorized representative has been granted. Coverage shall be provided during all project activities, including after-hours work and weekends.

In the absence of the Safety Professional, the Contractor shall assign an alternate Safety Professional full time whenever work is in progress. The alternate Safety Professional's

qualifications shall be submitted and accepted by the Owner or the Owner's authorized representative prior to his/her assuming the position.

Supervisors are responsible for safety performance.

## 2.2 REFERENCE DOCUMENTS

Related standard specifications are referenced in this Section. The Work performed shall comply with the referenced and applicable requirements of the latest issue date of these documents, in addition to federal, state or local codes having jurisdiction.

References to regulatory or standards agencies will be made in accordance with the following abbreviations:

1. ANSI - American National Standards Institute
2. MSHA - Mine Safety and Health Administration
3. NFPA - National Fire Protection Association
4. OSHA - Occupational Safety and Health Administration
5. Oregon-OSHA – Oregon Occupational Safety and Health Administration

## 2.3 SUBMITTALS

Submit the Site Specific Safety and Health Plan, Subcontractor Site Specific Safety and Health Plans, and resume of each Safety Professional for review in accordance with the submittal requirements of Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

## 2.4 GENERAL SAFETY AND HEALTH PLAN PROVISIONS

The Contractor's SSSHP shall specify the health and safety requirements to provide for the safety and health of its workers and others.

The Owner's applicable safety and health requirements shall be incorporated into the development of Contractor's SSSHP.

Contractor's SSSHP shall establish performance expectations and clearly state the roles, responsibilities and requirements for management, supervisors and individual workers within Contractor's organization. The subcontractor's SSSHP shall, at a minimum, comply with Contractor's performance expectations.

Acceptance of Contractor's SSSHP does not relieve the Contractor of any of its obligations for safety and health under its Contract with the Owner or as provided by law.

The Contractor shall advise the Owner or the Owner's authorized representative of any unique hazards of the Work or any other hazards expected as a result of the Work. The

Contractor shall notify the Owner of the hazard. The hazard notification shall be documented according to the Owner's documentation requirements and shall be followed up until the hazard is controlled or resolved.

The Contractor's accepted SSSHP shall demonstrate:

1. The Contractor's management commitment to protecting the safety and health of its employees.
2. That compliance with OSHA (regulatory) is achieved.
3. That procedural requirements and commitments for the anticipated scope of work are met.

Specifically, the Contractor's SSSHP shall include, at a minimum, the following elements:

1. That the SSSHP is endorsed by the highest level of management in the Contractor's organization.
2. The organizational management roles and responsibility for implementation and enforcement of safety requirements are clearly defined.
3. The qualifications, roles and responsibilities of the Contractor's safety personnel are clearly defined.
4. That as a minimum, one Safety Professional is provided for each 50 (or portion thereof) workers it has at the project site.
5. The method by which training procedures are utilized by the Contractor for initial training, ongoing training and task specific safety training is provided to workers.
6. The method by which workers are to be trained and supervised to ensure understanding of the safety requirements of the project and instructions for their specific work activity.
7. That the Contractor develops and implements a safety orientation for all of its workers. This includes the subcontractor's workers, owner representatives, as well as all visitors to the project site.
8. Utilization of Job Hazard Analysis (JHA) on all work operations, job safety briefings and daily task analysis. Location of first-aid kits, fire extinguishers, and automated external defibrillators (AED).
9. Prevention of use or operation of machinery, equipment or tools unless the worker has received specific safety training for the activity.
10. Means of communicating management expectations and information, including weekly toolbox meetings and confirming attendance at safety meetings.
11. Employee involvement in decision making, problem solving and expressing concerns is included in the SSSHP.
12. Management job descriptions including the safety and health responsibilities for all workers.
13. Discipline policy is clearly defined, including the responsibility for enforcement.
14. Regular inspections of work activities and equipment are performed and documented of site conditions, and any non-conformance issues observed.

15. Assessments of subcontractor work activities and equipment are regularly performed and documented.
16. Subcontractor qualifications, expectations and monitoring are regularly communicated.
17. Assurance that hazards that are identified have prevention and control measures implemented and documented.
    a. Hearing conservation/baseline hearing test
    b. Heat stress program

The Contractor shall include Safe Work Procedures in its SSSHP as necessary to perform the Work in compliance with the project specification and applicable federal, state and local requirements. Requirements addressed by the procedures should include, but not be limited to, the following:

1. Confined space activities that comply, at a minimum, with Oregon-OSHA Regulation OAR 437-002-0146.
2. Hazard Communication Program that complies, at a minimum, with OSHA Regulations 29 CFR 1926.59 and 29 CFR 1910.1200. The Contractor shall ensure that all containers containing chemical products are stored in compatible containers that can be closed and shall not be left outdoors at end of shift, weekends, etc. The Contractor shall notify the Owner or the Owner's authorized representative of hazardous materials to be brought onto the project site. Copies of safety data sheets (SDS) shall be provided to the Owner or the Owner's authorized representative.
3. Chemical spill response, clean-up and reporting that complies, at a minimum, with Oregon-OSHA OAR 437 Subdivision H.
4. General Safety and Health Provision and Environmental Controls that complies at a minimum with OSHA Regulation 29 CFR 1926 Subparts C and D including, but not limited to:
    a. Medical and first aid plans, facilities, staffing and training.
    b. Evacuation, emergency planning and notification procedures.
    c. Housekeeping and debris removal protocols.
5. Personal Protection and Life Saving Equipment selection, use and training, that complies, at a minimum, with OSHA Regulation 29 CFR 1926 Subpart E including, but not limited to activities working over or near water that comply, at a minimum, with OSHA Regulation 1926, Section 106.
6. Fire protection and prevention (including 'Hot Work' permits) that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart F including, but not limited to flammable and combustible liquids storage and dispensing activities that comply, at a minimum, with OSHA Regulation 29 CFR 1926.152.
7. Signs, signals and barricades that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart G.
8. Material handling that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart H.

9. Hand and power tools that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart I.
10. Welding and cutting activities that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart J.
11. Electrical work that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart K including, but not limited to Control of Hazardous Energy - Lockout/Tag Out that complies, at a minimum, with OSHA Regulations 29 CFR 1926.417 and 29 CFR 1910.147.
12. Scaffolding erection, dismantling and use that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart L.
13. Fall and Trip Protection that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart M.
14. Helicopter, hoists, elevators and conveyors activities that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart N.
15. Powered industrial motor vehicles and equipment operations that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart O.
16. Excavation and trenching operations that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart P.
17. Concrete and masonry work that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart Q.
18. Steel erection work that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart R.
19. Underground construction, caissons and cofferdam activities that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart S.
20. Demolition activities that comply, at a minimum, with OSHA Regulations 29 CFR 1926, Subpart T.
21. Blasting and the use of explosives that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart U.
22. Power Transmission and Distribution work that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart V.
23. Rollover protective structures and overhead protection that complies, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart W.
24. Stairway and ladder use that complies with, at a minimum, OSHA Regulation 29 CFR 1926, Subpart X.
25. Commercial diving operations that comply with, at a minimum, OSHA Regulation 29 CFR 1926, Subpart Y.
26. Toxic and hazardous substance activities that comply with, at a minimum, OSHA Regulation 29 CFR 1926, Subpart Z.
27. Work activities involving asbestos containing materials (ACM) or suspected ACM that complies, at a minimum, shall comply with OSHA Regulation 29 CFR 1926.1101.
28. Monitoring of workplace and workers exposures to noise, dust, fumes, etc., shall be required for any substance that might be suspected to be approaching or exceeding the permissible exposure limits (PEL) as listed in OSHA Regulations,

29 CFR 1926, Subpart Z and 29 CFR 1910, Subpart Z and accompanying tables.
29. Crane and derrick activities that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart CC.
30. Cranes and derricks used in demolition and underground construction that comply, at a minimum, with OSHA Regulation 29 CFR 1926, Subpart DD.

The exemptions in the OSHA standard that certain workers and work operations are not required to utilize fall protection when exposed to falls greater than six (6) feet, MAY NOT be recognized by the Owner on this project.

The Owner may impose minimum fall protection heights other than six (6) feet. Contractor and its subcontractors shall adhere to this requirement.

## 2.5 HEALTH PROGRAMS AND SUBSTANCE ABUSE/PREVENTION POLICIES

1. The Contractor shall develop, implement, administer and enforce a formal substance abuse policy which is required to meet minimum standards as set forth by the Owner.
2. The Contractor shall be responsible for ensuring the compliance with the substance abuse policy by any Subcontractors under its employ.
3. The Contractor shall provide a copy of its substance abuse policy to the Owner or the Owner's Representative prior to the start of the Work.
4. Contractor shall verify and document that all of its workers as well as all workers of its approved subcontractors performing work on the project are in compliance with this requirement.
5. The Owner or the Owner's authorized representative reserve the right to audit the Contractor for adherence to its Substance Abuse Policy.

## 2.6 ACCIDENT, INCIDENT REPORTING PROCEDURES

1. Contractor shall provide notification to the Owner of any reported accident, incident (including near miss events) or injury. Contractor shall contact the Owner or the Owner's Representative, as soon as the situation has been assessed, any injured persons treated and area made safe. A near-miss or incident report shall be completed once the near-miss or incident is under control and before the end of the shift. A copy of the report shall be routed to the Owner within 48 hours.
2. Contractor shall fully cooperate in supplying information related to any accident, incident, near miss, or worker injury (including names and addresses of individuals involved in the event).
3. Contractor shall provide detailed incident related documentation to the Owner or the Owner's Representative.

4. For all recordable injuries, an incident investigation shall be performed that will determine root causes and preventative measures.
5. An initial report of all recordable injuries shall be submitted to the Owner or the Owner's authorized representative within 48 hours, with the final report no later than 5 business days after the event. Additional time may be granted for complex investigations.

## 2.7 OREGON-OSHA/OSHA INSPECTIONS

1. The Contractor shall immediately notify the Owner and the Owner's authorized representative if it becomes aware of the presence of an Oregon-OSHA or OSHA compliance officer on the site.
2. The Owner or the Owner's authorized representative may be involved in all opening and closing conferences related to Contractor's Oregon-OSHA or OSHA inspection.
3. The Owner or The Owner's authorized representative shall receive copies of any/all complaints, citations or other documentation directed to Contractor or any Subcontractor by Oregon-OSHA or OSHA.
4. The Owner or the Owner's authorized representative shall receive copies of all abatement actions and/or "Notice of Contest" correspondence to Oregon-OSHA or OSHA.

## 2.8 ADDITIONAL TRAINING

The Owner may require the Contractor personnel to attend Owner-specific safety training prior to allowing workers access to the project site. The Contractor shall ensure that all workers, including subcontractor workers and visitors, attend the Owner-required training.

## 2.9 SECURITY

All Security Protocols established by the Owner shall be followed by the Contractor, its subcontractors and visitors at all times on the project site.

## 2.10 ADDITIONAL PLANT REQUIREMENTS

1. The Contractor shall designate competent persons and qualified individuals for excavations, confined space entry, electrical, rigging and heavy lifts. Heavy lifts shall be planned per ASME P30.1. All lift and excavation plans shall be provided to Owner for review prior to performing the work.
2. Elements of the Contractor's SSSHP requiring written programs and documented training shall be made available for review by the Owner or the Owner's authorized representative upon request.
3. An Anti-Harassment policy and procedures shall be established to prohibit sexual harassment or any other behavior (verbal, physical, visual, etc.) that is reasonably likely to create a hostile, intimidating or offensive work environment.

In addition, Contractor and its Subcontractor shall adhere to the Owner's Anti-Harassment policy, if one is established by the Owner.

4. At a minimum, Contractor shall make provisions for the annual review of the SSSHP and the effectiveness of its implementation.
5. Contractor shall post speed limit and traffic control signs to maintain safe vehicle traffic on-site. Minimum clearance heights shall be marked to ensure that heights of truck deliveries can pass underneath safely.

## 2.11 GENERAL SITE ACCESS REQUIREMENTS

1. Prior to beginning the Work on the project site the Contract documents shall be signed (executed) by both the Contractor and the Owner to confirm their acceptance of the contractual obligations contained therein.
2. Facial hair including stubble, mustache, sideburns, beard, goatee, long hair line or bangs, which may be between the face and sealing surface of a respirator, are not permitted on individuals that may be exposed to hazards requiring respirator. Use of respirators shall be limited to only those personnel who are respirator-certified.
3. Specific requirements of the work-site shall be reviewed prior to or upon arrival by the Contractor and its employees.
4. A pre-job orientation shall be conducted by the Contractor to assure that its supervisors or company representatives along with its currently known major subcontractors' representatives meet with the Owner's on-site coordinator to review the Scope of Work or services, potential hazards and other details as it pertains to the Work.
5. Proof that the Contractor's employees have received a drug test within the previous 12 months that is negative in accordance with the Contractor's substance abuse policy.
6. The insurance certificate in accordance with the Contract requirements is posted.
7. The Contractor shall ensure that all personnel entering the Owner's power plant or facilities have applicable training in the SSSHP. The Contractor shall maintain records of employee training to demonstrate the following:
    1. Training on applicable Owner procedures and area overviews, which include potential fire hazards, toxic release hazards and emergency procedures.
    2. Verification that all on-site personnel understand the training (via a passing grade on a written test for training given) and retain documentation of this verification process in accordance with the Owner's facility guidelines (if available).
    3. Compliance with all federal, state, local and industry training requirements applicable to the work performed, equipment used and certifications necessary to complete the Work.

## 2.12 MINIMUM SAFETY STATISTICS (I.E., ACCEPTABLE SAFETY PERFORMANCE RATING)

1. Documentation of the Contractor's OSHA recordable rate from previous three years (the preferred value is not to exceed the corresponding OSHA recordable rate for the industry published by the Bureau of Labor Statistics).
2. Documentation of the most recent annual Experience Modification Rate (EMR) (the preferred value is not to exceed 1.0).

## 2.13 REQUIREMENTS UPON ARRIVAL AT OWNER'S FACILITY

1. Attend the facility orientation or review specific facility orientation material when provided.
2. Ensure that all Contractor personnel understand the elements of any existing Owner Emergency Action Plans and of the Contractor's personnel's expected response during an emergency. In the event a site specific plan does not exist, the Contractor shall prepare one and ensure that its personnel understand the plans elements. The Contractor shall provide documentation to the Owner upon request.
3. The Contractor shall ensure that all personnel understand the location of energized equipment in or adjacent to the work area and the limits of any de-energized work area. The Contractor shall implement actions to ensure that non-electrical workers are kept away from electrical hazards. A protective screen shall be installed near energized equipment and signage should be placed in areas where potential for arc flash exists.
4. Provide the Owner with an approved SDS for all hazardous material (regardless of the quantity) that the Contractor plans to bring on-site.
5. Limit access to the Owner's facility through only designated entry points.
6. The Contractor shall provide qualified equipment operators, with documented training and experience, to operate the equipment in accordance with the manufacturer's recommendations and federal and state standards. The Contractor shall provide the documented training and experience to the Owner upon request.
7. Ensure that all Contractor motor vehicles, other than passenger vehicles, are equipped with an appropriate size and type of fire extinguisher.
8. Where respiratory protective equipment is required to perform the Work, the Contractor shall provide its personnel with the appropriate respiratory protection, education, current medical surveillance and fit testing as outlined by the regulatory requirements. Respirators provided shall be suitable for the areas and tasks that the worker will be undertaking.
9. If non-English speaking personnel are utilized to perform work, the Contractor shall provide supervisors fluent in both languages to conduct the required training and orientation. This bilingual supervision shall be present at the facility at all times in case an emergency condition arises and emergency instructions

shall be translated. In an emergency where the bilingual supervisor is not immediately available, aid and treatment may be delayed.

## 2.14 REQUIREMENT PRIOR TO BEGINNING WORK ON-SITE

Prior to use, verify with a current inspection report that the Contractor supplied manlifts, cranes, forklifts and other personnel or material handling equipment are in compliance with federal, state and local regulations. The Contractor shall provide the appropriate documentation to the Owner upon request.

The Contractor shall allow access to personnel training records upon request.

The Contractor shall provide the name(s) and title(s) of its designated Contractor Safety Professional(s) to the Owner.

The Contractor is responsible for requiring that its personnel are wearing the appropriate personal protective equipment (PPE) in all operations where there is a potential exposure to hazardous conditions. The Contractor is responsible for providing all PPE required to safely perform the Work. Minimum required PPE for the Owner's facility includes:

1. Hard Hat (meeting ANSI-Z89.1).
2. Safety glasses with side shields (meeting ANSI-Z87.1).
3. Protective footwear (as required by 29 CFR1910.136).
4. High-visibility clothing on the upper part of the body, such as a vest or jacket specifically sold as high-visibility clothing (bright shirts are not acceptable), provided by the contractor.

The Contractor will be responsible for requiring its personnel with PPE in dusty on-site conditions (e.g. dust proof safety glasses).

Certain areas within the Owner's facilities may be exempt from the minimum PPE requirements (e.g., office areas) depending on the task. Consult with the Owner.

## 2.15 REQUIREMENTS WHILE PERFORMING WORK

The Contractor is not allowed to start, stop or in any way tamper with the facility's operating equipment without the Owner's written authorization. All Owner, Contractor and subcontractor employees shall be empowered to stop work in the event of a safety concern or unusual event. Work shall not proceed until identified hazards are controlled or the safety or the concern is otherwise resolved.

Connection (other than normal service outlets) to any outlet for gas, water, air, electricity, steam, nitrogen, fire protection water, etc. requires authorization by the Owner.

Ground fault interrupters (GFCI) are required on all 110 Volt portable equipment and lighting.

In general, the Contractor is responsible for abiding by the requirements of the applicable OSHA Standard 29CRF1926 and/or 29CFR1910.

Comply with the applicable Owner safety procedures such as clearances, lockout-tagout, confined space, etc., when performing work on Owner facilities. The Owner will designate applicable procedures and area overviews. The Owner's procedures and area overviews will be made available to the Contractor by the Owner upon mobilization at the project site.

The Owner (and/or Owner's representative) may monitor and audit the Contractor's compliance with regulatory safety and health standards and facility requirements. Non-compliance may result in work stoppage by the Owner and may constitute a material breach of Contract by the Contractor. Non-compliance issues shall be followed up with a written notification of corrective action taken.

Advise the Owner of any unique hazards presented by the Work or any hazards found during performance of the Work. The Contractor may utilize signs, postings, etc. according to facility procedures to warn of any unique hazards.

## 2.16 **RELATED ON-SITE REQUIREMENTS**

Prohibited items in the secure area of the Owner's facility are as follows:

1. Personally owned firearms (except in the possession of law enforcement personal in the course of official law enforcement business).
2. Explosives, pyrotechnics and firework (except as authorized by the Owner).
3. Pets.
4. Controlled substances and alcohol.
5. Any material which may be deemed offensive, harassing, discriminatory, sexually explicit or disparaging of others based on race, national origin, gender, sexual orientation, age, disability or political or religious beliefs.
6. Solicitation material (except as approved in writing by the Owner's management and human resources).
7. Unauthorized photography, videography or image capturing.
8. Videos, games, personal music devices or radio except in designated break areas.

The following security rules apply to all Contractor personnel entering the facility:

1. Use only parking lots, gates, routes designated by the Owner to enter and leave the facility. The Contractor shall restrict its personnel and representatives to the assigned work areas, access routes and to other areas the Owner specifically authorizes.

2. The Contractors vehicles may be required to display an Owner furnished pass if driving inside the facility. Vehicles within facility operational areas shall have identifiers of the company they represent posted on the vehicle at all times.
3. If identification badges are issued they shall be shown to Owner personnel upon request.
4. Contractor visitors, including business agents, will not be allowed to enter the facility unless authorized by the Owner and escorted by the Contractor's designee.
5. The Contractor is responsible for securing its toolboxes, tool rooms, offices, trailers and buildings. The Owner is not responsible for any losses or theft of Contractor equipment or material.
6. Facility telephones are for business use only. Cell phones may only be used outside of work areas and where specifically required for the work activity. This includes plant-issued radios.
7. Contractor and Contractor employee vehicles and lunchboxes are subject to inspection upon request by Owner personnel.

## 2.17 **EMERGENCIES**

1. The Contractor is responsible for accounting for its employees during an emergency and for notifying the Owner of unaccounted-for personnel. Some areas may contain warning lights and alarms specific to the area or building. The Contractor's Safety Professional shall consult with the Owner to determine the impact on, and the required response of the Contractor's personnel to such warning lights, alarms, communication plan for field personnel, and muster point.
2. The Contractor shall provide off-site transportation for medical treatment for injuries or illnesses of its personnel that are not life-threatening and shall notify Owner of such occurrences within 24 hours. If the Owner responds to an emergency, the Owner may determine the appropriate transport.

## 2.18 **FIRE PROTECTION AND PREVENTION**

1. The Contractor shall ensure that adequate fire protection is readily available in its work areas for compliance with the NFPA and the Owner's standards.
2. Solid combustible material and equipment stored in combustible packing or crating shall be stored in areas designated by the Owner. Combustible material shall not be stored in areas where the threat of ignition is present.
3. Hot work permits shall be obtained prior to beginning such work. The Contractor shall include Hot Work Procedures in its SSSHP, as necessary, and in accordance with OSHA 29 CFR 1910.252.

# 3. ENVIRONMENT

## 3.1 RESPONSIBILITIES

Contractor shall strictly adhere to the measures specified herein, and take additional measures, as may be required by federal, state, and local regulations, to minimize any adverse impacts to the environment during the performance of the Work. In the event of conflict between the requirements herein and pollution control laws, rules, or regulations of the federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

Contractor shall be responsible for preventing, to the extent practicable, the off-site movement of all waste materials, spills, etc., resulting from the construction process, and shall be responsible for any consequences of any such off-site movement of the material.

Contractor shall be fully responsible for any and all damages to life, property, and animal life that occur as a result of his negligence. Damages resulting from negligence of the Contractor which result in polluting watercourses shall be repaired, restored, or compensated for by Contractor.

Any delays that result from failure to comply with environmental laws and regulations shall be the responsibility of Contractor.

## 3.2 SUBMITTALS

In addition to fulfilling the permit requirements referenced herein, submit a site-specific EMP for review in accordance with the submittal requirements of Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables. EMP shall describe the environmental protection measures that will be implemented at the Site and shall address/include the following:

1. National Pollutant Discharge Elimination System (NPDES) permit, at Contractor's cost, from Oregon DEQ. Include the permit in the EMP.

2. Spill Prevention, Control, and Countermeasures (SPCC) Plan meeting applicable regulatory requirements (by end of construction). It must include calculations for design of containment (e.g., all oil-filled equipment with a quantity greater than 55 gals - equipment, tanks, piping, oil-filled operating equipment, etc.- must have secondary containment). The SPCC Plan shall address the use and storage of petroleum and chemical products used at the site, including the following:

    a. Notification procedures and proper employee response and responsibilities in the event of a spill

    b. Construction equipment maintenance and refueling procedures.

c. Specific cleanup and disposal instructions for different products.

d. Quick response containment and cleanup measures that will be available on the site.

e. Proposed methods for disposal of spilled materials.

f. Employee training for spill containment.

3. Noxious Weeds Management Plan. Contractor shall prepare a Project-specific weed management plan that meets applicable State and local requirements, and implement all measures in the plan applicable to pre-construction and construction activities and post-construction maintenance of revegetation areas within the first year following seeding.

4. Submit Cultural Resources Plan. Contractor shall develop a plan for addressing cultural resources found unexpectedly during construction or maintenance activities and include notifying PGE's archeologist.

5. Stormwater Plan. Contractor shall provide a post-construction Stormwater Plan that includes site drainage drawings.

6. Drinking Water Plan. If drinking water at the Site will be provided by a well, Contractor must meet State's requirements for constructing a well, including submitting plan reviews and sample analysis.

## 3.3 MATERIALS AND EQUIPMENT

1. Provide storage tanks, sump pumps and hoses, temporary berms, drainage ditches, polyethylene sheeting and sandbags, silt fencing, sediment retention measures, and other materials and equipment necessary to control surface water and sediment during construction of the Work.

2. Provide suitable products to construct the erosion and sediment controls (e.g., silt fencing and straw bales). Contractor shall submit proposed erosion and sediment control material specifications to Owner for approval prior to construction of the control. Sterile straw or hay bales shall be used

## 3.4 PROTECTION OF WATER QUALITY

1. It is imperative that watercourses do not become contaminated with sediment or other contaminants.

2. Contractor shall be responsible for preventing, to the extent practicable, the off-site movement of all waste materials, spills, etc., resulting from the construction

process, and shall be responsible for any consequences of any such off-site movement of the material.

3. Contractor shall observe rules and regulations of federal, state, and local agencies prohibiting pollution of any stream, river, or wetland by dumping of refuse, wastewater, rubbish, or debris therein.

4. Any water collected from dewatering activities (e.g., during trenching) shall remain on site and be allowed to infiltrate into site soils.

## 3.5 PROTECTION OF AIR QUALITY

1. Comply with federal, state, and local ambient air quality standards for all parameters throughout the community surrounding the work areas as applicable.

2. Minimize potential for air pollution by wetting down bare and disturbed soils; minimizing free fall of soil and eliminating excessive drop heights during material transfer; covering soil stockpiles; limiting the size of open excavations or the duration an excavation is open; controlling vehicle speeds and designating traffic patterns; properly operating combustion emission control devices on all construction vehicles and equipment; and shutting down motorized equip¬ment when not in use.

3. If temporary heating devices are necessary for protection of work, such devices shall be of a type that will not cause air pollution.

## 3.6 VEGETATION PROTECTION

1. Removal of vegetation or trees shall be restricted to those areas necessary to complete the Work, and as approved by Owner.

2. Vegetation not designated or approved for removal shall be left in place and protected from damage or injury during construction. Contractor shall provide full and adequate protection against construction damage to all vegetation that is to remain.

## 3.7 NOISE CONTROL

1. Conduct operations to minimize the potential for annoyance to residents in vicinity of the Work, and comply with applicable local ordinances.

2. Equip compressors and other apparatus with such mechanical devices as may be necessary to minimize noise and dust. Equip compressors with silencers on intake lines.

3. Equip gasoline- or oil-operated equipment with silencers or mufflers on intake and exhaust lines.

4. Comply with federal, state, and local noise regulations as applicable

## 3.8 EROSION CONTROL

1. Contractor shall provide erosion control measures to control, minimize, and prevent soil erosion and water pollution that could be brought about by the effects of its construction operations and/or procedures upon the existing terrain.

2. Contractor shall provide temporary erosion and sediment control best management practices (BMPs) to control and/or prevent soils and sediment from traveling outside of work areas. BMPs may include, but are not limited to, silt fences, berms, and straw bales.

3. Temporary erosion control measures shall be provided for work performed outside the limits of the work areas, when such work is necessary (e.g., haul roads).

4. Effective erosion control measures shall be in-place at all times during the construction, and shall remain and be maintained until such time that permanent erosion control measures are effective.

5. Contractor shall cover all soil stockpiles with appropriate material so as to prevent wind and water erosion.

## 3.9 CONSTRUCTION EQUIPMENT AND REFUELING

1. Contractor's equipment that is left on site shall be maintained in such a manner as to prevent leaks and spills of oil, gasoline, lubricants, and other materials used for maintenance work.

2. Refueling areas shall have measures in place to collect drips beneath nozzles.

3. Fuel storage tanks shall have double containment.

4. Contractor shall be responsible for cleanup and proper disposal of any materials spilled onto a work area or surrounding areas.

## 3.10 MANAGEMENT OF DEBRIS AND WASTE MATERIALS

1. Contractor shall be responsible for preventing off-site movement of all waste materials, spills, etc., resulting from construction processes, and shall be responsible for any consequences of such off-site movement of the material.

2. All debris and waste material leaving the site shall be disposed of at a DEQ-approved permitted landfill.

3. Comply with all federal, state and local laws and regulations concerning waste movement, transport, and disposal.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 07**

# SECURITY AND COMPLIANCE

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
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| 0 | 13Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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## 1.0 GENERAL

In addition to specifications outlined herein, Contractor shall comply with the requirements provided in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications and Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications.

## 2.0 CYBER SECURITY

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. The term Vendor for this specification refers to the SCADA vendor contracted by the Contractor to perform the associated scope of work covering sections 2.1-3.0.

### 2.1 SUBSTATION SCADA SYSTEM

The substation SCADA network will be an isolated network that connects via proxy gateway to other networks. Vulnerability scanning will not be performed on the substation SCADA network.

### 2.2 GENERATION SCADA SECURITY CENTER

#### 2.2.1 Security appliances:

##### 2.2.1.1 Patch Management:

1. Owner will supply an on-site patch management server capable of deploying patches for all software, hardware, and integrated third-party applications within the SCADA system and all support systems.
2. Vendor and Owner will agree upon an acceptable patch management software suite to comply with Owner's internal standards. If an agreement cannot be reached, Owner will have the choice of what patch management application is used.
3. Vendor will install selected patch management software on all SCADA system devices.
4. Vendor will evaluate, test, and provide appropriate patches to all devices and software within the SCADA system or any other provided system.
5. Vendor must be able to provide patches and other support for the life of the system through a separate O&M agreement with Owner.
6. Owner will have final say on which patches get applied to the SCADA system devices.

### 2.2.1.2 Malware prevention/Whitelisting

1. Owner will supply an on-site Malware Prevention server capable of managing all whitelisting applications within the SCADA system and all support systems.
2. Vendor and Owner will agree upon an acceptable malware prevention software suite to comply with Owner's internal standards. If an agreement cannot be reached, Owner will have the choice of what malware prevention application is used.
3. Vendor will install whitelisting software on all SCADA system devices.
4. All Windows and Unix-based endpoints within the SCADA system, and any other provided system, will have host-based whitelisting.
5. Vendor will provide a list of all applications that need to be whitelisted on all provided equipment.
6. Owner will manage all aspects of the whitelisting system.

### 2.2.1.3 Backup and Restoration

1. Owner will provide a backup management server and a Network Attached Storage (NAS) device capable of storing all backups. This server will be capable of scheduling all automatic backups within the SCADA system and all support systems.
2. Vendor and Owner will agree upon an acceptable backup and restoration software suite to comply with Owner's internal standards. If an agreement cannot be reached, Owner will have the choice of what malware prevention application is used.
3. Vendor will install backup and restoration software into SCADA system devices.
4. Vendor will provide specific recovery instructions for all devices.
5. All Windows and Unix-based devices within the SCADA system and other provided systems must be capable of being backed up.
6. Other devices within the SCADA system and support systems (such as networking devices) will be configured to have their configurations, firmware, and any other applicable configuration files pulled automatically on a scheduled basis.
7. Owner will manage all aspects of the backup and restoration system.

### 2.2.1.4 Anti-Virus

1. Owner will provide an anti-virus management server to manage all anti-virus applications within the SCADA system and all support systems.
2. Vendor and Owner will agree upon an acceptable anti-virus software suite to comply with Owner's internal standards. If an agreement cannot be reached, Owner shall will the choice of what anti-virus application is used.
3. Vendor will install anti-virus software on all SCADA system devices
4. All Windows and Unix-based endpoints will be configured to have anti-virus software running at all times.

5. Vendor will provide updated anti-virus definitions on a weekly basis as part of a separate O&M agreement with Owner.
6. Owner will manage all aspects of the anti-virus system.
7.
8. Vulnerability Scanner (Applies to Generation SCADA system only)
9. Owner will provide an on-site vulnerability scanner that will perform scheduled scans to identify missing patches, viruses, identify vulnerabilities, detect out-of-date anti-virus signatures, etc.
10. Vendor will ensure that all generation equipment is robust enough to handle vulnerability scans while remaining fully operational. This excludes substation equipment.
11. Owner will manage all aspects of the vulnerability scanner.

#### 2.2.1.5 Security Incident and Event Manager (SIEM)

1. Owner will provide an on-site SIEM to analyze all logs produced by all SCADA and sub-system devices.
2. Vendor and Owner will agree upon an acceptable SIEM to comply with Owner's internal standards. If an agreement cannot be reached, Owner will have the choice of what SIEM solution is used.
3. Vendor will install any endpoint software on all SCADA system devices.
4. All other Windows machines will have all of their event logs pulled by a server.
5. All non-Windows machines (including network devices) will send Syslogs to Owner's Syslog server.
6. Owner will manage all aspects of the SIEM system.

## 2.3 DEVICE MANAGEMENT

### 2.3.1 Networking Devices

1. Owner will manage all networking devices within the SCADA system or any other provided system.
2. All networking devices will receive validated patches from the vendor via the patch management server.
3. Vendor will provide all configurations and other requested documentation on all network devices prior to factory acceptance test.
4. Vendor will provide information on all required communications through the firewalls prior to the factory acceptance test.
5. Vendor will properly harden all networking devices including disabling all unnecessary services and ports prior to the site acceptance test.

### 2.3.2 End Devices

1. Examples of end devices include, but are not limited to, servers, workstations, HMIs, RTUs, controllers, sensors, actuators, meters, and inverters

2. Owner will manage all end devices within the SCADA system or any other provided related system
3. Vendor will provide documentation detailing all applications, utilities, system services, scripts, configuration files, databases, and all other system requirements
4. Vendor will provide documentation of all services required by all endpoints along with justification for why they are necessary to operate the facility
5. Vendor will remove and/or disable all software components not required for operation prior to the site acceptance test.
6. Vendor will disable all unneeded communication ports and removable media drives. Vendor will provide documentation that this has been completed prior to the site acceptance test.
7. Vendor will incorporate host-based appliances for all endpoints required by the security center.
8. Vendor will verify that the additional security features do not adversely affect connections, latency, response times, and throughput, including during the site acceptance test.
9. Vendor is responsible for providing hardware capable of performing all required security functions in addition to its normal operations.

## 2.4 ACCOUNT MANAGEMENT

1. Owner will supply and manage a domain controller to manage all authentication within the SCADA system and all support systems
2. All default and guest accounts must be removed prior to the factory acceptance test
3. Vendor will supply a list of accounts which need to be active on the SCADA system. These accounts must be approved by the Owner.
4. All accounts within the SCADA systems and support systems will adhere to least privilege permission schemes.
5. All passwords will adhere to Owner's password policy.
6. Vendor will notify Owner within 12 hours of an employee, who has access to the SCADA system or any support system, quits or is terminated with cause.
7. Vendor 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.
8. No local accounts will be enabled within the generation SCADA system. This excludes some substation SCADA devices that do not have local accounts that can be disabled.

## 2.5 NETWORK DESIGN

1. SCADA Vendor 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.
2. SCADA Vendor will disclose the existence and reasons for any identified backdoor codes.

3. Unencrypted protocols (FTP, telnet, HTTP, etc.) shall be disabled in lieu of their encrypted counterparts (SFTP, SSH, HTTPS, etc.).
4. All remote access that results in a remote desktop, shell or equivalent access will require the use of a terminal server and multi-factor authentication

### 2.5.1 Network Segmentation

1. The SCADA system will be segmented in a logical manner. The following networks shall remain separate where technically feasible:
   a. Domain Controllers
   b. Servers
   c. Workstations
   d. Controllers/PLCs
   e. Auxiliary Systems
   f. Terminal/VPN Servers
   g. Independent strings/loops of remote devices
2. Vendor will provide ACLs and port security address lists for all communications between subnets
3. Vendor will provide and document secure network architecture where higher security zones originate communications to less secure zones.
4. All devices within the Generation SCADA system and all support systems may only belong to one network. The use of two NIC cards to bridge two networks is strictly forbidden. The only circumstances where two NICs can be used on a single device is for teaming and redundancy.

### 2.5.2 Wireless Communications

Wireless technologies such as microwave, cell, Bluetooth, Wi-Fi (802.11x), ZigBee, WirelessHART, or other wireless technologies shall not be used within the SCADA system.

### 2.5.3 High Availability and Redundancy

All critical systems, to be jointly determined by Owner and Vendor, shall have redundant hardware and software operating in a high-availability mode.

### 2.5.4 Network Space

1. Owner will provide Vendor with banks of IPs that can be used for devices within the SCADA system or other support systems.
2. Vendor will provide Owner with a list of devices with associated IP address prior to the factory acceptance test.

## 2.6 REMOTE ACCESS

1. All remote access traffic will be fully encrypted.

2. All remote access where a user interfaces with any part of the SCADA system or support system will require multi-factor authentication.
3. All access points including routable connections, serial links, or other communication methods will be documented and supplied by the Vendor.
4. All remote access will be managed by Owner.
5. No Contractor (including Vendor) will have access to SCADA network or equipment without explicit Owner authorization.

### 2.6.1 Web Access

1. Under no circumstances will the SCADA system or any support system have direct access to the internet.
2. Vendor will provide documentation of input sanitation for all web form inputs including, but not limited to, prevention of command injection, SQL injection, directory Traversal, RFI, XSS, and buffer overflow

### 2.6.2 VPN Access

1. All remote access to the control system network must be performed through a VPN
2. VPN terminal server will be located in a DMZ
3. VPN terminal server will have monitoring software installed to record and forward pre-encrypted traffic
4. VPNs must utilize multifactor authentication
5. VPN connections will have communication logging, alarming, and monitoring to protect SCADA system from unauthorized modification or use

### 2.6.3 Dialup and dedicated phone lines

Dial-up and dedicated phone lines will not be used within the SCADA network or any support system.

## 2.7 INCIDENT RESPONSE/DISASTER RECOVERY

1. Vendor shall provide existing Incident Response and Disaster Recovery plans for the SCADA network.
2. Vendor shall work with the Owner to address deficiencies in Vendor’s Incident Response and Disaster Recovery plans.

## 2.8 TEST ENVIRONMENT

1. Vendor shall provide equipment for a test environment to simulate standard operating conditions. The purpose of this system is not to completely reproduce the SCADA system; rather it should mimic key features of the system for testing purposes.

2. Vendor shall include all hardware necessary to generate this environment including, but not limited to, SCADA servers, workstations, HMIs, Firewalls, Routers, Switches, Controllers, Protocol Converters, etc.
3. Vendor shall include all software licenses and patches for all equipment in the test lab as they would the SCADA system.
4. This network must be capable of testing patches, backups, and preforming penetration tests
5. Test environment will be solely managed by Owner.

## 2.9 WORKSHOPS

1. Owner, Contractor, and any pertinent subcontractor (including Vendor) will have at minimum 5 cyber security workshops lasting no less than one hour each.
2. 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 CIP-002-5.1, CIP-005-5, CIP-007-5, and CIP-007-6
3. The minimum topics that will be covered in these workshops are:
   a. Review of requirements
   b. Presentation of hardware and software products to be used
   c. Implementation plan
   d. Long term system maintenance, operation, and support requirements
   e. Network design and requirements

## 2.10 ACCEPTANCE TESTS

### 2.10.1 Factory Acceptance Test (FAT)

1. Vendor shall provide current configuration files for all devices and results of any script provided by the Owner prior to the FAT. Any changes to devices during the FAT will necessitate new configurations and/or scrips to be provided to Owner post-FAT.
2. Firewall rules, as well as all other access control mechanisms, will be enabled throughout the duration of the FAT.
3. Devices will have logging enabled and logs will be provided to Owner at the end of the FAT.
4. All firewall rules and router ACLs will be reviewed during the FAT.

### 2.10.2 Site Acceptance Test (SAT)

1. Vendor shall ensure all devices are patched to their most current level.
2. Vendor shall provide current configuration files for all devices and results of any script provided by the Owner prior to the SAT.
3. Firewall rules, as well as all other access control mechanisms, will be enabled throughout the duration of the SAT.
4. Devices will have logging enabled and logs will be provided to Owner at the end of the SAT.

5. All Firewall rules and router ACLs will be verified at the SAT.
6. Vulnerability scans must be performed on critical system components as part of the SAT.
7. Remote access and remote access restrictions must be tested as part of the SAT.
8. Vendor will disable, remove, or modify all Vendor-owned accounts as part of the SAT.
9. Vendor shall document the results of any logging signatures and adjusting thresholds to reduce false positives and minimize false negatives.
10. Upon the conclusion of the SAT, the Vendor will remove all vendor managed accounts and access

## 3.0 SCADA PHYSICAL SECURITY

1. Vendor shall provide a lockable or locking enclosure for all control system components.
   a. Core equipment, such as any backbone switches, SCADA servers, Remote access terminals, Firewalls, Routers, etc. must be locked, at minimum, by a non-reproducible keycard. Access to these cards and equipment must be logged, and this system must electronically record and timestamp who enters the room (e.g. AMAG).
   b. Remote equipment, such as remote switches, controllers, media converters, PLCs, RTUs, and other end devices must be secured, at a minimum, by a non-reproducible key or keycard. Access to these keys and equipment must be logged.
2. Contractor shall verify and provide documentation that unauthorized logging devices are not installed (e.g. key loggers, cameras, and microphones).
3. All physical security networks must be separate from SCADA networks.

## 4.0 GENERATION PHYSICAL SECURITY SYSTEM

### 4.1 GENERAL DESIGN

Contractor shall provide a security system that includes, but is not limited to the following requirements:

1. Security system to consist of fencing, intrusion detection system, CCTV, and card access control.
2. Fiber Sensys fence protection to be installed where perimeter fencing is installed.
3. Bosch Intrusion Alarm system - Bosch Panel, Bosch Keypad, Bosch output relays and position switches for all gates and building doors.
4. Access control system must be compatible with AMAG or Owner approved equivalent.
5. All access control and intrusion detection field terminations must be landed on Phoenix terminal blocks at the head unit.
6. All doors with access control must have electrified door lever sets with integrated request to exit devices.

7. Wind turbine exterior entry points must have electronic lock sets (e-locks) by Assa-Abloy.
8. Access control enclosures must be universal and may be of the Hoffman style construction rated appropriately.
9. All exterior door position switches must be double pole double throw (DPDT) and dual monitored by an access control and intrusion detection system.
10. The access control system shall be installed on all personnel gates, vehicle gates and building entry doors. An arm/disarm reader shall be connected to the access control system which toggles the intrusion detection system. Card access reader shall be HID brand multiclass technology.
11. The CCTV system vendor shall be ONSSI Ocularis. Cameras must be IP based and connected to a Razberi SSIQ unit for recording. Fiber optic infrastructure is acceptable for camera to recorder.
12. Camera coverage must have the ability to observe any location within the exterior Project area or as approved by Owner. Cameras must be of the pan-tilt-zoom (PTZ) style with an unobstructed view of the entry/exit points of any Project building.
    a. Wind turbines may not be required to be within the observable area of the CCTV system.
13. Power supplies must be class II limited.
14. Contractor or Contractor's vendor will program and commission the system into the Owner Security System with an Owner representative.
15. All wiring shall be installed in raceways provided by Contractor.
16. Contractor will provide the wire from the head unit to the doors, gates, cameras, and security fence.

## 4.2 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.
4. Light fixtures shall be light emitting diode (LED) type.
5. All site lighting equipment shall be UL listed.
6. Lighting control shall consist of a HAND-OFF-AUTO switch.
7. Photocells shall be used for automatic control.
8. Photocells shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness.
9. Photocells shall be rated at 1800 VA, 120 volts ac.
10. Photocells shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.
11. Site lighting fixtures shall be installed in accordance with the equipment manufacturer's installation instructions.

12. Lighting fixtures shall be installed plumb and level and aimed as specified on the drawings, as applicable.

## 4.3 SECURITY FENCING PERIMETER WITH GATES

13. 8-foot high chain-link fencing with 3 barbed wire strands, as specified below or as approved by Owner
    a. Fence fabric shall be 2" mesh, #9 gauge wire, Class 2 Zinc-coated steel.
    b. End, corner, and pull posts shall be type 1, 2.375 inch nominal outside diameter and be hot dipped galvanized with a minimum average zinc coating of 1.8 oz./ft.2 (0.55 kg/m2) meeting ASTM F-1083 for standard weight (Schedule 40) galvanized pipe.
    c. Tension wire shall conform to ASTM A-824 Type I, Aluminum-coated, 0.40 oz/ft2 (122g/m2) or Type II Zinc-coated Class 2, 1.20 oz/ft.2 (366g/m2)
    d. Post tops shall consist of ornamental tops or combination tops with barbed wire supporting arms, as required. When so required, or when a top rail is to be provided, the top shall be provided with a hole suitable for the through-passage of the top rail. The post tops shall fit over the out-side of posts and shall exclude moisture from posts.
    e. Tension bars shall not be less than 3/16 inch (4.76mm) by 3/4 inch (19.05mm) and not less than 2 inches (50mm) shorter than the normal height of the fabric with which they are to be used. One tension bar shall be provided for each end and gate post, and two for each comer and pull post.
    f. Ties or clips of adequate strength shall be provided in sufficient number for attaching the fabric to all line posts at intervals not exceeding 15 inches (380mm); and not exceeding 24 inches (610mm) when attaching fabric to top rail or tension wire.
14. Powered, key-card controlled sliding or swinging gate
    a. One for access to O&M building entrance/parking area
    b. One for access to storage/laydown area
    c. Both of widths large enough to provide easy ingress to the facility for a full size tractor trailer combo

## 4.4 SECURITY SYSTEM TESTING

Security system equipment shall be commissioned, tested and calibrated by a certified installer of the equipment manufacturer using the manufacturer's specified procedures. Security system testing shall include testing of all operating modes and alarm conditions. Camera coverage shall demonstrate the ability to observe any location within the Project area as approved by Owner.

Security system commissioning reports shall use a reporting format or forms provided by the security system provider.

## 5.0 SUBSTATION PHYSICAL SECURITY

The Project Substation shall be enclosed by a steel expanded metal perimeter fence, constructed in accordance with the relevant Section(s) of the NESC and Owner Substation Design Standard.

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.

## 6.0 CONSTRUCTION SITE SECURITY AND ACCESS

Contractor shall ensure the Project Site is secured, limiting access to construction workers, Owner, and AHJ during construction. All personnel permitted to access the site shall receive the proper training, and bear the appropriate personal protective equipment, commensurate with their level of access and risk while on site. Personnel that are granted access to the site shall wear a security badge, containing either the word "Guest", or if full time the employee's company name and position. Security badges shall be worn visibly at all times, and only by the individual to which it has been issued.

## 7.0 NERC AND WECC COMPLIANCE

Contractor shall proactively consider NERC and WECC Compliance in the Project. New facilities connecting to the Bulk Electrical System (BES) require significant coordination with affected entities and specific planning and timely milestones will be required. The contractor will establish a schedule to ensure adherence to any standard issued by the North American Electric Reliability Corporation (NERC) or the Western Electric Coordinating Council (WECC) allowing for or applicable to the commissioning and operation of the Project.

Below are the current standards the contractor is expected to comply with:

1. BAL-005-0.2b R1.1: Generation facilities must be included within the metered boundaries of a Balancing Authority

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

3. CIP-002 R1: Generator Owner will determine BES impact for generation resources

4. CIP-003 R2: Generator Owner will implement controls to ensure low impact rating is met for all applicable CIP requirements.

5. EOP-005-2 R4: System Restoration Plan must be submitted to Peak for approval before any planned BES modification that would change the implementation

6. IRO-010/TOP-003: There are a number of data specifications requiring modeling information to be submitted to Peak and others 30 days before the change to the network.

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

8. MOD-025-2 R1 and R2 real and reactive power capability verification

9. MOD-026-1 R2 and R4 generator excitation control system or plant volt/var control function model verification

10. MOD-027-1 R2 and R4 turbine/governor and load control or active power/frequency control model verification

11. 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.

12. PRC-005 R1, R2, R3, R4, and R5: Generator Owner must perform and document battery maintenance is a timely manner.

13. PRC-019-2 R2 verify coordination of voltage regulating system controls, (including in-service limiters and protection functions) with the applicable equipment capabilities and settings of the applicable Protection System

14. PRC-024-2 R1 and ER2 verify generator frequency and voltage protective relaying does not trip the applicable generating unit(s) within the “no trip zone” of PRC-024 Attachment 1 and Attachment 2.

15. PRC-025-2 R1 verify generator relay settings are in accordance with PRC-025-1 – Attachment 1

16. VAR-001-4.1 E.A. 15 and E.A. 17 verify that generating equipment uses voltage set point, and complies with external voltage control loop specification established by these requirements.

17. VAR-002-4 (all) comply with operation and notification requirements during testing and upon initial commercial operation.

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

19. VAR-501-WECC-3 (all) comply with settings. Testing and operational requirements established by this Standard.

The standards listed are subject to change and the contractor will need to communicate specific planning and timely milestones to Subject Matter Experts (SMEs) to ensure all regulatory compliance obligations are met.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 08**

# QUALITY MANAGEMENT SYSTEM

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 11Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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# 1.0 QUALITY MANAGEMENT SYSTEM (QMS) PLAN

## 1.1 PRINCIPLES AND BASIS

Contractor shall develop and implement a Quality Management System(QMS) Plan that covers the entire scope of the project to ensure the necessary measures are taken to support successful execution of the project. Quality is the Contractors responsibility with oversight and input from the Owner.

Specifically, the objective of the QMS is to ensure appropriate quality planning; written processes/procedures in key areas; clearly defined responsibilities and accountabilities with metrics where possible; performance, non-conformance and deficiencies tracking; active feedback and continuous improvement.

The QMS shall be based on ISO 9001:2015 international standard that is either certified by an accreditation body (AB) and/or approved by the Owner.

Contractor shall provide QA/QC supervision to maintain quality control in line with industry standards for similar Work and according to the Project's QMS Plan.

## 1.2 QMS COMPONENTS

Within forty five (45) days following the Notice To Proceed Date, Contractor shall provide to Owner the site-specific, detailed QMS Plan. The Plan, at a minimum, shall address:

### 1.2.1 Safety:

Owner places a high emphasis on safety. All activities including Receiving, Handling, Storage, Shipping, Construction and Commissioning will be subjected to the highest standards of safety.

### 1.2.2 Contract Review:

Contractors documented review and comprehension of Owner's contract, specifications, drawings, policies, procedures, work instructions and guidelines.

### 1.2.3 Document Control:

The Contractor shall assure that measures are established and implemented to control the issuance of documents (i.e., procedures, instructions, drawings, work orders, etc.) including changes. These measures shall assure that documents are:

- Reviewed for adequacy
- Approved for release by authorized personnel
- Distributed to applicable work areas, and include definitive quantitative/qualitative acceptance criteria as applicable

- Adequately controlled if maintained electronically

### 1.2.4 Design Controls:

Design documentation and controls that demonstrate Design Inputs, Interfaces, Reviews, Verification and Validation.

### 1.2.5 Procurement Controls:

A documented process to evaluate (including factory on-site assessments), approve, and regularly monitor performance of critical and major sub-suppliers. Owner may accompany/observe the factory assessments. The Purchase Orders placed with approved sub suppliers shall have the necessary Technical, Quality, Statutory and Commercial requirements. The Quality requirements may include reference to the sub-supplier's QMS and the statutory requirements such as environmental and RoHS, as applicable.

### 1.2.6 Counterfeit, Substandard, and Fraudulent Items (CSFI):

Supplier must assure that their components, subcomponents, and materials are procured responsibility with oversight and input from distributors who are authorized by the original equipment manufacturer (OEM). This is particularly critical for the procurement of fasteners and similar products. The supplier must consider efforts to develop a CSFI program including those applicable to procurement, receipt inspection, and process identification and resolution of items.

### 1.2.7 Inspections:

Contractor shall implement a robust inspection program including that for Receiving (procured items), In-Process (construction/fabrication) and Final (as individual activities are completed). Inspections shall be based on Inspection Plans. The inspection shall be performed by independent QC inspectors who are qualified to industry standards and their qualifications are current and documented. Contractor shall perform inspections and field quality control testing throughout the construction process including:

- Assessing existing conditions
- Construction installation placement and qualification measurements
- Final inspections and tests

Contractor shall coordinate and document all QA/QC requirements, inspections, operational testing, and performance test results. The data from performance testing will be provided to Owner.

Contractor shall provide a five (5) Business Day notice to Owner prior to the following events for Owner review of the QA/QC inspection and testing results required.

***Solar Energy Project***

- Installation of mounting structure, if required
- Backfill of first trench of each trench type
- Installation and testing of poured concrete foundations
- Installation of pre-cast concrete foundations
- Installation of inverters and transformers
- Backfeed to the utility
- Road Construction
- Rebar and conduit placement
- Visual inspections
- PV module inspection
- Contractor shall focus on the initial array i.e. the mock-up array or row and use that at a basis for Owner input and as a reference for the remaining turbines

***Wind Energy Project***

- Installation of road subgrade
- Installation of road surface
- Foundation excavation
- Foundation rebar placement
- Foundation concrete placement
- Turbine foundations – Owners representative intends to confirm conformance with design drawings and witness installation of rebar and pour of first 2 or 3 foundations.
- Turbine installation and mechanical completion walkdowns
- Contractor shall focus on the initial turbine i.e. the reference turbine to be completed mechanically and use that at a basis for Owner input and as a reference for the remaining turbines
- Installation of substation foundations
- Substation main power transformer installation
- Initial run of collection system cabling installation for each circuit

### 1.2.7 Tests:

All testing shall be based on Test Plans. The tests shall be performed by independent QC inspectors who are qualified to industry standards and their qualifications are current and documented.

Testing shall comply with good industry practices, Applicable Laws and Applicable Standards. Contractor shall notify Owner of testing schedules and testing procedures at least 30 days in advance of such testing.

Contractor's qualified representative shall date and sign documentation, indicating completion and acceptance of each onsite test, for Owner's review.

Testing shall be completed to confirm equipment meets design specifications and shall include, but is not limited to:

- Commissioning and testing requirements
- NETA ATS standards
- Pile loads tests
- Concrete compressive strength testing for all poured concrete, in accordance with ASTM C39, and ACI 318.
- Underground cabling for burial depth, spacing, tape placement and insulation resistance.
- Photographs shall be taken of each open trench with all conductors prior to backfill.
- Any tolerance requirements as outlined in the approved engineering drawings and/or manufacturer's recommendations.
- Compaction tests of subgrades and surfaces (roads, foundations and trenches)
- Function tests of electrical equipment
- Resistance, megger, very lower frequency and continuity tests of all circuits
- Partial discharge tests on splices
- Communication system functionality
- Welding and non-destructive testing (NDT)
- Transformer tests (i.e. turns ratio, resistance, megger, insulation, load loss, dissolved gas) according to proper IEEE Standards or Guidelines
- MV Cable tests according to proper IEEE Standards or Guidelines
- Fiber optic system performance. Installer shall be certified by ETA® International (Electronics Technicians Association) or BICSI (Building Industry Consulting Service International) for fiber optic installation.

### 1.2.8 Torque:

Contractor shall ensure that all fasteners are torqued properly per the manufacturer's instructions.

Contractor shall provide a torque calibration report three (3) Business Days prior to securing fasteners for Owner review of the results. A calibration report shall be provided to the Owner that lists gage numbers, dial numbers, and torque wrench numbers. All torque and tensioning equipment calibration dates shall be recorded indicating which pieces of equipment they were used on. This may be documented on the torque sheets for that equipment.

Contractor shall compile a torque chart for the Project that includes the required torque settings for all fasteners and electrical terminations.

Torque marks shall be provided on all structural fasteners and electrical terminations to indicate torque has been verified.

If 5% or greater of fasteners are found to be not torqued properly, Contractor shall recheck and retorque all fasteners associated with that piece of equipment. In all cases, Owner has the right to verify torque after fasteners have been secured.

### 1.2.9 Calibration:

All Inspections and Testing shall be performed by using appropriate Measuring and Test Equipment (M&TE) that are calibrated by accredited (preferably ISO-17025) and approved laboratories with the calibration is traceable to the National Institute Standards and Technology (NIST) or equivalent.

### 1.2.10 Nonconforming Materials (NCMs):

All NCMs shall be promptly tagged and segregated for documented dispositions such Repair, Reword, Scrap or Use-as-is. Significant NCMs shall be reported to the owner before final disposition.

### 1.2.11 Corrective and Preventive Actions (CAPAs):

Contractor shall assure that any significant quality concern related to design, procurement, QMS, construction or commissioning are promptly addressed CAPAPs that include Extent of Condition, Direct Cause, Contributing Causes and Root Cause. The Corrective Actions shall be taken on a timely basis and their effectiveness verified prior to closure. All Corrective Actions shall also be evaluated for Preventive Actions (lessons learned).

### 1.2.12 Records Retentions

. The contractor shall assure that records and documents are indexed, filed, and maintained in facilities that provide suitable environment to minimize deterioration, damages and prevent loss from flood, fire or theft. Contactor shall commit to the specified period of retention of various records.

### 1.2.13 Continual Improvement Program:

The Plan shall include a continuous improvement program. All improvements shall be logged as lessons learned and made available to the Owner.

### 1.2.14 Audits:

All the project activities shall be periodically audited by qualified internal quality auditors. Audit Reports shall be provided to the owner for their review and comments.

### 1.2.15 Reclamation and Cleanup:

Contractor shall develop and implement a reclamation and cleanup plan subject to Owners approval.

### 1.2.16 Turnover Package:

Contractor shall develop an outline of the turnover documents and job book and submit to the Owner for approval. The documents and the job book shall be provided within a reasonable timeframe after Project completion and shall include 3 hardcopies and an electronic copy of all documents and the job book.

### 1.2.17 End of Warranty (EOW) Inspections and Claims Process:

A joint EOW inspection shall be conducted involving the Contractor and Owner and/or Owners representative at least 3 months prior to the end of the warranty. Deficiencies shall be noted and promptly corrected by the Contractor. Uncorrected deficiencies shall be addressed by an EOW claims process.

**APPENDIX G1**
**ATTACHMENT 01**
**EXHIBIT 09**

# CAD STANDARDS AND DRAFTING PROCEDURES

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

# Portland General Electric
# Power Supply Engineering Services (PSES)


# CAD Standards and Drafting Procedures
# Civil / Electrical / Mechanical / Survey

## DOCUMENT REVISION RECORD

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## CAD Standards and Procedures Issuing Department

Power Supply Engineering Services is responsible for revising, maintaining, and distributing the CAD Standards and Procedure documentation. Comments and suggestions are welcome. Additional copies may be obtained from:


Portland General Electric
Power Supply Engineering Services
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PGE employees can view or download this document from the company's SharePoint web page.
https://sharepoint/pses/PSES%20CAD%20Standards/Forms/AllItems.aspx
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Technical questions regarding the contents of this document may be directed to the discipline lead as shown above.
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# I. OVERVIEW

## 1. Introduction

This document outlines how to set up and produce CAD drawings of new and as-built construction drawings. For purposes of this document, image files refer to the PDF format.

The purpose of this document is to serve as a standard for producing CAD drawings and image files that document new construction projects and As-Built conditions for construction projects. The guidelines are intended to ensure consistency and to maximize both short- and long-term usability of construction documentation.

Layer Guidelines have been developed by PGE Power Supply Engineering Services (PSES). The layering standard outlined herein was derived from the United States National CAD Standard (NCS) – Version 5. For additional detail beyond what is outlined herein, please refer to the NCS for guidance.

# II. GLOSSARY OF TERMS

The following is a list of terms and verbiage used in this document:

## 1. Drawing Terminology

**Border**: The box outline that contains the drawing elements and details. The border is specific to the drawing size (ANSI and ARCH sizes). See Figure 2.1.

**Title Block**: Refers to the text portion of the drawing details. The title block information will include facility name, drawing title, drawing number, sheet number, revision, etc. See Figure 2.2 thru 2.4.

**Layout Tabs**: Refers to the Paper Space sheets in an AutoCAD drawing, which are similar to worksheets in an Excel workbook. See Figure 2.5

**Figure 2.1 Drawing Border**

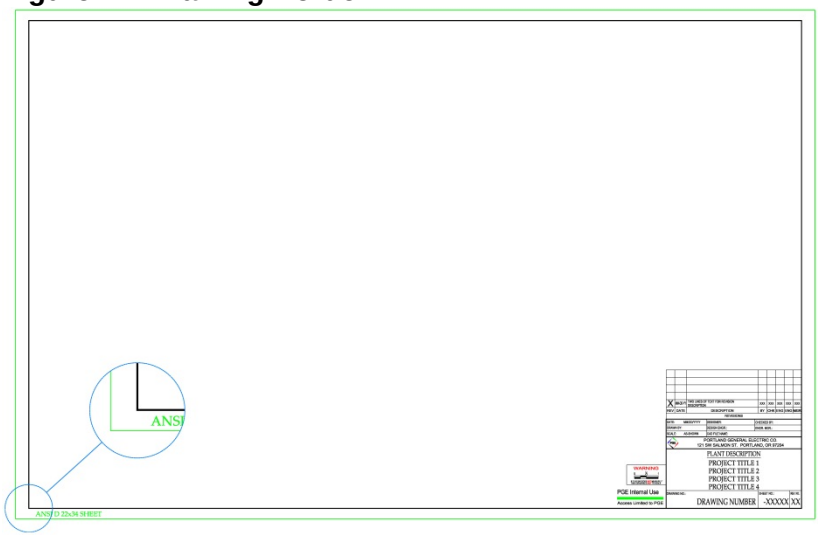



**Figure 2.2 Title Block**

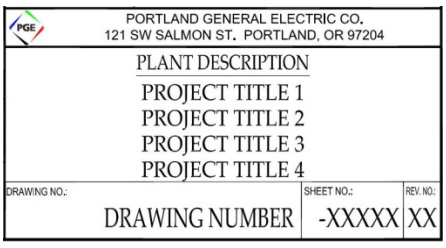



**Figure 2.3 Title Block Components**

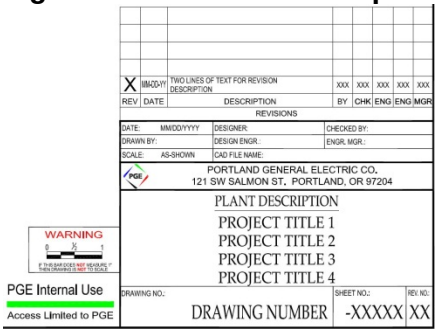


**Figure 2.4 Title Block Help Details**

This page is included in CAD template.

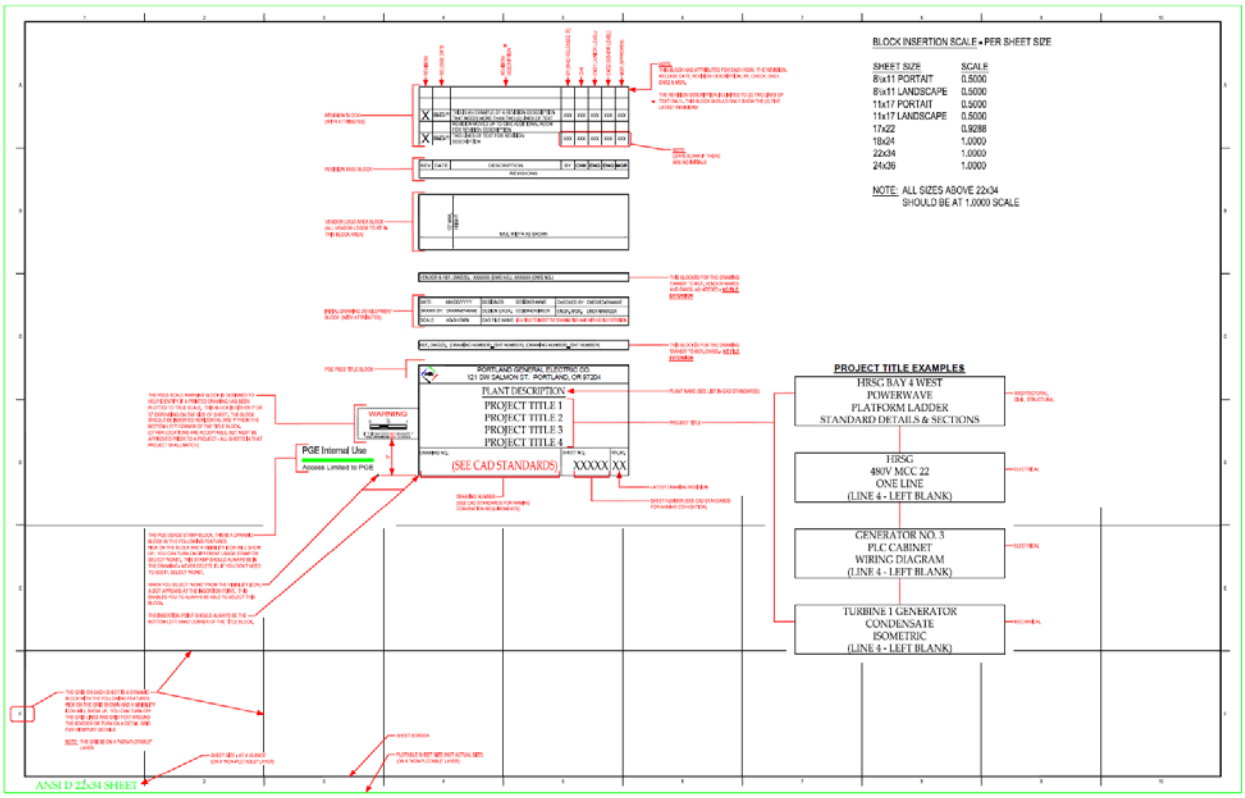
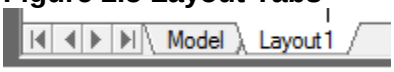



**Figure 2.5 Layout Tabs**



# III. DEPARTMENT TERMINOLOGY

## 1. PSES Department Terminology

**Engineering**: The group responsible for the development or change in drawings that represent a company facility.

**Design / Drafting Services**: The individual or group that is responsible for CAD work, Drawing Control, Auditing, Field Verifying and publication of the drawing files.

**Consultant / Vendor**: An outside firm or individual hired on a contract basis to perform engineering, design, and/or drafting services.

**Issuing a Drawing**: The process of releasing documentation for Bid, Construction, As-Built Record, Record Change, or reference.

**Issued Drawing(s)**: A signed approved drawing that is issued for the purpose stated in the revision description.

**Bid Drawing**: A drawing that represents a design concept and is issued to a Consultant / Vendor in an RFP.

**NERC Drawing (North American Electric Reliability Corporation):** A drawing created essential to the reliable operation of Critical Assets and physical security.

**FERC Drawing (Federal Energy Regulatory Commission):** A drawing created for the purpose of project licensing.

**Construction Drawing**: A drawing that represents design, and is used to perform construction work.

**As-Built Record Drawing**: A Drawing that reflects the actual built conditions as represented by documentation received from the field.

**Record Change Drawing**: Used to issue drawing updates for non-field related changes.

**Superseded**: When a drawing is incorporated into another drawing, it is superseded by the drawing into which it is incorporated. When a drawing is superseded, it is then deleted from the issued drawing list.

**Void**: When a drawing is no longer valid (the equipment and/or structure is gone), it is then voided and marked as such. When a drawing is voided, it is deleted from the issued drawing list. Note that once a drawing is voided, the drawing number cannot be reused.

## 2. PSES Acronym Definitions

**DCP (Detailed Construction Package)**: A document which contains written detailed work instructions for a project. This document usually has drawings associated with it.

**ABR (As Built Request)**: A request for As-Built drawings (see As-Built Record Drawing).

**IFB (Issued for Bid)**: A drawing or set of drawings distributed for the purpose of bidding and communicating project scope. These drawings are not for construction purposes (see Bid Drawing).

**IFC (Issued for Construction)**: A drawing or set of drawings distributed for the purpose of project construction (see Construction Drawing).

# IV. FACILITY / PLANT DESCRIPTIONS

## 1. Facility / Plant Descriptions

Refer to Table 10.1 for the four-digit Facility / Plant Designation.

The following list represents PGE facilities maintained by PSES. These names shall appear in the first line of the Title Block (Plant Descriptions) for projects. Refer to Figure 2.2 for a Title Block example.

**BEAVER GENERATING PLANT**

BEAVER 230 KV SWITCHYARD (Line 2)

**PORT OF ST. HELENS (POSH)** ** (Line 1) Shared with Port Westward

**BIGLOW CANYON WIND FARM**

**BOARDMAN COAL PLANT**

**CARTY GENERATING PLANT 1**

**GRASSLAND SUBSTATION**

**CLACKAMAS RIVER HYDROELECTRIC PROJECT**

FARADAY DEVELOPMENT
FARADAY PLANT

NORTH FORK DEVELOPMENT
NORTH FORK PLANT

RIVER MILL DEVELOPMENT
RIVER MILL PLANT

**OAK GROVE DEVELOPMENT**

FROG LAKE DAM

HARRIET LAKE DAM
HARRIETT LAKE POWERHOUSE
HARRIETT LAKE SUBSTATION ***

OAK GROVE PLANT
OAK GROVE SWITCHYARD

STONE CREEK POWERHOUSE (EWEB) *
STONE CREEK SUBSTATION (EWEB) *

TIMOTHY LAKE DAM
TIMOTHY LAKE POWERHOUSE

**COYOTE SPRINGS PLANT 1**

**COYOTE SPRINGS PLANT 2 ***

**KELSO-BEAVER PIPELINE**

- BEAVER METERING STATION
- PORT WESTWARD 1 GAS YARD
- PORT WESTWARD 2 GAS YARD
- WALNUT ACRES

**PELTON-ROUND BUTTE HYDROELECTRIC PROJECT**

- ROUND BUTTE DEVELOPMENT
- ROUND BUTTE DAM
- ROUND BUTTE PLANT
- PELTON DEVELOPMENT
- PELTON PLANT
- PELTON RE-REGULATING DAM

**PORTLAND HYDRO PROJECT 1**

**PORTLAND HYDRO PROJECT 2**

**PORT WESTWARD PLANT 1**

**PORT WESTWARD PLANT 2**

**PORT WESTWARD SWITCHYARD**

**TROJAN NUCLEAR PLANT**

**TUCANNON RIVER WIND FARM**

- MULLAN SUBSTATION

**WILLAMETTE FALLS PROJECT**

- T.W. SULLIVAN PLANT

* PGE OPERATED, MAINTAINED BY OTHERS.
** OWNED BY PORT OF ST. HELENS, DRAWINGS ON FILE WITH PGE.
*** PGE OWNED/MAINTAINED EQUIPMENT OWNED/OPERATED BY PGE AS DESIGNATED BY INTERCONNECT AGREEMENT.

# V. Drawing Practices

**Scope**

This section details various drawing practices which are required to provide uniformity and ease of use for drawings.

## 1. Quality and Neatness

All drawings done for PSES must be done neatly and accurately. They shall follow good drawing practices, and clearly illustrate the necessary details for the work to be performed.

Some practices to abide by include:

- Object lines should meet at corners.
  - Use OSNAP settings
  - Use FILLET
- Dimension extension lines shall not touch objects (this distance is preset in the dimensions style – not to be changed). The node of the extension lines shall be snapped to objects.
- All drawing content shall be inside the paper space border.
- Objects in Model Space shall be drawn full scale (1:1) to the actual dimension.
  - Do not “free pick” object lines
  - Use ORTHO
- Use appropriate text justifications when placing or modifying text. (Left Justified)
- Standard layers are to be used to depict line weights, linetypes, and color. All AutoCAD entities are to be “ByLayer,” and are not to be modified individually changing the linetype scale, color or linetype by entity.
- The drawing units are to be Architectural, with precision of 1/32”, and the insertion set to “inches.” An exception to this is the Civil Survey template. The units of the Survey file are to remain decimal feet.
- Lineweight Settings (LWEIGHT) shall be ByLayer and not displayed (unchecked).

The remaining sections in this document describe guidelines and requirements necessary to maintain a professional drawing appearance.

## 2. File Format and Setup

Each new drawing will utilize the PSES standard template (dwt.).

## 3. FERC

All FERC drawings shall use the approved FERC drawing border provided by PSES. No consultant logo shall appear on the FERC drawings.

## 4. Drawing Scale

All PSES engineering drawings shall be drawn in real–world dimensions (full scale; 1:1) in Modelspace. In some instances it is necessary to plot out the drawing in a manner that will allow users to scale off dimensions from the paper copy. Care should be taken when doing this to avoid confusion when copies or reductions of the original plot are made. The borders shall be inserted in Paperspace (layout) at a coordinate of 0,0 and at full scale (1:1).

## 5. Revision Block

An area to record drawing revisions has been provided above each title block. Any changes made to a drawing must be recorded in this area by inserting the revision block. The full block library can be made available, if requested.

The attributed revision block has been designed to be inserted into a new or existing drawing and is required to be on all PSES engineering CAD files. PSES blocks are not to be modified, burst, exploded, or replaced with floating single line text.

Table 5.1 is a list of the tag name/attributes in the order that they appear when you edit the revision:

**Table 5.1 — Revision Block Tag Names**

| Tag: | Prompt: | Default Value / Format: |
|---|---|---|
| REV-SP1 | REVISION NUMBER (SPACE 1) | X |
| REV-D-SP1 | REVISION DATE (SPACE 1) | MM-DD-YY |
| REV-DSCPTN-SP1-L1 | REVISION DESCRIPTION LINE 1 (SPACE 1) | TWO LINES OF TEXT |
| REV-DSCPTN-SP1-L2 | REVISION DESCRIPTION LINE 2 (SPACE 1) | FOR DESCRIPTION |
| REV-BY-SP1 | REVISED BY (SPACE 1) | XXX |
| REV-CHK-SP1 | CHECKED BY (SPACE 1) | XXX |
| REV-ENG1-SP1 | ENGINEER 1 (SPACE 1) | XXX |
| REV-ENG2-SP1 | ENGINEER 2 (SPACE 1) | XXX |
| REV-MGR-SP1 | MANAGER (SPACE 1) | XXX |

Table 5.1 represents one of the five groups of revision tags.

### 5.1. Revision Block Initials

Revision block initials shall use the following format:

- Initials shall be a maximum three-letters ALL CAPS. Example: BDC
- Vendors and contractors shall provide a list of project staff and their initials
- Vendors and contractors shall follow the format shown in Table 5.1.

The CAD user must use the revision block as provided. This information will then be used in the drawing management system to manage document control.

### 5.2. Drawing Approval (New and Revised Drawings)

When a drawing is created or revised, it requires specific levels of approval. If a drawing doesn't have the appropriate approval signatures, it cannot be issued as final.

Tables 5.2 and 5.3 list the approval block fields and the required signature levels.

The following people shall perform approval for design work done in-house:

**Table 5.2 — Revision Block In-House Design Work Approval**

| Prompt: | Value: |
|---|---|
| BY: | Designer / CAD Tech. |
| CHK: | Appointed Checker (by Manager) |
| ENGR 1: | Design Engineer |
| ENGR 2: | Review Engineer (Both spaces required for Intern or EIT) |
| MGR: | PSES Engineering Manager / Supervisor (or appointed person) |

The following people shall perform approval for design work done by outside consultants:

**Table 5.3 — Revision Block Design Work Approval**

| Prompt: | Value: |
|---|---|
| BY: | Consulting Firm Designer or Drafter |
| CHK: | Consulting Firm Appointed Checker (by Manager) |
| ENGR 1: | Consulting Firm Design Engineer |
| ENGR 2: | Consulting Firm Review Engineer |
| MGR: | Consulting Firm Engineering Manager |

There must be at least a transmittal with an Approved and Signed Document Review Stamp sent with ALL design work done by outside consultants.

## 6. Lock/ Unlock Viewports

Locking viewports prevents the scale and scope of the viewports from changing. All viewports shall be locked.

**Exiting a Drawing**

When exiting a drawing, use Exiting Procedure 6.1 to insure that the drawing is in a clean state for other users and to reduce the drawing file size, thus saving disk space.

**6.1. Exiting Procedure**

Check the drawing to ensure it has the following settings:

- Paper Space layout is current. The drawing border is displayed.
- Zoom Extents to display all drawing entities.
- Purge drawing of all unused and unreferenced blocks, layers, etc.
- The reference drawing file attachment paths have been removed (No Path).
- All entities outside of the border shall be erased.
- OVERKILL removes objects whose geometry is redundant. (Express Tools)
- Repeat this process to verify all unwanted entities have been deleted.

## 7. Borders

**Scope**

This subsection is used to standardize the border format which includes consistent drawing areas, revision block layout, and a title block for PSES engineering drawings. Multiple drawing sizes are provided to accommodate various needs. All new or modified drawings shall be created on the size listed in Table 5.4 below. All existing drawings not currently on this previous stated size border shall be updated. Approval must be obtained from PSES for any exceptions. Modifications may not be made to standard PSES borders or revision blocks.

**Table 5.4 — Discipline Drawing Size and Type**

| Type | Drawing Size |
|---|---|
| Mechanical ISO | ANSI C (Max) or ANSI B (Min) |
| Electrical CWD | ANSI B |
| Mechanical & Electrical: Plans, Sections, Details & P&ID, Wiring Diagrams, Wiring Layouts | ANSI D |
| All other disciplines | Arch. D |

Any consultant's logo or insignia placed on PSES's drawing shall be agreed upon on a case by case basis.

**General**

All PSES engineering drawings shall be drawn full scale (1:1) in Model Space. The borders shall be inserted at full scale (1:1) in Paper Space (layout). During the creation of a new drawing or the editing of an existing drawing, the PSES standard borders shall be used. The borders contain standard layout of the attributed title block.

The full block library, including the current borders, revision block and title block can be made available if requested.

### 7.1. Border Insertion Point

Borders shall be inserted in Paper Space (layout) at a coordinate of 0.0 and at full scale (1:1). This configuration will set up the drawing area to conform to PSES standard printing and plotting capabilities.

# VI. Graphics Standards

## 1. Sheet Layout

**Figure 6.1 — Sheet Layout**

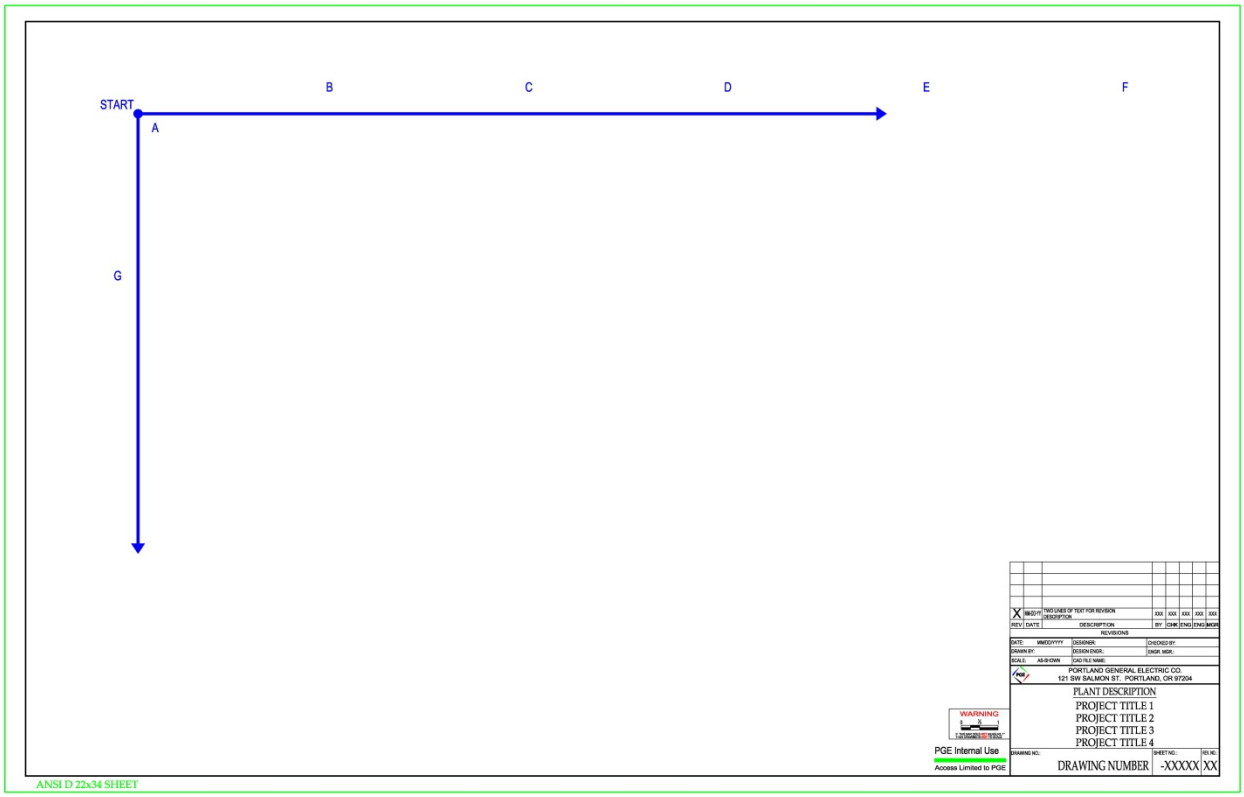
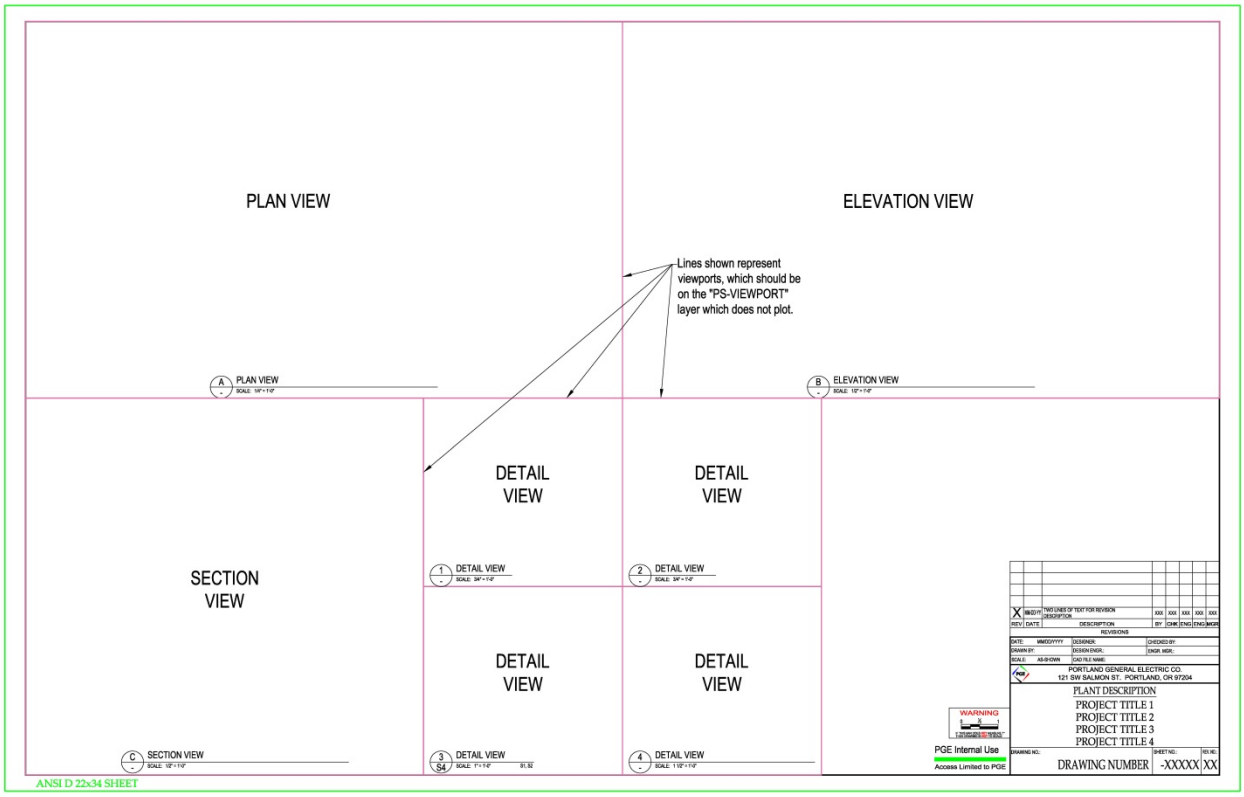
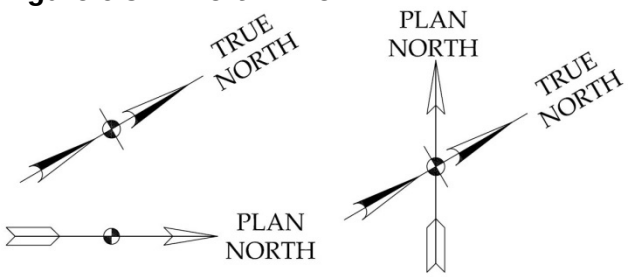


**Figure 6.2 — Sheet Detail Layout**




## 2. North Arrow

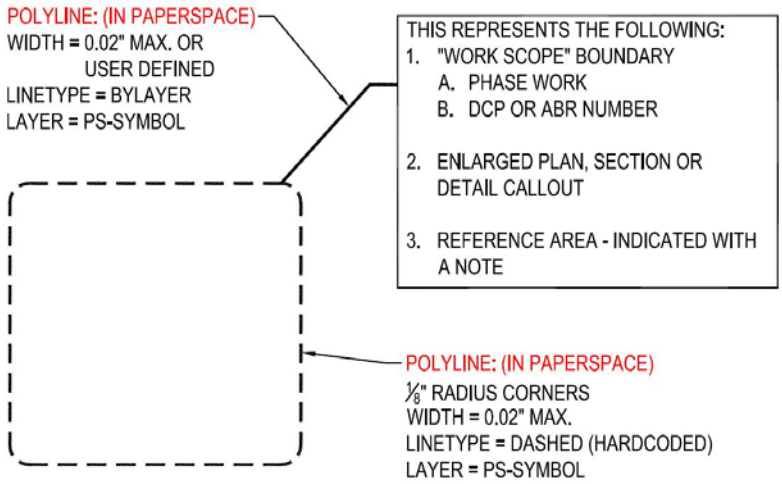
**Figure 6.3 — North Arrow**



### 3. Project / Work Boundary

A boundary shall be placed on the drawing to represent the Project location or "Work Scope" limits.

**Figure 6.4 — Project / Work Boundary**




### 4. Labels

**Figure 6.5 — Sheet Identification**

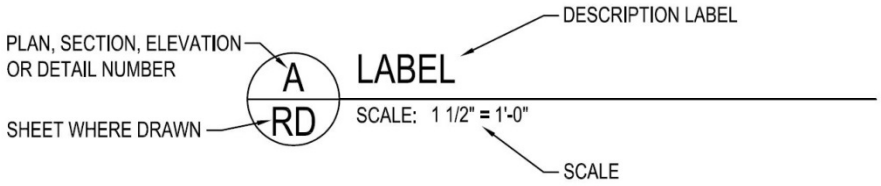
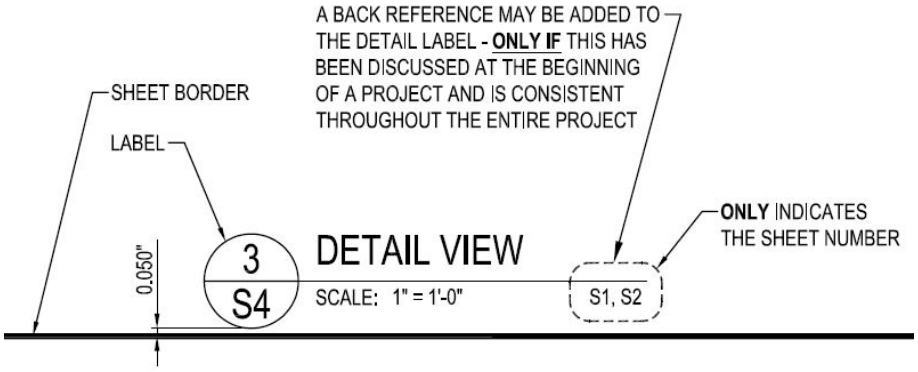


**Figure 6.6 — Sheet Identification**



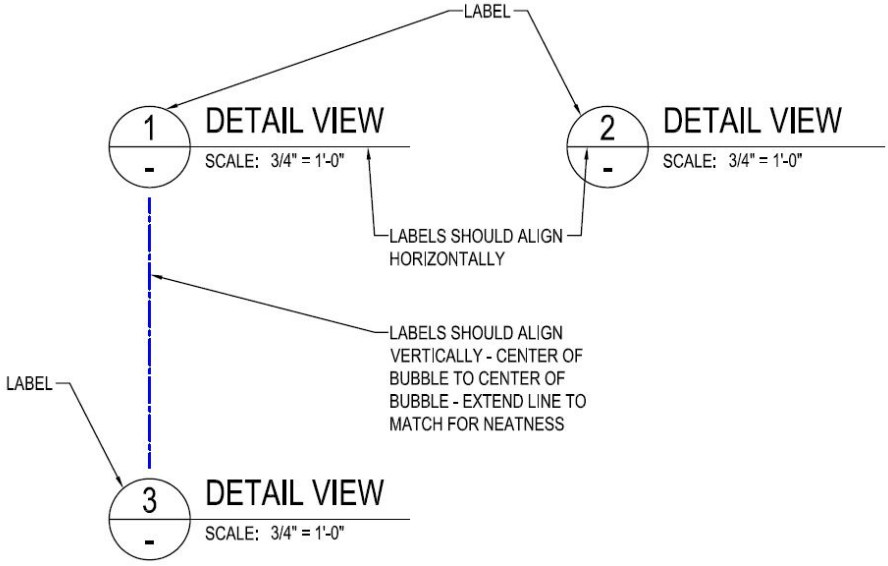
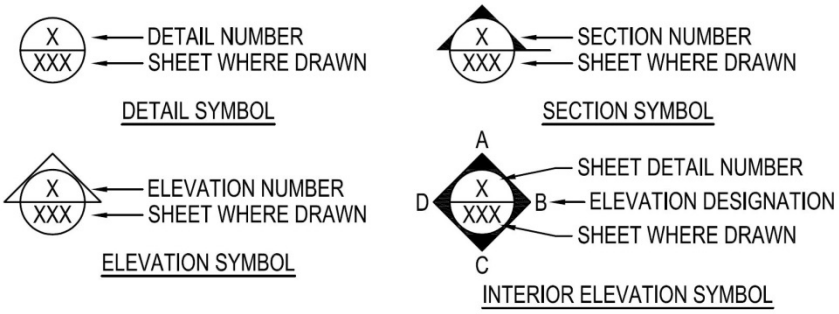
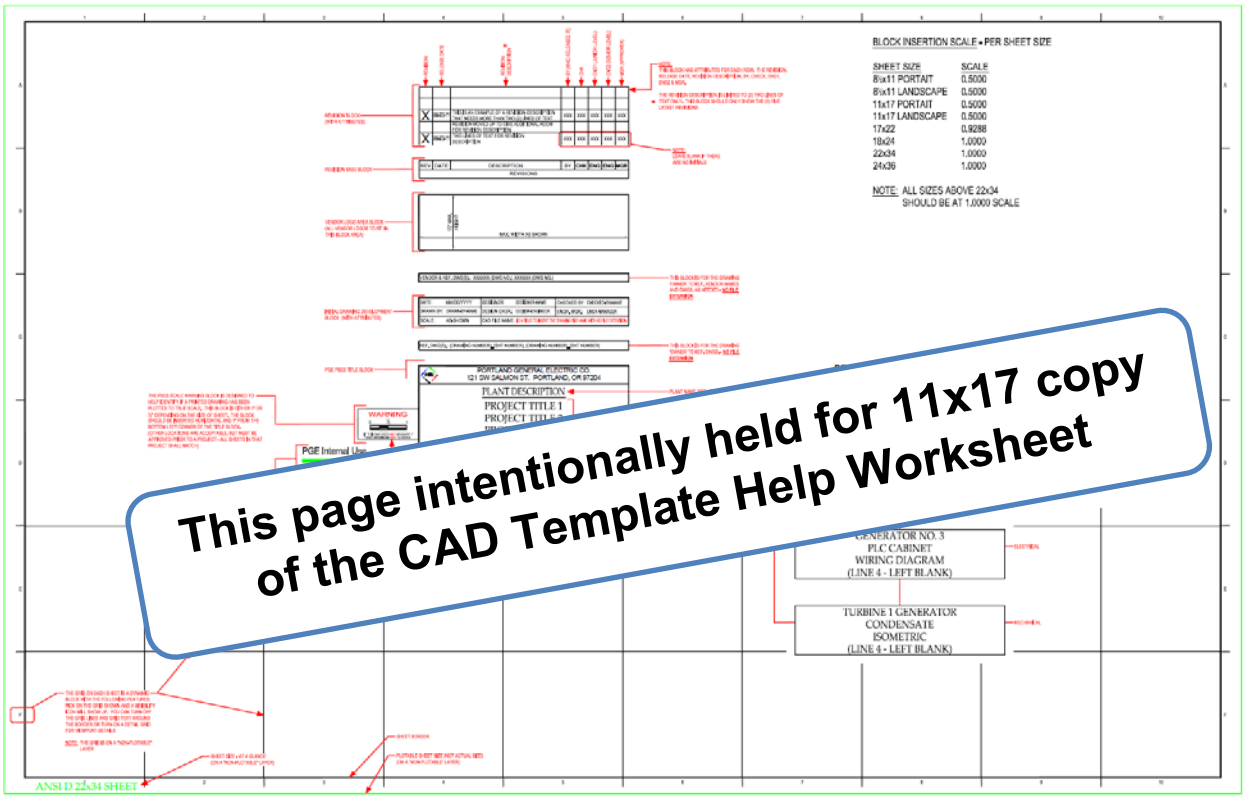




**Figure 6.7 — Sections and Details**




BLOCK INSERTION SCALE = PER SHEET SIZE
SHEET SIZE SCALE
8½x11 PORTAIT 0.5000
8½x11 LANDSCAPE 0.5000
11x17 PORTAIT 0.5000
11x17 LANDSCAPE 0.5000
17x22 0.9288
18x24 1.0000
22x34 1.0000
24x36 1.0000
NOTE: ALL SIZES ABOVE 22x34 SHOULD BE AT 1.0000 SCALE
PORTLAND GENERAL ELECTRIC CO.
121 SW SALMON ST., PORTLAND, OR 97204
PLANT DESCRIPTION
PROJECT TITLE 1
PROJECT TITLE 2
WARNING
PGE Internal Use
GENERATOR NO. 3
PLC CABINET
WIRING DIAGRAM
(LINE 4 - LEFT BLANK)
TURBINE 1 GENERATOR
CONDENSATE
ISOMETRIC
(LINE 4 - LEFT BLANK)
ANSI D 22x34 SHEET
This page intentionally held for 11x17 copy of the CAD Template Help Worksheet

# VII. CAD DRAWING STANDARDS

Standard "out-of-the-box" linetypes, shape files, and fonts shall be used. If custom linetypes, shape files, and fonts are used, the non-standard files shall be included with the drawing deliverables.

## 1. Drawing Scale, Units, and Tolerances

All CAD drawing models shall be drafted at full scale (1:1) in architectural units (inches), such that one drawing unit equals one inch. All Survey CAD drawings shall be decimal (feet) units.

## 2. Fonts & Text Styles

PSES has created several text styles with different fonts. These text styles are provided within the PSES template file. The use of font 'Arial.shx' for most applications is desirable. Dimensions, labels and notes shall not be less than 0.100" height on printed drawings. All text, regardless of scale, shall visually appear to be the same height on printed drawings.

### 2.1. Text Style, Font, and Special Characters

This standard specifies the font and the special character codes for symbols and fractions for drawings prepared in AutoCAD.

#### 2.1.1. Text Style and Standard Font

All PSES drawing text shall use the "Arial.ttf" font as supplied by Autodesk. The "Arial.ttf" font contains all standard keyboard characters, fractions, and other special characters

The following are default text styles set up within the PSES AutoCAD Template:

Text Style Name: **PSES-STD**
Style: PSES-STD (annotative)
Font Name: Arial.ttf
Font Style: Regular
Paper Text Height: 0.10 inch (may show 3/32")
Effects: Width Factor: 0.80 inch
Oblique Angle: 0.00

Text Style Name: **PSES-STD-TB** (TB = Title Block)
Style: PSES-STD-TB (non-annotative)
Font Name: Arial.ttf
Font Style: Regular
Height: 0.00 inch
Effects: Width Factor: 1.00 inch
Oblique Angle: 0.00

Text Style Name: **PALATINO-TB** (TB = Title Block)
Style: PALATINO-TB (non-annotative)
Font Name: Palatino Linotype.ttf
Font Style: Regular
Height: 3/16 inch
Effects: Width Factor: 1.00 inch
Oblique Angle: 0.00

Text Style Name: **USAGE** (PGE USAGE BLOCK ONLY)
Style: USAGE (non-annotative)
Font Name: @Arial Unicode MS.ttf
Font Style: Regular
Height: 3/16 inch
Effects: Width Factor: 1.00 inch
Oblique Angle: 0.00

**2.1.2. Text: Special Character Codes: Single-line (Dtext, Text) or Multi-line (Mtext)**

Special Characters may be used by including control information, or Control Codes (%% codes) in the text string. Refer to Table 7.1 for special character codes and common symbols.

**Table 7.1 — Commonly Used Special Character Codes**

| Symbol / Function | Code | Notes |
|---|---|---|
| ° Degrees | %%d | |
| Ø Diameter / Phase | %%c | |
| ± Plus / Minus | %%p | |
| Underline / Underscore | %%u | At beginning & end |
| Overline / Overscore | %%o | At beginning & end |
| Ω Ohm | %%199 | |
| µ MicroAmp | Alt + 0181 | |

### 2.2. Multiline Text: Special Characters, Symbols and Unicode strings

**MTEXT stacked text styles (Fractions)**
The automatic stacking feature applies only to numeric characters immediately before and after the slash, this is done automatically, set to default diagonally stacked, 70%, centered.

To save your changes and exit the editor, use one of the following methods:

- click OK on the toolbar
- click in the drawing outside the editor
- press CTRL+ENTER

## 3. Blocks

PSES shall provide a digital block library. Blocks shall not be modified from their original state. Inform PSES of any issues with provided blocks. Symbology blocks not provided shall follow American National Standards Institute (ANSI), American Society of Mechanical Engineers (ASME), and Institute of Electrical and Electronics Engineers (IEEE) standards.

### 3.1. Development

All line and object entities that reside in blocks are to be developed on layer 0, with the color and line type attributes set to Bylayer. Refer to Layering Standards in Section XI for more information.

Blocks shall be created with an insertion point at a position where it will be useful in snapping a block to neighboring objects.
The use of dynamic blocks is allowed.

### 3.2. Insertion Point

The insertion point is the reference point for subsequent insertions of the block. It is also the point about which the block can be rotated during insertion. A typical insertion point is the center of the block or its lower left corner.

## 4. Title Blocks

Each CAD file created shall have only one title block. Text styles shall not be modified from their original settings. The title block shall be located in the lower right hand corner of the drawing.

**5. Modelspace and Paperspace (Sheet) Layout**

PSES utilizes Modelspace and Paperspace for drawing documentation. Sheet drawings with multiple tabs/sheet layouts are **not allowed**. Each sheet drawing shall be an individual file. Refer to section VIII for CAD drawing setup and conventions

**6. Attributes (Colors, Line Types, Pen Weight)**

Layer properties shown in the Standard Layer Listing (Refer to Section XI, Tables 11.3 through 11.7) define specific attributes that have been assigned by PSES according to the following categories: color, pen weight, and line type. Attributes that have not been pre-defined by PSES may be assigned at the discretion of the user.

**7. Colors**

PSES uses specific colors for the layers and annotation layers most often used to assist documentation. The color assignment of these layers can be found in the Standard Layer Listing of this document. These color assignments match to PSES plotting CTB file.

As a general rule for all projects, drawing entities shall assume the color property of the layer on which they reside. This means that the color of individual entities shall be assigned “By Layer” as opposed to “By Entity”. Entities that have been translated from other systems may fail to meet this requirement.

**8. Line Types**

The default line type of each layer is typically “Continuous” unless otherwise specified.

As a general rule for all projects, drawing entities shall assume the line type property of the layer on which they reside. This means that the line type of individual entities shall be assigned “By Layer” as opposed to “By Entity”. Entities that have been translated from other systems may fail to meet this requirement.

**9. Pen Weight**

The pen weight for each entity (not including blocks) will typically be controlled by the layer on which it resides. However, PSES recognizes that an entity might need to have a width hard-set by the user (polyline width) and therefore may be assigned at the discretion of the user.

**10. Raster/Image Hybrid Files**

Raster Image files shall be provided in Tag Image File Format (*.tif, *.tiff) format. Other formats will not be acceptable. Vectorized files are preferred. Raster images shall only be linked to drawings using CAD software. The company-preferred raster/vector editing software is Raster Design by Autodesk.

## 11. Leaders

All leaders (QLEADER or LEADER) shall be associative, and drawn in the dimension style: PSES-STD or discipline specific. Leaders should be drawn with no more than three points (i.e., two line segments). However, this rule does have exceptions and should be limited in use. Leaders associated to text are placed on the same layer as the text.

## 12. Associative Dimensioning

Associative dimensioning will be used on all new and modified drawings. This will ensure that the dimensioning is consistent and dynamic throughout the drawing.

Dimensioning shall be placed on a Dim layer, color Bylayer. Refer to Section XI, Tables 11.3 through 11.7 for discipline layers.

No modification of existing dim styles is permitted.
The dim style STANDARD is not one that should be used or tailored to fit the scale of the drawing.

### 12.1. Associative Dimensioning Guidelines

Guidelines for dimensioning variables are outlined below:

- Layer: Dim (Refer to Section XI for Standard Layer Listing)
- Color: Bylayer (Refer to Section XI for Standard Layer Listing)
- Linetype: Bylayer
- Dimension Style name (refer to Figure 7.1):

## 12.2. Associative Dimension Settings: PSES-STD

**Dimension Style Manager > Modify Dimension Style: PSES-STD**

**Lines:**

Dimension Lines:
Color: ByLayer
Linetype: ByLayer
Lineweight: ByLayer
Extension Lines
Color: ByLayer
Linetype ext line 1: ByLayer
Linetype ext line 2: ByLayer
Lineweight: ByLayer
Extend beyond dim lines: 1/32”
Offset from Origin: 1/16”

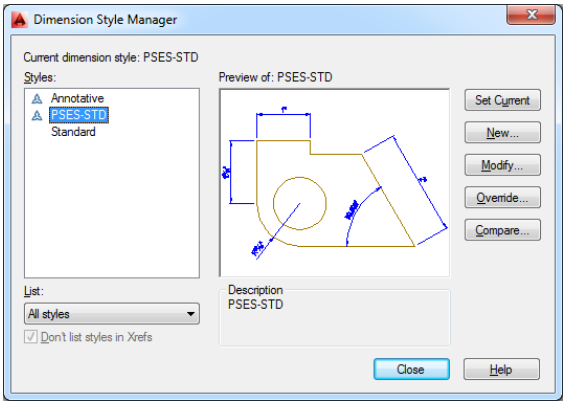
**Symbols and Arrows:**

Arrowheads:
Arrow size: 3/32”
Center marks:
⊙ Line 3/64”
Dimension Break
Break Size: 5/64”

**Text**:

Text appearance:
Text style: PSES-STD
Text color: ByLayer
Text height: (*set by Text Style*)
Text placement:
Vertical: Above
Horizontal: Centered
View Direction: Left-to-right
Offset from dim line: 1/32”
Text alignment:
⊙ Aligned with dimension line

Figure 7.1 Dimension Style Manager




**Fit:**

Fit options:
⊙ Either text or arrows (best fit)
Text placement:
⊙ Beside the dimension line
Scale for dimension features:
☑ Annotative
Fine tuning:
☑ Draw dim line between ext lines

**Primary units:**

Unit format: Architectural
Precision: 1/16”
Fraction format: Diagonal
Zero suppression:
☑ 0 feet
Angular dimensions:
Precision: 0.000
Zero suppression:
☑ Trailing

- Do not explode or stick build associative dimensioning.
- System Variable DIMASO = On: Turns associative dimension on.
- System Variable DIMASSOC = 1. Refer to Table 7.2

**Table 7.2 — Controls the associativity of dimension objects and whether dimensions are exploded.**

| | |
|---|---|
| 0 | Creates exploded dimensions. There is no association between the various elements of the dimension. The lines, arcs, arrowheads, and text of a dimension are drawn as separate objects. |
| 1 | Creates non-associative dimension objects. The elements of the dimension are formed into a single object. If one of the definition points of the dimension moves, the dimension is updated. |
| 2 | Creates associative dimension objects. The elements of the dimension are formed into a single object, and one or more definition points of the dimension are coupled with association points on geometric objects. If the association point on the geometric object moves, the dimension location, orientation, and value are updated. |

DIMASSOC is not stored in a dimension style.

Dimension values shall not be over-written. However, this rule does have exceptions and should be limited in use. The exception to this is the addition of a note or text string added within the dimension. (Text editor)

# VIII. CAD DRAWING DELIVERABLES

## 1. Electronic File Format Deliverables

All CAD drawings for construction projects, new and as-built, shall be saved in AutoCAD format. The following file formats shall be provided in the drawing deliverables:

- Drawing: AutoCAD Drawing (*.dwg)
- 3D models :AutoCAD Plant 3D (Native *.dwg) Navisworks (*.nwd), AutoCAD Drawing (*.dwg), Autodesk Design Web Format (DWF)
- Raster image files: Tag Image File Format (*.tif, *.tiff)
- Adobe Portable Document Format (*.pdf)

All drawing deliverables (legacy and new) shall be updated to include the current PSES title block, border and revision block. The revision block will include at minimum the current revision and one previous revision. If a legacy drawing contains unresolved job or non-record revision information that cannot be resolved during the current revision, the previous open revisions will be included in the revision block.

### 1.2 Electronic Files

All drawing deliverables in electronic form shall be maintained in the same respective discipline folders as described in Drawing Storage. Refer to Section X, Drawing storage.

XREF drawings: The parent drawing and all XREF (child drawing) must be included in the submittal of drawings. The XREF path shall be removed or set to “No Path” in the parent (master) file. All drawing deliverables shall include both a bound and unbound parent digital drawing file.

All 3D models shall be exported and saved as an individual AutoCAD Drawing (*.dwg) format. (Exception AutoCAD Plant 3D shall be saved as native file in Plant 3D Project Directory, Plant 3D Project Directory shall be a deliverable to PGE or Client with all Files, Spec’s, Spec Libraries, Blocks and Specialty items.) Provide one combined Navisworks (*.nwd) file with all model links listed in the overall model and/or Autodesk Design Web Format (DWF) with all model links listed.

Each drawing shall have a corresponding 1:1 (full size) record document in Adobe PDF format in addition to the CAD drawing files. The PDF shall have sufficient detail to recreate 100% of the information contained in the hard copy original, without creating an excessively large digital file.

## 2. XREF Archiving

Prior to returning the files to PSES, the files must be prepared for storage. Drawings that contain XREFs may be archived by one of the following methods:

- Store the XREF drawings along with the final drawing. NO PATH must exist.
- Bind the XREF drawings to the final drawing.

**Store:**

Storing an XREF drawing along with the final drawing requires that the drawings always remain together. This leaves the parent-child relationships created intact.

**Bind:**

Bind XREFs to the final drawing to prevent unintentional updating of archived drawings by later changes to referenced drawings and reduce or eliminate concerns of attachments being changed.

Binding an XREF to a drawing makes the XREF a permanent part of the drawing and no longer an externally referenced file. You can bind the entire database of the XREF drawing, including all its xref-dependent named objects (blocks, dimension styles, layers, linetypes, and text styles), by using the XREF Bind option.

XREF files that have been bound to Parent drawings can be extracted from the Parent file to re-create the XREF condition if future edits are needed.

Binding xrefs to a drawing is also an easy way to send a drawing to reviewers. Rather than sending a master drawing plus each of the drawings it references, you can use the Bind option to merge the XREF into the master drawing.

Note: You cannot bind XREFs that contain proxy objects.

# IX. CAD DRAWING SETUP AND CONVENTIONS

## 1. Modelspace / Paperspace

### 1.1. Drawing Division

This section describes which entities reside in Modelspace versus Paperspace, and the procedure for setting up the appropriate drawing scale, size, border, and viewports. Standard defaults and options are automatically set in the template files.

CAD drawings shall utilize Modelspace and Paperspace functions. Refer to Figure 9.1 and Table 9.1 for examples of Modelspace and Paperspace.

**Modelspace** (Model tab) is the working environment for all dimensional objects. All objects are drawn 1:1 true scale; this includes 2D and 3D objects.

**Paperspace** (Layout tab) is the sheet drawing space used for plotting and viewing as a sheet drawing. The sheet drawing contains the 1:1 border block, title block, bar scale, general sheet notes, keyed notes, viewport of Modelspace area (for plans, elevations, sections, and details), callout symbols, dimensions, and other annotative information.

**Viewports** are placed in Paperspace and allow visual access to Modelspace to freeze and thaw layers, adjust the viewing scale, or provide alternative views (3D). The Paperspace drawing area can be split into single or multiple viewports. The viewports viewing scale can be modified once they are created. Multiple viewport windows (MVIEW) may be used as needed in the Paperspace layout. The number of Paperspace viewports allowed is limited to the number that fit appropriately on a full-scale (1:1) border. Layer visibility can be controlled independently as needed for each layout viewport through settings in the layer tool palette.

**Annotation** shall use one of the following methods:

- Method #1 Annotation to be in Paperspace **(preferred)**
- Method #2 Annotation to be in Modelspace
- Method #3 Annotation can be a combination of both Modelspace and Paperspace

Refer to Table 9.1 for object placement.

**Figure 9.1—Modelspace / Paperspace**

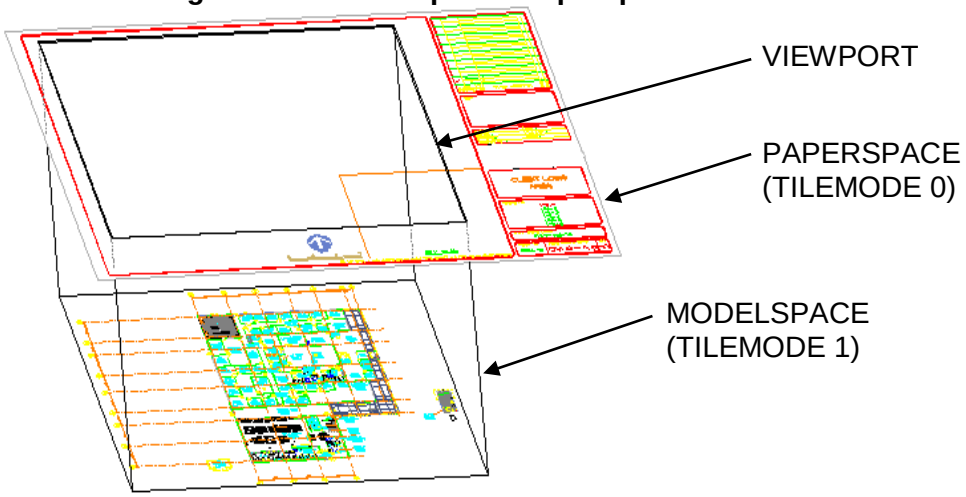



**Table 9.1—Modelspace vs. Paperspace Object Placement**

| Drawing Classification | MS | PS | Remarks |
|---|---|---|---|
| Borders | | X | Title Blocks, and Drawing Borders (Scale 1:1) |
| Legends | | X | Title Sheet, Notes, Legends, Symbols |
| Diagrams | | X | 1/16 (.0625") Snap *Recommended* |
| P&ID | | X | 1/16 (.0625") Snap *Recommended* |
| Schedules | | X | |
| Plans, Layouts | X<br>X | | Objects<br>All annotation items (Text, Dims, Titles…, Lock VP) |
| Sections | X<br>X | | Objects<br>All annotation items (Text, Dims, Titles…, Lock VP) |
| Elevations | X<br>X | | Objects<br>All annotation items (Text, Dims, Titles…, Lock VP) |
| Details | X<br>X | | Objects<br>All annotation items (Text, Dims, Titles…, Lock VP) |
| Electrical | X | | Wiring, Schematics, Diagrams |

## 2. External Reference Drawings (XREF)

### General

External Reference (XREF) Drawings should be kept to a minimum. However in some projects, it is the best method for handling the data and sharing information between drawings.

The parent drawing and all XREFs (child drawings) must be included in the submittal of drawings to PSES.

The XREF path shall be removed or set to “No Path” in the Parent (master) drawing file.

Drawing Origins: XREFs and 3-D Models shall be brought in at 0,0,0.

3D models shall be developed in Real World coordinates. Real World coordinates shall be specified with a file or in text form on Defpoints (non-printing layer) in Modelspace and provided with the drawing deliverables.

### Definition

An XREF is an external reference to another AutoCAD drawing file. One file can reference many other files and display them as if they were one drawing. They are often used in large or complex projects to reduce time, repetition, and errors in design.

XREF drawings are referred to as a compound drawing or drawings, with a parent-child relationship. Child drawings (also referred to as XREF) are external drawings that are attached to or included with another drawing. The Parent drawing is the master or base file that has other drawings (children) attached to it. Hybrid drawings are also compound drawings. This occurs when the attached file is an image file (TIF).

The Parent drawings contain pointers to the child drawings. The only XREF drawing information contained in the parent file is the path pointing to the XREF (child) file. Layers, blocks, and other information associated with the XREF are maintained in the XREF drawing file.

### 2.1. When to XREF

A practical application for an XREF drawing is when the drawing(s) consists of entities which will appear in more than one drawing file as a background, plan, or topographic view.

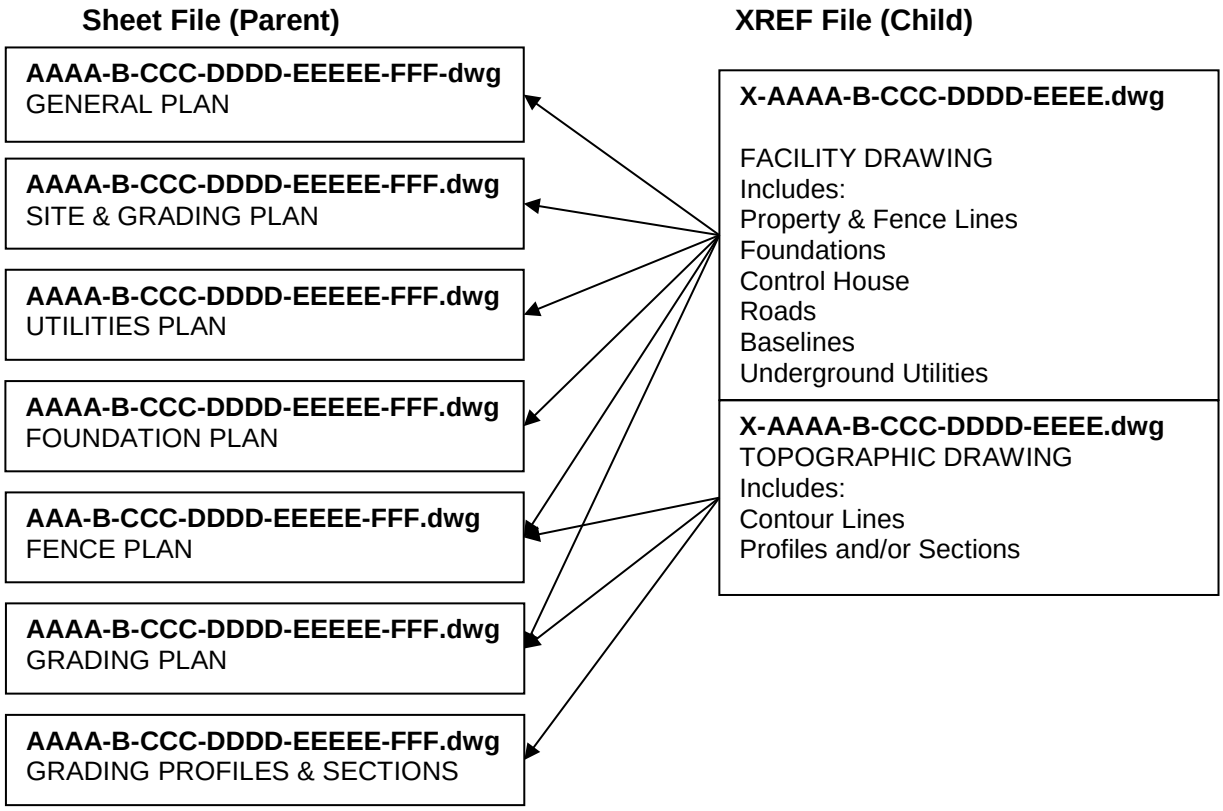
## 2.2. XREF File Management

Refer to XREF Drawing File Naming: Section X, Figure 10.2 for more information.

The XREF Parent-Child Drawing Relationships are shown in Figure 9.2.

The illustration below shows XREF relationships across various drawing numbers.

**Figure 9.2 Parent-Child Drawing Relationships**



## 3. Package and Discipline Drawing Order

This section describes the order of the drawings in a project package set.

**Table 9.2— Drawing Configuration**

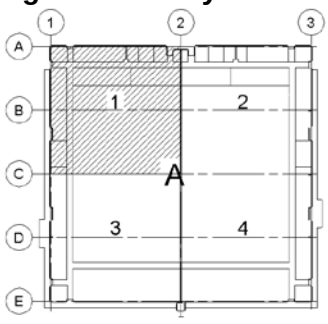
| PSES Owner | Discipline | PSES Owner | Discipline |
|---|---|---|---|
| **C** | Architectural | **M/E** | Operations |
| **C** | Geotechnical | **M** | Plumbing |
| **C** | Civil | **E** | Security (by PSES) |
| **M** | Process | **All** | Resource |
| **E** | Electrical | **C** | Structural |
| **M** | Fire Protection | **E** | Telecommunications |
| **C/E/M** | General | **"U"** | User Defined (by PGE PSES) |
| **M** | HVAC | **V** | Survey / Mapping |
| **C** | Interiors | **E** | Distributed Energy |
| **C** | Landscape | **"X"** | Other Disciplines |
| **M** | Mechanical | **C/E/M** | Contractor/Shop Dwg |

## 4. Key Plan/Vicinity Maps

A key plan showing all areas of the project shall be placed in model space and key plans shall be viewable in Paperspace with a viewport.

The key plan must indicate, by hatching (ANSI31), the location(s) illustrated on the plan. Refer to Figure 9.3 for example.

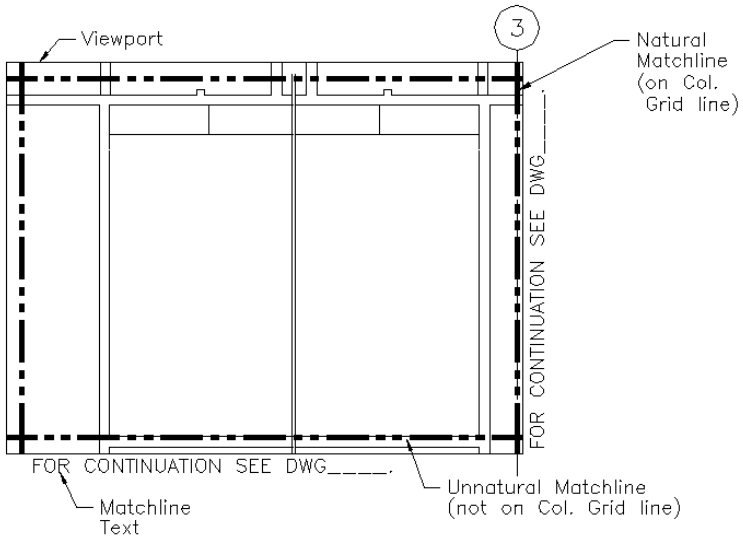
**Figure 9.3—Key Plan**



## 5. Matchlines

Matchlines on a partial plan must be clearly noted with the drawing number of the sheet where the plan is continued. The Matchline text shall read:
"FOR CONTINUATION SEE DWG _____".
Where more than one sheet is required to show a plan (or view), the same relationship between the plan (or view) and the borders, at right angles to the Matchlines, shall be maintained on all sheets.
Where Matchlines are used by more than one discipline, the Discipline Leads shall coordinate the location of Matchlines so that they are shown at the same location.
Matchlines should be aligned a minimum of 1/4" inside the viewport.
Refer to Figure 9.4 for an example of Matchlines and Matchline text.

**Figure 9.4—Matchlines**



**6. Raster Image Electronic File Format (Ref. Section 7, 13)**

Construction project drawing raster images must be provided in Tag Image File Format (*.tif, *.tiff) format. Other formats will not be acceptable. Vectorized files are preferred.
Raster images shall only be linked to drawings using CAD. Raster Design by Autodesk shall be used for raster/vector editing.

Before the raster image may be used, it must be despeckled, deskewed, cropped, and otherwise prepared as necessary to assure that all portions are legible. Areas that cannot be successfully repaired by such methods shall be redrawn in CAD.

All raster images shall be

- inserted into Modelspace
- scaled to full scale (actual size, 1=1) using true measurements
- layer: *-IMAGE, Bylayer (color 7)
- transparency set to ON
- frame turned off

The image attachment path shall be removed or set to “No Path” in the Parent (master) file.
Refer to Section IX, Table 9.2 for layer name prefix Discipline Codes.

The attached image file when inserted into AutoCAD should have the following settings:

- file Type: Tag Image File Format (*.tif, *.tiff)
  Color Mode: Monochrome (Black and White)
- encoding method/Compression: CCITT (Fax) Group 4
- data Organization: Stripped
- color Depth: 1-bit (bitonial)
- density: 300 dpi (pixels per inch)
- transparency <off>

## 7. Mechanical AutoDesk Plant 3D Drafting Setup

PSES Mechanical Design staff utilize Autodesk Plant 3D for modifications to existing power plant mechanical systems and new power plant mechanical systems. The layer naming convention has been modified to aid in the use of Plant 3D modeling, orthographic sheet development, Isometric sheets, and P&ID sheet drawings.

All annotation layers shall follow the formats shown on Tables 11.6. Applies to Sections 7.2, 7.3, and 7.4.

### 7.1. Layer Naming Convention

All piping models, Isometric piping, and Orthographic piping layers shall be developed using the following pipe line numbering method:

Example layer name: **4MS2-30**.

- (4) = Pipe system category, category range's 1 thru 7. Refer to piping materials and specifications.
- (MS) = Pipe System Symbol, MS for example is Main Steam. Refer to Systems Abbreviations list in Section XII.
- (2) = Pipe line size
- (30) = Pipe line spool.

### 7.2. P&ID's

P&ID's developed or modified using Autodesk Plant 3D P&ID software will maintain the layering method provided by the software; however, P&ID's must have the line numbering assignment associated in the line tag (4MS2-30) option as specified above.

P&ID layer colors shall use colors with a pen weight of

- Primary pipe: 0.0280"
- Secondary pipe: 0.0150"
- All instrumentation signal line: 0.0060"

Refer to PSES FULL.ctb file for colors.

Refer to Section XI, Table 11.6 Mechanical Layers for instrumentation lines line types.

### 7.3. Plant 3D Piping Model

Plant 3D piping models shall be developed from P&ID line number tag assignments, the pipe model name will be the same as the line number associated to the pipe system (4MS2-30).

Layer for the piping shall be assigned the same as the model using the pipe system line number (4MS2-30).

Piping layer colors shall use colors with a pen weight of 0.0280".

Project setup: assign layer by line number tag; assign color by layer.

### 7.4. Orthographic's (plans, sections, details sheet drawings)

Plant 3D utilizes orthgraphics module for developing plans, sections and detail sheet drawings. The plant 3d project setup for orthographics will need to be set to use 3D model layers. This will bring the layer name into the ortho sheet file.

### 7.5. Isometric sheet drawings

Plant 3D utilizes Isometric module for Isometric sheet drawings, piping layers shall be set for colors with a pen weight of 0.0280".

# X. DRAWING NUMBERS and CAD FILENAMES

This section describes the conventions used for numbering sheets and naming CAD files and file sharing through external referencing.

## 1. Project File Structure

This sub-section intentionally left blank.

## 2. Drawing Storage

All approved project drawings and documents are stored in a network drive project folder with discipline folder structure.

- CAD 2D files shall be stored and worked in a network drive project folder.
- AutoCAD 3D *(BIM software)* shall be worked in a network drive structured for 3D software file structure (still within the project folder).

All drawings and documents pertaining to each of the disciplines shall be stored in their respective folders.

## 3. Legacy Drawing Numbers

Existing PGE drawings provided by owner shall not be re-numbered per the new naming convention. Legacy numbering shall be retained. If needed, sheets may be added. Contact PSES Design group for sheet number availability. Contact PSES Design group for any comments or concerns.

A new system added to an existing facility may use the new drawing numbering system.

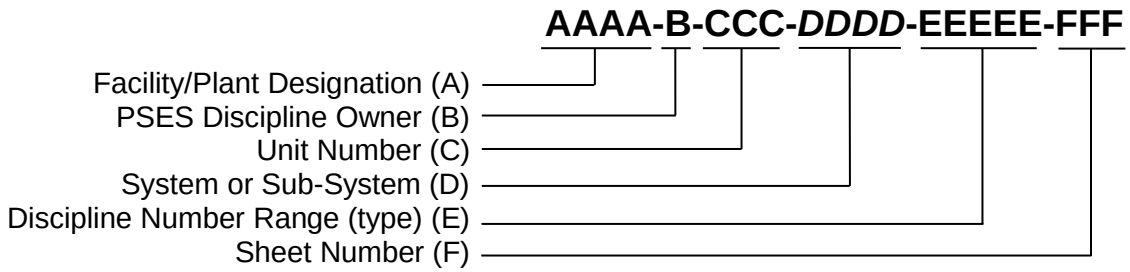
## 4. Drawing and Digital CAD File Naming Convention

The drawing numbering convention is designed to give both the digital CAD file and the print "hard copy" numbering the same format. This system also simplifies our drawing numbering system and provides increased overall clarity.

Drawing Number: **AAAA-B-CCC-DDDD-EEEEE** Sheet No. **FFF**
Shown as it appears in title block.

Digital CAD Filename: **AAAA-B-CCC-DDDD-EEEEE-FFF.dwg**

**Figure 10.1—Naming**




The following list of items may be dropped or added as determined by the PSES Design group at the initiation of the drawing number usage or project development.

- (C) Unit Number. Required if more than one unit.

## The Six designation elements of the CAD filename are:

Refer to Figure 10.1 for the following descriptions.

**1) Facility/Plant Description (A)**

The ***First*** designator position of the filename is reserved for the site designation. Site designations can be found on Table 10.1 below.

**Table 10.1—Facility / Plant Designations**

| Designation | Site | Designation | Site |
|---|---|---|---|
| **BCW1** | Biglow Canyon Wind Farm | **PNP1** | Pelton Plant |
| **BNP1** | Boardman Coal Plant | **POSH** | Port of St. Helens (BRP1) |
| **BRP1** | Beaver Generating Plant | **PRP1** | Pelton Re-Regulating Dam |
| **CSP1** | Coyote Springs Plant 1 | **PWP1** | Port Westward Plant 1 |
| **CSP2** | Coyote Springs Plant 2 | **PWP2** | Port Westward Plant 2 |
| **CYP1** | Carty Generating Plant 1 | **PWSY** | Port Westward Switchyard |
| **FYP1** | Faraday Plant | **RBP1** | Round Butte Plant |
| **FYSY** | Faraday Switchyard | **RMP1** | River Mill Plant |
| **HPH1** | Harriet Lake Powerhouse | **RMSY** | River Mill Switchyard |
| **KBPL** | Kelso-Beaver Pipeline | **SCP1** | Stone Creek Plant (EWEB) |
| **NFP1** | North Fork Plant | **SNP1** | T.W. Sullivan Plant |
| **OGP1** | Oak Grove Plant | **TLP1** | Timothy Lake Powerhouse |
| **PHP1** | Portland Hydro Project 1 | **TNP1** | Trojan Nuclear Plant |
| **PHP2** | Portland Hydro Project 2 | **TRW1** | Tucannon River Wind Farm |
| | | | |

**2) PSES Owner (B)**

The ***Second*** designator position of the filename are reserved for the PSES Owner. PSES has four primary drawing owner groups: Civil, Electrical, Mechanical, and Survey. Refer to Table 10.2 below.

**Table 10.2—PSES Owner Codes**

| Designation | Owner |
|---|---|
| **C** | Civil |
| **E** | Electrical |
| **M** | Mechanical |
| **V** | Survey |

**3) Unit Number (C)**

The ***Third*** designator position of the filename are reserved for the equipment unit number. For sorting accuracy all three positions shall be used. Numbers under 100 shall be preceded by zeros. Required if more than one unit.

**4) System or Sub-System (D)**
The ***Fourth*** designator position of the filename is reserved for Facility Systems or Sub-Systems. Refer to Section XI, Abbreviations, for list.

**5) Discipline drawing index numbers (Drawing Type) (E)**
The ***Fifth*** designator position of the file name are for discipline drawing number allocations. Tables 10.3, 10.4, and 10.5 provide a guideline for drawing number determination by drawing type.

**Table 10.3—Arch/Civil/Structural (A/C/S) Drawing Numbering**

| Drawing Type | Number Allocation / and Range |
|---|---|
| Title or Cover sheet Abbreviation/Legend/Note/Symbol | 1000*0*-1099*9* |
| Schedules, Bill of Materials | 1100*0*-1199*9* |
| Plans | 1200*0*-1399*9* |
| Enlarged Plans | 1400*0*-1499*9* |
| Elevations | 1500*0*-1599*9* |
| Sections | 1600*0*-1699*9* |
| Details | 1700*0*-1899*9* |

A/C/S drawing number example (Elevations):
**AAAA-B-CCC-DDDD-14000-001.dwg**

**Table 10.4—Electrical Drawing Numbering**

| Drawing Type | Number Allocation / Sheet Range |
|---|---|
| Title or Cover sheet Abbreviation/Legend/Note/Symbol | 2000*0*-2999*9* |
| One Lines, Three Lines | 2100*0*-2199*9* |
| Schematics, Elementaries | 2200*0*-2299*9* |
| Control Wiring Diagrams * | 2300*0*-2399*9* |
| Wiring Diagrams | 2400*0*-2499*9* |
| Panel Schedules | 2500*0*-2599*9* |
| Plans and Arrangements | 2600*0*-2699*9* |
| Elevations and Sections | 2700*0*-2799*9* |
| Details | 2800*0*-2899*9* |
| Loop Diagrams * | 2900*0*-2999*9* |

Electrical drawing number example (Wiring):
**AAAA-B-CCC-DDDD-24000-123.dwg**
* = if used
Cable and Raceway Schedule: Access Database

**Table 10.5—Mechanical Drawing Numbering**

| Drawing Type | Number Allocation / Sheet Range |
|---|---|
| Title or Cover sheet Abbreviation/Legend/Note/Symbol | 3000*0*-3999*9* |
| Schedules, Bill of Materials | 3100*0*-3199*9* |
| Flow Diagrams, P&IDs | 3200*0*-3299*9* |
| Isometrics ** | *3300*0*-3399*9* |
| Block Diagrams | 3400*0*-3499*9* |
| Plans | 3500*0*-3599*9* |
| Enlarged Plans | 3600*0*-3699*9* |
| Elevations | 3700*0*-3799*9* |
| Sections | 3800*0*-3899*9* |
| Details | 3900*0*-3999*9* |

Mechanical drawing number example (Diagrams):
**AAAA-B-CCC-DDDD-32000-123.dwg**

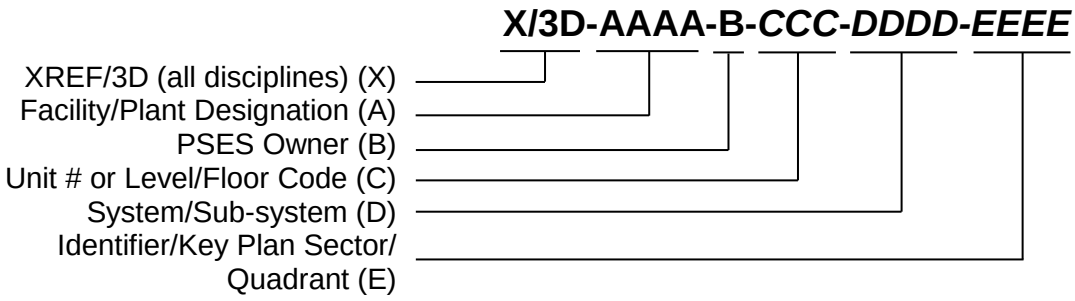
**Isometric drawings to be numbered per system with sheet numbers for additional same system example: BF-33001-001, BF-33001-002, would be for boiler feed (BF), isometrics (33001 sheets one and two (001, 002).

**6) Sheet Number (F)**
The ***Sixth*** designator position of the filename is reserved for the drawing sheet number. Show all three characters in both the digital CAD file and the title block.

**5. XREF and 3D Model Digital CAD File Naming Convention**
The 3D Model naming convention is designed to give clear understanding what plant it is designed for, what discipline it belongs to, where it is located, and for what use. This system simplifies our 3D Model naming and provides increased overall clarity.
XREF/3D Model Digital CAD File name: **X/3D-AAAA-B-CCC-DDDD-EEEE.dwg**

The XREF and 3D Model CAD filenames shall not contain revision information.

**Figure 10.2— 3D Model Naming Convention**




The following list of items may be dropped or added as determined by the PSES Design group at the initiation of the drawing number usage or project development.

- (C) Unit Number or Level/Floor Code. Required if more than one unit.
- (D) System or Sub-System

**The Six designation elements of the 3D Model CAD filename are described below:**
Refer to Figure 10.2 for example.

**1) XREF/3D (X)**
The ***First*** designator position of the filename is reserved for XREF or 3D Model designation. XREF shall be **X** and 3D model shall be **3D**

**2) Facility/Plant Designation (A)**
The ***Second*** designator positions of the filename are reserved for the project facility or site designation. Refer to on Table 10.1, for Facility / Plant Designations.

**3) PSES Owner (B)**

The ***Third*** designator position of the filename is reserved for the PSES Owner. PSES has four primary drawing owner groups: Civil, Electrical, Mechanical, and Survey. Refer to Table 9.2, for PSES Owner Codes.

**4) Unit Number or Level/Floor Code (C)**

The ***Fourth*** designator positions of the filename are reserved for describing the floor level or the site building designation (see overall site plan). **These designators may be up to three (3) characters and will be dropped if not used. These should be consistent (i.e.: start with three (3) characters, continue to use three (3) characters).**

**Level/Floor Code:**

Numeric designators (001 – First Floor Elev. 0'-0") denote the main floor levels that occur in any structure with Alpha designators (01A) denoting any intermediate elevated planes between each main floor level and the next main floor above. Although these intermediate planes are usually physical structures like platforms, walkways, and mezzanines, they may also be non-physical planes used to cut sections. For main floor levels below Elev. 0'-0", the Numeric and Alpha designators should be preceded with a "U" (U02 or U2A). The "U" prefix shall indicate underground or below the Elev. 0'-0".

**5) System or Sub-system (D)**

The ***Fifth*** designator positions of the filename are reserved for describing the System type. These designators may be up to six (6) characters and will be dropped if not used. Refer to Section XII, for System Codes Abbreviations.

Additions to the System types/codes may be added if the PSES CAD Standards Change/Addition form is filled out and submitted to the CAD Standards team.

**6) Identifier/Key Plan Sector/Quadrant (E)**

The ***Sixth*** designator positions of the filename are reserved for describing the key plan sector and quadrant. These designators may be up to three (3) characters and will be dropped if not used. These should be consistent (i.e.: start with three (3) characters, continue to use three (3) characters).

**Key Plan Sector:**

Alpha designators (A) denote the main sector on each floor level that occur in any structure with numeric designators (1 thru 4) denoting the quadrant within the main sector.

# XI. LAYERING STANDARDS

## 1. Intent

PSES has adopted most of the layer name and use rules recommended by the CAD Layer Guidelines published in the United States National CAD Standard (NCS) – Version 5. Where noted, PSES has supplemented the NCS guidelines with its own rules and standards as necessary. The layering standard complies with the NCS Layer Guidelines as found in the United States National CAD Standard – Version 5. For additional detail beyond what is outlined herein, please refer to the National CAD standard for guidance.

## 2. Discipline Code

The discipline code is a one- or two-character field with a designator from the table below and if necessary an optional second character (a user defined modifier) followed by a hyphen. The Discipline designators are the same for both layer names and file names.

**Table 11.1—Discipline Codes**

| Designation | Discipline | Designation | Discipline |
|---|---|---|---|
| **A** | Architectural | **O** | Operations |
| **B** | Geotechnical | **P** | Plumbing |
| **C** | Civil | **Q** | Security (by PSES) |
| **D** | Process | **R** | Resource |
| **E** | Electrical | **S** | Structural |
| **F** | Fire Protection | **T** | Telecommunications |
| **G** | General | **U** | User Defined (by PGE PSES) |
| **H** | HVAC | **V** | Survey / Mapping |
| **I** | Interiors | **W** | Distributed Energy |
| **L** | Landscape | **X** | Other Disciplines |
| **M** | Mechanical | **Z** | Contractor/Shop Dwg |

## 3. Major Groups

The major group designation is a four-character field that identifies the building system, such as doors, walls, windows, etc. Although most major groups are logically associated with specific discipline codes, it is possible to combine major group codes with any of the discipline codes. For example: A-WALL or I-WALL.

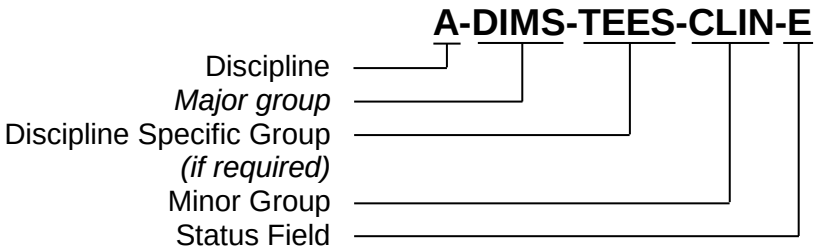
**4. Minor Groups**

This is an optional, four-character field for further differentiation of major groups. For example, partial height walls (A-WALL-PART) might be differentiated from full height walls (A-WALL-FULL). The following common modifiers defined by the AIA can also be used in the minor group field:

| | | | |
|---|---|---|---|
| IDEN | identification tags | example: | A-DOOR-IDEN |
| PATT | cross hatching, poche | example: | A-WALL-PATT |

If necessary, the minor group field may also be defined by the user, allowing additional layers to be added to accommodate special project requirements. However, this should only be done after checking the National CAD Standard to see if any of the predefined layer names in that list would meet the special project requirements.

**Figure 11.1— Layer Naming System**




**5. Status Field**

The status field is an optional one- to four-character designator that indicates work status or construction phase. Since drawings submitted at close-out are As-Built, this field shall be used to differentiate new construction from existing phases of work that must be differentiated. The status field is always the last character of the layer name. See also the Status Field / Dominant Phase Rule below. Examples of values defined for this field by the AIA are as follows:

**Table 11.2—Status Field Codes**

| Status Field Codes | | | |
|---|---|---|---|
| **A** | Abandoned | **N** | New Work |
| **D** | Existing to Demolish | **T** | Temporary Work |
| **E** | Existing to Remain | **X** | Not in Contract |
| **F** | Future Work | **1-9** | Phase Numbers |
| **M** | Items to be Moved | | |

## 6. General Rules About Names and Uses

Layer uses are generally implied by the layer name. However, the following explanation of certain layer use rules should be noted.

### 6.1. Status Field / Dominant Phase Rule:

This rule pertains to the use of the status field in naming layers for construction projects. Layers indicating the dominant phase of a project can be represented without a status field. For example, in a small remodeling project, N would indicate new construction, while layers without status fields would indicate parts of the existing building to remain. Conversely, a remodeling project consisting of mostly new construction might use E to indicate "existing to remain" building systems, while all layers without a status field designator would represent new construction.

### 6.2. Elevations, Sections, and Three-Dimensional (3D) Drawings:

PSES prefers that all elevation, section, and detail titles be placed on the PS-SYMBOL – Layer names that are used in 3D drawings shall have 3D as the discipline code, with all other layer naming conventions to follow the same rules as previously mentioned.

## 7. Plotting / Entity Weights

PSES uses two separate color-dependent plot style tables (*.ctb). PSES shall provide the following CTB files:

1) Civil and Structural: "PSES-CIVIL.ctb" and "PSES-SURVEY-COLOR.ctb".
2) All other disciplines: "PSES-FULL.ctb" and "PSES-FULL-COLOR.ctb".

The PSES layer list provides color assignments to each layer, which match the appropriate PSES CTB file and discipline templates.

## 8. Standard Layer Listing

PSES has defined the following list of layers designated for construction projects as part of the template drawing to ensure consistency throughout disciplines and to provide a starting point for all new and existing drawings. If additional layers are needed, new layers may be added using the formatting rules described in this section.

## 8.1. PSES Multi-Discipline Layers

**Table 11.3—PSES Multi-Discipline Layers**

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| PS-BORDER1 | Green | 3 | Continuous | Default | Sheet Extents (D.N.P.) |
| PS-BORDER2 | White | 7 | Continuous | Default | PS printable Border |
| PS-GRAPHIC-SCALE | White | 7 | Continuous | Default | Graphic Scale |
| PS-LOGO-7 | White | 7 | Continuous | Default | PGE Logo ONLY |
| PS-LOGO-10 | | 10 | Continuous | Default | PGE Logo ONLY |
| PS-LOGO-160 | | 160 | Continuous | Default | PGE Logo ONLY |
| PS-LOGO-70 | | 70 | Continuous | Default | PGE Logo ONLY |
| PS-NORTH-ARROW | White | 7 | Continuous | Default | PS North Arrow |
| PS-NOTES | White | 7 | Continuous | Default | PS Notes |
| PS-OREGON-MAP | | 8 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-HWY | | 1 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-PLANTS | Green | 3 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-PLANTS-COAL | | 202 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-PLANTS-HYDRO | | 150 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-PLANTS-THERMAL | | 40 | Continuous | Default | PGE Oregon Map |
| PS-OREGON-MAP-PLANTS-WIND | | 1 | Continuous | Default | PGE Oregon Map |
| PS-PRELIM-NOTE | Green | 3 | Continuous | Default | Preliminary Stamp |
| PS-REVS | White | 7 | Continuous | Default | Revision Clouds, Rev Sym. |
| PS-STAMP-10 | | 10 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMP-130 | | 130 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMP-160 | | 160 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMP-50 | | 50 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMP-7 | White | 7 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMP-70 | | 70 | Continuous | Default | PGE Usage Stamp ONLY |
| PS-STAMPS | White | 7 | Continuous | Default | PS Stamps – All |
| PS-SYMBOL | White | 7 | Continuous | Default | PS Labels |
| PS-TABLE | White | 7 | Continuous | Default | PS Tables (not BOM) |
| PS-TEXT | White | 7 | Continuous | Default | PS Text & Leaders |
| PS-TITLE-BLOCK | White | 7 | Continuous | Default | Title Block |
| PS-TITLE-TEXT | White | 7 | Continuous | Default | Title Block Text |
| PS-VICINITY-MAP | White | 7 | Continuous | Default | PS Vicinity Map |
| PS-VIEWPORT | | 233 | Continuous | Default | Viewports (D.N.P.) |

## 8.2. Civil/Structural Layers

**Table 11.4—Civil/Structural Layers**

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| C-ALIGNMENT | Magenta | 6 | Continuous | Default | Alignment Layer |
| C-BEAM-STEEL | Blue | 5 | Center2 | Default | Steel Beam – Plan View |
| C-BEAM-WOOD | | 210 | Center2 | Default | Wood Beam – Plan View |
| C-BOLT | Orange | 30 | Continuous | Default | Bolt, Nuts, Washers Line work |
| C-BOLT-CL | Orange | 30 | Hidden | Default | Bolt Centerline |
| C-BRACE | | 150 | Continuous | Default | Brace Line work |
| C-BRACE-CL | Blue | 5 | Center | Default | Brace Centerline |
| C-BRADE-HID | Cyan | 4 | Hidden | Default | Brace Hidden Line work |
| C-CL | Shade Grey | 253 | Center | Default | Centerline |
| C-CLOSURE | Magenta | 6 | Continuous | Default | Closure Line work |
| C-CONC-WALL | | 140 | Continuous | Default | Concrete Wall Line work |
| C-CONCRETE | | 150 | Continuous | Default | Concrete Line work |
| C-CONST | Yellow | 2 | Continuous | Default | Construction Line work |
| C-CUT | Red | 1 | Continuous | Default | Cut Line work |
| C-CUTLINE | White | 7 | Hidden | Default | Cut Line |
| C-DECK-EDGE | Cyan | 4 | Continuous | Default | Deck Edge Line work |
| C-DETAIL | White | 7 | Dashed | Default | |
| C-DETL-ITEM-SYMB | Green | 3 | Continuous | Default | Part Detailing Item Block |
| C-DIM | Beige | 31 | Continuous | Default | Dimensions – True (ALL) |
| C-DIM1 | | 11 | Continuous | Default | Dimensions – Text Modified (NOT True) |
| C-DIM2 | | 52 | Continuous | Default | Dimensions – Alternate (use as needed) |
| C-EDGE | Cyan | 4 | Continuous | Default | Edge Line work |
| C-EXISTING | Dark Grey | 8 | Continuous | Default | Existing Line work |
| C-EXISTING-HID | Dark Grey | 8 | Hidden2 | Default | Existing Hidden Line work |
| C-FOOTING | Orange | 30 | Continuous | Default | Footing Line work |
| C-FOOTING-HID | Orange | 30 | Hidden2 | Default | Footing Hidden Line work |
| C-GIRT | Cyan | 4 | Continuous | Default | Girt Line work |
| C-GIRT-HID | Yellow | 2 | Continuous | Default | Girt Hidden Line work |
| C-GRADING | | 11 | Continuous | Default | Grading Line work |
| C-GRID | Green | 3 | CenterX2 | Default | Grids, Grid Bubbles |
| C-HARDWARE | | 233 | Continuous | Default | Hardware (use as needed) |
| C-HARDWARE-2 | | 234 | Continuous | Default | Hardware (use as needed) |
| C-HATCH | Lt. Grey | 253 | Continuous | Default | Hatch |
| C-HIDDEN | Shade Grey | 8 | Hidden | Default | |
| C-HOIST | White | 7 | Continuous | Default | Crane, Hoist Line work |
| C-IMAGE | White | 7 | Continuous | Default | Image |
| C-JOIST-STEEL | | 210 | Center2 | Default | Steel Joists – Plan View |
| C-JOIST-WOOD | Orange | 30 | Center2 | Default | Wood Joists – Plan View |
| C-PARCEL | | 40 | Continuous | Default | Parcel & Areas Line work |
| C-PIPE | Cyan | 4 | Continuous | Default | Pipe Line work |
| C-PIPE-HID | Yellow | 2 | Hidden | Default | Pipe Hidden Line work |
| C-PROFILE | Green | 3 | Continuous | Default | Profile & Profile Views |
| C-PROP-BNDY | Cyan | 4 | Continuous | Default | Property Boundary |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| C-PROP-BRNG | Green | 3 | Continuous | Default | Property Bearing |
| C-PROP-CURV-LABL | Green | 3 | Continuous | Default | Property Radii & Dist. Segment Labels |
| C-PROP-LABL | Green | 3 | Continuous | Default | Property Labels |
| C-PROP-LINE | | 230 | Continuous | Default | Property Parcel Lines |
| C-PROP-LINE-LABL | Green | 3 | Continuous | Default | Property Bearings & Dist. Segment Labels |
| C-PROP-LOTS | Magenta | 6 | Continuous | Default | Property Lot Line work |
| C-PROP-PATT | | 131 | Continuous | Default | Property Parcel Hatching |
| C-PROP-RSRV | | 94 | Continuous | Default | Property Reserved |
| C-PROP-TEXT | Green | 3 | Continuous | Default | Property Label |
| C-PURLIN | Cyan | 4 | Continuous | Default | Purlin Line work |
| C-PURLIN-HID | Yellow | 2 | Hidden | Default | Purlin Hidden Line work |
| C-RAIL | Green | 3 | Continuous | Default | Rail Line work |
| C-REBAR | Red | 1 | Continuous | Default | (reserved) Rebar Line work |
| C-REFERENCE | Yellow | 2 | Phantom2 | Default | ALL Reference Line work |
| C-REINFORC | Green | 3 | Continuous | Default | Rebar Line work |
| C-REINFORC-HID | | 21 | Hidden | Default | Rebar Hidden Line work |
| C-ROAD | White | 7 | Continuous | Default | Roadways |
| C-ROAD-ASSM | | 40 | Continuous | Default | Roadway Assemblies & Sub-Assemblies |
| C-ROAD-ASSM-BLIN | Red | 1 | Continuous | Default | Roadway Assembly Baseline |
| C-ROAD-ASSM-OFFS | Red | 1 | Continuous | Default | Roadway Assembly Offset |
| C-ROAD-ASSM-TEXT | White | 7 | Continuous | Default | Roadway Assembly Text |
| C-ROAD-BRNG | Red | 1 | Continuous | Default | Roadway Bearings |
| C-ROAD-CNTR | Red | 1 | Center2 | Default | Roadway Centerline (D.N.P.) |
| C-ROAD-CNTR-N | Green | 3 | Center | Default | Roadway Centerline NEW |
| C-ROAD-CORR | Blue | 5 | Continuous | Default | Roadway Corridor |
| C-ROAD-CORR-BNDY | Red | 1 | Phantom2 | Default | Roadway Corridor Boundary |
| C-ROAD-CORR-PATT | | 141 | Continuous | Default | Roadway Corridor Patterns |
| C-ROAD-CURV | Blue | 5 | Continuous | Default | Roadway Curves |
| C-ROAD-ESMT | | 23 | Continuous | Default | Roadway Easements |
| C-ROAD-FEAT | | 182 | Continuous | Default | Roadway Feature Line |
| C-ROAD-LABL | Green | 3 | Continuous | Default | Roadway Labels |
| C-ROAD-LINE | Red | 1 | Continuous | Default | Roadway Tangent Lines |
| C-ROAD-LINE-EXTN | Shade Grey | 252 | Hidden | Default | Roadway PVI Extension Lines |
| C-ROAD-LINK | | 150 | Continuous | Default | Roadway Corridor & Section Links |
| C-ROAD-LINK-TEXT | White | 7 | Continuous | Default | Roadway Corridor & Section Link Text |
| C-ROAD-MARK | | 212 | Continuous | Default | Roadway Corridor & Section Marks |
| C-ROAD-PROF | Green | 3 | Dashed | Default | Roadway Profiles |
| C-ROAD-PROF-ASMC | Green | 3 | Continuous | Default | Roadway Profile Asymmetrical Curves |
| C-ROAD-PROF-CURV | Blue | 5 | Continuous | Default | Roadway Profile Vertical Curve |
| C-ROAD-PROF-DIAG | Cyan | 4 | Continuous | Default | Roadway Profile Band Diagrams |
| C-ROAD-PROF-GRID | Cyan | 4 | Continuous | Default | Roadway Profile Grid |
| C-ROAD-PROF-GRID-GEOM | Blue | 5 | Continuous | Default | Roadway Profile Grid @ Geometry Points |
| **Layer Name** | **Color** | **#** | **Linetype** | **Line Weight** | **Description** |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| C-ROAD-PROF-GRID-MAJR | Dark Grey | 8 | Continuous | Default | Roadway Profile Grid @ Major Stations |
| C-ROAD-PROF-GRID-MINR | Dark Grey | 8 | Continuous | Default | Roadway Profile Grid @ Minor Stations |
| C-ROAD-PROF-LINE | Red | 1 | Continuous | Default | Roadway Profile Vertical Lines |
| C-ROAD-PROF-LINE-EXTN | Shade Grey | 252 | Hidden | Default | Roadway Profile Centerline Extension |
| C-ROAD-PROF-LTOF | Yellow | 2 | Continuous | Default | Roadway Profile Left Offset Sample Lines |
| C-ROAD-PROF-N | Cyan | 4 | Continuous | Default | Roadway Profile NEW |
| C-ROAD-PROF-PARB | White | 7 | Continuous | Default | Roadway Profile Parabolic Curves |
| C-ROAD-PROF-PNTS | Shade Grey | 252 | Hidden | Default | Roadway Profile Geometry Points |
| C-ROAD-PROF-RTOF | Red | 1 | Continuous | Default | Roadway Profile Right Offset Sample Lines |
| C-ROAD-PROF-STAN-GEOM | Yellow | 2 | Continuous | Default | Roadway Profile Geometry Point Labels |
| C-ROAD-PROF-STAN-MAJR | Yellow | 2 | Continuous | Default | Roadway Profile Major Station Labels |
| C-ROAD-PROF-STAN-MINR | Yellow | 2 | Continuous | Default | Roadway Profile Minor Station Labels |
| C-ROAD-PROF-TEXT | Yellow | 2 | Continuous | Default | Roadway Profile Text |
| C-ROAD-PROF-TICK | White | 7 | Continuous | Default | Roadway Profile Tick Marks |
| C-ROAD-PROF-TITL | Yellow | 2 | Continuous | Default | Roadway Profile Label |
| C-ROAD-PROF-TTLB | Blue | 5 | Continuous | Default | Roadway Profile Border |
| C-ROAD-PROF-VIEW | White | 7 | Continuous | Default | Roadway Profile View |
| C-ROAD-SAMP | | 131 | Hidden | Default | Roadway Sample Lines |
| C-ROAD-SAMP-LABL | Green | 3 | Continuous | Default | Roadway Sample Lines Labels |
| C-ROAD-SAMP-TEXT | | 131 | Continuous | Default | Roadway Sample Lines Text |
| C-ROAD-SCTN | White | 7 | Continuous | Default | Roadway Grade in Sections |
| C-ROAD-SCTN-DIAG | | 212 | Continuous | Default | Roadway Section Diagram |
| C-ROAD-SCTN-GRID | White | 7 | Continuous | Default | Roadway Section Grid |
| C-ROAD-SCTN-LABL | Green | 3 | Continuous | Default | Roadway Section Labels |
| C-ROAD-SCTN-N | Cyan | 4 | Continuous | Default | Roadway Section NEW |
| C-ROAD-SCTN-SHET | White | 7 | Continuous | Default | Roadway Grade in Section Sheets |
| C-ROAD-SCTN-TEXT | Green | 3 | Continuous | Default | Roadway Section Text |
| C-ROAD-SCTN-TICK | White | 7 | Continuous | Default | Roadway Section Tick Marks |
| C-ROAD-SCTN-TITL | | 3 | Continuous | Default | Roadway Section Title |
| C-ROAD-SCTN-TTLB | Blue | 5 | Continuous | Default | Roadway Section Border |
| C-ROAD-SHAP | | 32 | Continuous | Default | Roadway Corridor & Section Shapes |
| C-ROAD-SHAP-PATT | White | 7 | Continuous | Default | Roadway Corridor 7 Section Shapes Hatch |
| C-ROAD-SPIR | Green | 3 | Continuous | Default | Roadway Spirals |
| C-ROAD-STAN | Yellow | 2 | Continuous | Default | Roadway Stationing |
| C-ROAD-STAN-MAJR | Yellow | 2 | Continuous | Default | Roadway Major Stationing Labels |
| C-ROAD-STAN-MINR | Yellow | 2 | Continuous | Default | Roadway Minor Stationing Labels |
| C-ROAD-TEXT | Yellow | 2 | Continuous | Default | Roadway Text |
| C-SAMPLE-LINE | Magenta | 6 | Continuous | Default | Cross Section Sample Lines |
| C-SECTION-VIEW | White | 7 | Continuous | Default | |
| C-SHIMPACK | Magenta | 6 | Continuous | Default | Shimpack Line work |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| C-SIMPSON | | 21 | Continuous | Default | Simpson Hardware Line work |
| C-SIMPSON-HID | | 21 | Hidden | Default | Simpson Hardware Hidden Line work |
| C-SSWR-CNTR | | 200 | Continuous | Default | Sanitary Sewer Center Line work |
| C-SSWR-PIPE | | 200 | Continuous | Default | Sanitary Sewer Pipe Line work |
| C-SSWR-PIPE-PATT | White | 7 | Continuous | Default | Sanitary Sewer Pipe Hatch Pattern |
| C-SSWR-PROF | | 200 | Continuous | Default | Sanitary Sewer Profile Line work |
| C-SSWR-STRC | | 200 | Continuous | Default | |
| C-SSWR-STRC-PATT | | 200 | Continuous | Default | |
| C-SSWR-STRC-PROF | | 200 | Continuous | Default | |
| C-SSWR-TEXT | White | 7 | Continuous | Default | |
| C-STEEL | Green | 3 | Continuous | Default | Steel Line work |
| C-STEEL-BEYND | Orange | 30 | Phantom2 | Default | |
| C-STEEL-HID | Red | 1 | Hidden | Default | |
| C-STRM | White | 7 | Continuous | Default | Storm Line work |
| C-STRM-CNTR | | 170 | Center2 | Default | Storm Center Line work |
| C-STRM-PIPE | | 170 | Continuous | Default | Storm Pipe Line work |
| C-STRM-PIPE-PATT | White | 7 | Continuous | Default | Storm Pipe Hatch Pattern |
| C-STRM-PROF | | 170 | Continuous | Default | Storm Profile Line work |
| C-STRM-STRC | | 170 | Continuous | Default | Storm Line work |
| C-STRM-STRC-PATT | White | 7 | Continuous | Default | Storm Line work |
| C-STRM-TEXT | White | 7 | Continuous | Default | Storm Text |
| C-SYMBOL-1 | White | 7 | Continuous | Default | Symbols - section cuts, labels, titles, etc…. |
| C-SYMBOL-2 | White | 7 | Continuous | Default | Symbols - section cuts, labels, titles, etc…. |
| C-TEXT | White | 7 | Continuous | Default | Text |
| C-TEXT-2 | White | 7 | Continuous | Default | (reserved) Text |
| C-TINN | | 182 | Continuous | Default | |
| C-TINN-BNDY | | 110 | Continuous | Default | |
| C-TINN-VIEW | Shade Grey | 252 | Continuous | Default | |
| C-TOPO | White | 7 | Continuous | Default | |
| C-TOPO-CONT-MAJR-E | Dark Grey | 8 | Continuous | 0.2 | |
| C-TOPO-CONT-MAJR-N | Orange | 30 | Continuous | Default | |
| C-TOPO-CONT-MINR-E | Lt. Grey | 9 | Continuous | 0.09 | |
| C-TOPO-CONT-MINR-N | Beige | 31 | Continuous | Default | |
| C-TOPO-CONT-TEXT | White | 7 | Continuous | Default | |
| C-TOPO-CONT-TEXT-N | Red | 1 | Continuous | Default | |
| C-TOPO-FEAT | | 94 | Continuous | Default | |
| C-TOPO-GRAD | | 94 | Continuous | Default | |
| C-TOPO-GRAD-CUT | | 1 | Continuous | Default | |
| C-TOPO-GRAD-FILL | | 94 | Continuous | Default | |
| C-TOPO-MAJR | Lt. Grey | 9 | Continuous | Default | |
| C-TOPO-MAJR-N | Green | 3 | Continuous | Default | |
| C-TOPO-MINR | Dark Grey | 8 | Continuous | Default | |
| C-TOPO-MINR-N | Yellow | 2 | Continuous | Default | |
| C-TOPO-SLOPE | Cyan | 4 | Continuous | Default | |
| C-TOPO-SPOT-ELEV | Cyan | 4 | Continuous | Default | |

| | | | | | |
|---|---|---|---|---|---|
| C-TOPO-SURF | White | 7 | Continuous | 0.05 | |
| C-TOPO-SURF-BNDRY | White | 7 | Continuous | 0.05 | |
| C-TOPO-SURF-CONT-MAJR | Green | 3 | Continuous | 0.13 | |
| C-TOPO-SURF-CONT-MINR | | 42 | Continuous | 0.09 | |
| C-TOPO-TEXT | White | 7 | Continuous | Default | |
| C-TOPO-USER | | 40 | Continuous | Default | |
| C-TOPO-WDRP | | 141 | Continuous | Default | |
| C-TOPO-WSHD | | 141 | Continuous | Default | |
| C-TOPO-WSHD-TEXT | White | 7 | Continuous | Default | |
| C-WALL | White | 7 | Continuous | Default | Wall Line work |
| C-WALL-HID | Shade Grey | 253 | Hidden | Default | Wall Hidden Line work |
| C-WATER-LINE | Blue | 5 | ISO14W100 | Default | Waterline |
| C-WELD | Cyan | 4 | Continuous | Default | Weld Symbols |
| C-XREF | White | 7 | Continuous | Default | |

## 8.3. Electrical Layers

**Table 11.5—Electrical Layers**

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| E-AIP | | 209 | Hidden2 | Default | Abandon In Place - Outline Only |
| E-CEN | | 244 | Center | Default | |
| E-CEN-2 | | 244 | Center2 | Default | |
| E-CRS-OH-CBLE | Red | 1 | Continuous | Default | Cable Overhead |
| E-CRS-OH-COND | Yellow | 2 | Continuous | Default | Conduit or Tray Overhead |
| E-CRS-UG-CBLE | Cyan | 4 | Continuous | Default | Cable Underground |
| E-CRS-UG-COND | Blue | 5 | Continuous | Default | Conduit Underground |
| E-CRS-UG-MH | Blue | 5 | Continuous | Default | Manhole Underground |
| E-DASH | | 244 | Dashed | Default | |
| E-DASH-2 | | 244 | Dashed2 | Default | |
| E-DIMS | | 142 | Continuous | Default | Dimension |
| E-DOT-2 | | 81 | Dot2 | Default | |
| E-EQPM | Blue | 5 | Continuous | Default | Equipment |
| E-HIDD | | 244 | Hidden | Default | |
| E-HIDD-2 | | 244 | Hidden2 | Default | |
| E-IMAGE | White | 7 | Continuous | Default | Image attachments |
| E-LINE-CTRL | Cyan | 4 | Center2 | Default | |
| E-NETW-ARM1 | White | 7 | Cable_Armor | 0.009 | Network, Ethernet Address |
| E-NETW-CAPH | | 210 | Cable_Cable-Telephone | 0.009 | Network, Cable Phone |
| E-NETW-CAT56 | Blue | 5 | Continuous | 0.009 | Network, CAT 5 or 6 |
| E-NETW-COMP | Blue | 5 | Continuous | 0.009 | Network, Equipment, Computers |
| E-NETW-DH+ | | 210 | Cable_DH+ | 0.009 | Network, DH+ |
| E-NETW-ETHA | White | 7 | Continuous | 0.009 | Network, Ethernet Address |
| E-NETW-ETHC | | 150 | Cable _Ethernet | 0.009 | Network, Ethernet Cable |
| E-NETW-MISC | Green | 3 | Cable_Miscellan-eous_Equipment | 0.009 | Network, Misc |
| E-NETW-OPTC | | 30 | Cable _Optic | 0.009 | Network, Optical, Fiber |
| E-NETW-OPTC-2 | | 30 | Cable _Fiber_Optic | 0.009 | Network, Optical, Fiber |
| E-NETW-SER | | 210 | Cable _Serial | 0.009 | Network, Serial |
| E-NETW-SWIN | | 9 | Continuous | 0.009 | Network, Switch Interconnect |
| E-OBJ-1 | | 77 | Continuous | Default | Thin, Details (0.0037) |
| E-OBJ-2 | White | 7 | Continuous | Default | Standard (0.0100) |
| E-OBJ-3 | | 151 | Continuous | Default | Thick (0.0200) |
| E-OBJ-4 | | 200 | Continuous | Default | Bold (0.0250) |
| E-OBJ-5 | Magenta | 6 | Continuous | Default | Heavy (0.0280) |
| E-OBJ-6 | | 142 | Continuous | Default | Blocks, Symbols, Etc (0.0100) |
| E-PATT | | 44 | Continuous | Default | Patterns and Hatches (0.0100) |
| E-PHAN | | 244 | Continuous | Phantom | |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| E-PHAN-2 | | 244 | Continuous | Phantom | |
| E-PHYS | | 8 | Continuous | Default | Equipment, Light, Reference |
| E-PNL | Magenta | 6 | Continuous | Default | Equipment, Panels |
| E-TEXT-1 | | 124 | Continuous | Default | Text Small 5/64 (0.0781) |
| E-TEXT-2 | White | 7 | Continuous | Default | Text Standard 3/32 (0.09375) |
| E-TEXT-3 | | 151 | Continuous | Default | Text Large 1/8 or 5/32 (0.125 or 0.1563) |
| E-WIRE-1 | | 77 | Continuous | Default | Thin, Details (0.0060) |
| E-WIRE-2 | White | 7 | Continuous | Default | Standard (0.0100) |
| E-WIRE-3 | | 151 | Continuous | Default | Thick (0.0200) |
| E-WIRE-4 | | 200 | Continuous | Default | Bold (0.0250) |
| E-WIRE-5 | | 123 | Continuous | Default | Heavy (0.0280) |
| E-XREF | White | 7 | Continuous | Default | Xref attachments |

## 8.4. Mechanical Layers

**Table 11.6—Mechanical Layers**

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| M-ABNDN-NPLC | | 9 | Dashed2 | Default | |
| M-CMPA-EQPM | | 82 | Continuous | Default | |
| M-CMPA-PIPE | | 33 | Continuous | Default | |
| M-CNDW-EQPM | | 32 | Continuous | Default | |
| M-CNDW-PIPE | | 93 | Continuous | Default | |
| M-CNDW-RETN-PIPE | | 153 | Continuous | Default | |
| M-CNDW-SUPP-PIPE | | 213 | Continuous | Default | |
| M-CONT | | 15 | Continuous | Default | |
| M-CONT-THER | | 135 | Continuous | Default | |
| M-CONT-WIRE | | 85 | Continuous | Default | |
| M-CWTR-COND | | 23 | Continuous | Default | |
| M-CWTR-EQPM | | 142 | Continuous | Default | |
| M-CWTR-PIPE | | 83 | Continuous | Default | |
| M-CWTR-RETN-PIPE | | 143 | Continuous | Default | |
| M-CWTR-SUPP-PIPE | | 203 | Continuous | Default | |
| M-DIMS | | 72 | Continuous | Default | |
| M-DOMW-EQPM | | 202 | Continuous | Default | |
| M-DOMW-PIPE | | 193 | Continuous | Default | |
| M-DUST-DUCT | | 213 | Continuous | Default | |
| M-DUST-EQPM | | 152 | Continuous | Default | |
| M-EQPM | White | 7 | Continuous | Default | |
| M-EXHS-CDFF | | 33 | Continuous | Default | |
| M-EXHS-DUCT | | 93 | Continuous | Default | |
| M-EXHS-EQPM | | 92 | Continuous | Default | |
| M-EXHS-GRIL | | 33 | Continuous | Default | |
| M-FUEL-EQPM | | 52 | Continuous | Default | |
| M-FUEL-GGEP | | 133 | Continuous | Default | |
| M-FUEL-GGEP-HPIP | | 63 | Continuous | Default | |
| M-FUEL-GGEP-LPIP | | 243 | Continuous | Default | |
| M-GLYC | | 183 | Continuous | Default | |
| M-GLYC-RETN | | 123 | Continuous | Default | |
| M-GLYC-RETN-PIPE | | 123 | Continuous | Default | |
| M-GLYC-SUPP | | 183 | Continuous | Default | |
| M-GLYC-SUPP-PIPE | | 183 | Continuous | Default | |
| M-HOTW-EQPM | | 212 | Continuous | Default | |
| M-HOTW-PIPE | | 73 | Continuous | Default | |
| M-HVAC-CDFF-RETN | | 113 | Continuous | Default | |
| M-HVAC-CDFF-SUPP | | 173 | Continuous | Default | |
| M-HVAC-DMPR | | 233 | Continuous | Default | |
| M-HVAC-DUCT-MA | | 83 | Continuous | Default | |
| M-HVAC-DUCT-RETN | | 23 | Continuous | Default | |
| M-HVAC-DUCT-SUPP | | 233 | Continuous | Default | |
| M-HVAC-EQPM | | 42 | Continuous | Default | |
| M-HVAC-EQPM-CLER | Cyan | 4 | Continuous | Default | |
| M-HVAC-GRIL-RETN | | 113 | Continuous | Default | |

| Layer Name | Color | # | Linetype | Lineweight | Description |
|---|---|---|---|---|---|
| M-HVAC-GRIL-SUPP | | 173 | Continuous | Default | |
| M-IDEN | White | 7 | Continuous | Default | |
| M-IMAGE | White | 7 | Continuous | Default | Image attachments |
| M-INSTR | White | 7 | Continuous | Default | |
| M-INSTR-L | Cyan | 4 | Dashed2 | Default | |
| M-MISC | | 251 | Phantom2 | Default | |
| M-NGAS-EQPM | | 102 | Continuous | Default | |
| M-NGAS-PIPE | Green | 3 | Continuous | Default | |
| M-PIPE-P | Green | 3 | Continuous | Default | |
| M-PIPE-S | Blue | 5 | Continuous | Default | |
| M-PROC-EQPM | | 162 | Continuous | Default | |
| M-PROC-PIPE | | 133 | Continuous | Default | |
| M-RCOV-EQPM | | 222 | Continuous | Default | |
| M-RCOV-PIPE | | 193 | Continuous | Default | |
| M-REFG-DISC | | 203 | Continuous | Default | |
| M-REFG-EQPM | | 232 | Continuous | Default | |
| M-REFG-PIPE | | 143 | Continuous | Default | |
| M-REFG-RETN | | 93 | Continuous | Default | |
| M-REFG-SUPP | | 43 | Continuous | Default | |
| M-REV-CLD-D | | 70 | Continuous | Default | |
| M-REV-CLD-N | | 10 | Continuous | Default | |
| M-SMOK-CDFF | | 103 | Continuous | Default | |
| M-SMOK-DUCT | | 163 | Continuous | Default | |
| M-SMOK-EQPM | | 112 | Continuous | Default | |
| M-SPCL-EQPM | | 242 | Continuous | Default | |
| M-SPCL-PIPE | | 213 | Continuous | Default | |
| M-STEM-BLBD-PIPE | | 153 | Continuous | Default | |
| M-STEM-COND-PIPE | | 53 | Continuous | Default | |
| M-STEM-EQPM | | 172 | Continuous | Default | |
| M-STEM-HPIP | | 113 | Continuous | Default | |
| M-STEM-LPIP | | 173 | Continuous | Default | |
| M-STEM-MPIP | | 223 | Continuous | Default | |
| M-SYMB | | 136 | Continuous | Default | |
| M-TEST | | 233 | Continuous | Default | |
| M-TEXT | White | 7 | Continuous | Default | |
| M-TEXT-BOLD | White | 7 | Continuous | Default | |
| M-XREF | White | 7 | Continuous | Default | Xref attachments |

## 8.5. Survey Layers

**Table 11.7—Survey Layers**

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| V-CONTROL | Red | 1 | Continuous | 0.35 | Property or Control Mon. Found |
| V-POINT | White | 7 | Continuous | Default | Survey Point Objects & Labels |
| V-POINT-CALC | | 70 | Continuous | Default | Survey Calc. Points |
| V-POINT-CONTROL | | 10 | Continuous | 0.35 | Set or Found Control Point |
| V-POINT-MON | Magenta | 6 | Continuous | 0.35 | Property or Est. Geodetic Control Mon. |
| V-PROPLINE-EASEMENTS | White | 7 | Dashed | 0.35 | Easement Lines |
| V-PROPLINE-MAJR | | 40 | Phantom2 | 0.7 | Property Lines Around PGE |
| V-PROPLINE-MINR | | 41 | Phantom2 | 0.5 | Standard Property Lines |
| V-PROPLINE-TEXT | White | 7 | Continuous | 0.35 | ALL Bearings & Distances |
| V-PROPOSED | White | 7 | Continuous | Default | Proposed Improvements |
| V-TABLE | White | 7 | Continuous | Default | Point Table |
| V-TEXT | White | 7 | Continuous | Default | MS Survey Text |
| V-TEXT-DETAIL | White | 7 | Continuous | Default | Survey Detail Text |
| | | | | | |
| V-X-ASPHALT | Green | 3 | Continuous | Default | Asphalt Line work |
| V-X-BREAKLINE | White | 7 | Continuous | Default | Misc. Break line Layer (D.N.P.) |
| V-X-BUILDING | Red | 1 | Continuous | 0.5 | Building or Structures Line work |
| V-X-COMM | | 40 | Continuous | Default | Fiber Optic, Cable TV or Telephone Lines |
| V-X-CONCRETE | Dark Grey | 8 | Continuous | Default | Concrete Line work |
| V-X-DIRTROAD | | 44 | Continuous | Default | Dirt Road Line work |
| V-X-DITCH | | 140 | Divide2 | Default | Ditch Line work |
| V-X-FENCE | Magenta | 6 | Fenceline1 | Default | Fences, Gates, Posts & Barriers |
| V-X-GAS | | 52 | Gas_Line | Default | Natural Gas, Petroleum Lines & Facilities |
| V-X-GRAVEL | White | 7 | Continuous | Default | Gravel Line work |
| V-X-MON-WELL | Red | 1 | Continuous | Default | Monitoring Well |
| V-X-POWER | | 20 | Continuous | Default | Power Lines, Poles, Anchors & Structures |
| V-X-ROCK | Dark Grey | 8 | Continuous | Default | Natural Boulders, Bedrock |
| V-X-RXR | Magenta | 6 | Continuous | Default | Railroad Tracks & Structures |
| V-X-SANITARY | | 60 | Continuous | Default | Sewer Pipe, Manholes & Facilities |
| V-X-STORM | | 140 | Continuous | Default | Catch Basins, Manholes & Facilities |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| V-X-TOE | Cyan | 4 | Continuous | Default | Toe of Slope, Walls |
| V-X-TOP | | 200 | Continuous | Default | Top of Banks, Slopes, Walls |
| V-X-TREE | | 114 | Continuous | Default | Trees, Shrubs, Vegetation |
| V-X-WALL | | 11 | Continuous | Default | Manmade Walls, Gabions, Concrete & Rip-Rap |
| V-X-WATER | Blue | 5 | Continuous | Default | Water, Swamp, Pool Line work |
| V-X-WATER-UTILITY | Blue | 5 | Continuous | Default | Domestic Water Utility & Facilities |
| | | | | | |
| X-BLUE | Blue | 5 | Continuous | Default | |
| X-BOULDER | | 138 | Continuous | Default | |
| X-BUILDING | Yellow | 2 | Continuous | Default | |
| X-CABLETV | Orange | 30 | Continuous | Default | |
| X-CONCRETE | White | 7 | Continuous | Default | |
| X-CYAN | Cyan | 4 | Continuous | Default | |
| X-DITCH | | 150 | Continuous | Default | |
| X-EDGE-TIMBER | | 82 | Continuous | Default | |
| X-FENCE | Magenta | 6 | Continuous | Default | |
| X-FIBER-OPTIC | Beige | 31 | Continuous | Default | |
| X-GAS | | 50 | Continuous | Default | |
| X-GRAVEL | White | 7 | Continuous | Default | |
| X-GREEN | Green | 3 | Continuous | Default | |
| X-MAGENTA | Magenta | 6 | Continuous | Default | |
| X-MON-FOUND | Magenta | 6 | Continuous | Default | |
| X-MON-WELL | Red | 1 | Continuous | Default | |
| X-PAVEMENT | Green | 3 | Continuous | Default | |
| X-POWER | Red | 1 | Continuous | Default | |
| X-RED | Red | 1 | Continuous | Default | |
| X-SANITARY | | 80 | Continuous | Default | |
| X-SIGN | Magenta | 6 | Continuous | Default | |
| X-STORM | | 152 | Continuous | Default | |
| X-TELEPHONE | | 40 | Continuous | Default | |
| X-TOEBANK | Cyan | 4 | Continuous | Default | |
| X-TOPBANK | Magenta | 6 | Continuous | Default | |
| X-TREE(CON) | | 112 | Continuous | Default | |
| X-TREE(DEC) | | 42 | Continuous | Default | |

| Layer Name | Color | # | Linetype | Line Weight | Description |
|---|---|---|---|---|---|
| X-WALL | | 42 | Continuous | Default | |
| X-WATER | | 150 | Continuous | Default | |
| X-WHITE | White | 7 | Continuous | Default | |
| X-YELLOW | Yellow | 2 | Continuous | Default | |

# XII. ABREVIATIONS

## 1. PSES Common System Codes & Abbreviations

| | | |
|---|---|---|
| BLDG | = | BUILDING |
| CHEM | = | CHEMICAL SYSTEMS |
| COND | = | CONDUIT |
| EQPM | = | EQUIPMENT |
| FNDN | = | FOUNDATION |
| GAS | = | GAS SYSTEMS |
| GRND | = | GROUNDING |
| HRSG | = | HEAT RECOVERY STEAM GENERATOR |
| LGHT | = | LIGHTING |
| RCWY | = | RACEWAY (CABLE TRAYS) |
| SLDS | = | SOLIDS SYSTEMS |
| WAST | = | WASTE SYSTEMS |

**Sub-Codes**

| | | |
|---|---|---|
| EP | = | ELECTRICAL PLUGS / PANEL / ELECTRICAL PLAN |
| SS | = | SPECIAL SYSTEMS |

## 2. Survey Abbreviations

| | | |
|---|---|---|
| AC | = | ASPHALT SURFACE |
| ALC | = | ALUMINUM CAP |
| BC | = | BRASS CAP |
| BFR | = | BOULDER |
| BL | = | BOLLARD |
| BLD | = | BUILDING CORNER |
| BM | = | BENCH MARK |
| BW | = | BACK OF SIDEWALK |
| CB | = | CATCH BASIN |
| CI | = | CURB INLET |
| CL | = | CENTERLINE |
| CLD | = | CENTERLINE DITCH |
| CLP | = | CENTERLINE PIPE |
| CLR | = | CENTERLINE ROAD |
| CLS | = | CENTERLINE STREAM |
| CLT | = | CENTERLINE TRAIL |
| CMP | = | CORRUGATED METAL PIPE |
| CO | = | CLEAN OUT |
| CONC | = | CONCRETE |
| CPP | = | CORRUGATED PLASTIC PIPE |
| CT | = | CONIFER TREE GENERAL |
| CTC | = | CEDAR TREE |
| CTF | = | FIR TREE |
| CTH | = | HEMLOCK TREE |
| CTJ | = | JUNIPER TREE |

## Survey Abbreviations (continued)

| | | |
|---|---|---|
| CTP | = | PINE TREE |
| CTR | = | REDWOOD TREE |
| CTS | = | CONIFER TREE SNAG |
| CTY | = | YEW TREE |
| CW | = | CONCRETE WALL |
| DC | = | DITCH |
| DCI | = | DITCH INLET |
| DH | = | DRILL HOLE |
| DI | = | DUCTILE IRON PIPE |
| DIA or Ø | = | DIAMETER |
| DIR | = | DIRECTION |
| DIST | = | DISTANCE or DISTRIBUTED |
| DP | = | DAYLIGHT PIPE |
| DT | = | DECIDUOUS TREE GENERAL |
| DTA | = | ALDER TREE |
| DTC | = | COTTONWOOD TREE |
| DTD | = | DOGWOOD TREE |
| DTM | = | MAPLE TREE |
| DTR | = | RUSSIAN OLIVE TREE |
| DWG | = | DRAWING |
| EC | = | EDGE OF CONCRETE |
| EG | = | EDGE OF GRAVEL |
| EJB | = | ELECTRICAL JUNCTION BOX |
| EL or ELEV | = | ELEVATION |
| EP | = | EDGE OF PAVEMENT |
| ER | = | EDGE OF DIRT ROAD |
| ES | = | EDGE OF STREAM |
| EV | = | EDGE OF VEGETATION |
| EW | = | EDGE OF WATER |
| FDC | = | FIRE DEPARTMENT CONNECTION |
| FDN | = | FOUNDATION |
| FF | = | FINISHED FLOOR |
| FH | = | FIRE HYDRANT |
| FL | = | FLOW LINE |
| FNC | = | FENCE |
| FO | = | FACE OF |
| FOMH | = | FIBER OPTIC MANHOLE |
| FOR | = | FIBER OPTIC RISER |
| FOV | = | FIBER OPTIC VAULT |
| FP | = | FIRE PLUG |
| FT | = | FEET or FOOT |
| FTG | = | FOOTING |
| FV | = | FIRE VALVE |
| FVL | = | FIRE VAULT |
| GB | = | GABION BASKET WALL |
| GL | = | GAS LINE |

**Survey Abbreviations (continued)**

| | | |
|---|---|---|
| GLB | = | GAS LINE BLUE TEST RISER |
| GLM | = | GAS LINE METER |
| GLR | = | GAS LINE RISER |
| GLT | = | GAS LINE TEE |
| GLV | = | GAS LINE VALVE |
| GND | = | GROUND SHOT |
| GR | = | GUARDRAIL |
| GRD | = | GRADE |
| GUY | = | GUY ANCHOR |
| HT | = | HEIGHT |
| HORIZ | = | HORIZONTAL |
| ID | = | INTERIOR DIAMTER |
| IE | = | INVERT ELEVATION |
| IF | = | INSIDE FACE |
| IN | = | INCHES |
| INFO | = | INFORMATION |
| IR | = | IRON ROD |
| IP | = | IRON PIPE |
| LP | = | LIGHT POLE |
| MISC | = | MISCELLANEOUS |
| MH | = | MANHOLE UNKNOWN |
| MP | = | METAL PIPE SMOOTH |
| MV | = | MONUMENT VAULT |
| MW | = | MONITORING WELL |
| NTS | = | NOT TO SCALE |
| OD | = | OUTSIDE DIAMETER |
| OF | = | OUTSIDE FACE |
| OH | = | OVER HEAD |
| PL | = | POWER LINE OVERHEAD |
| PLC | = | CONDUCTOR |
| PLM | = | POWER METER |
| PLMH | = | POWER MANHOLE |
| PLP | = | POWER POLE |
| PLS | = | POWER SWITCH |
| PLT | = | POWER TRANSFORMER |
| PLTR | = | POWER TRANSMISSION LINE |
| PLTT | = | POWER TRANSMISSION TOWER |
| PLU | = | POWER LINE UNDERGROUND |
| PLV | = | POWER VAULT |
| POC | = | POINT ON CURVE |
| PP | = | PLASTIC PIPE SMOOTH |
| PT | = | POINT OF TANGENT |
| R or RAD | = | RADIUS |
| REQ'D | = | REQUIRED |
| REV | = | REVISION |
| RPC | = | RED PLASTIC CAP |

## Survey Abbreviations (continued)

| | | |
|---|---|---|
| SF | = | SQUARE FOOT or FEET |
| SHT | = | SHEET |
| SQ | = | SQUARE |
| SS | = | SANITARY SEWER LINE |
| SSCO | = | SANITARY CLEANOUT |
| SSMH | = | SANITARY MANHOLE |
| SST | = | SANITARY TEE |
| ST | = | STORM SEWER LINE |
| STCO | = | STORM CLEANOUT |
| STMH | = | STORM MANHOLE |
| STT | = | STORM TEE |
| TBC | = | TOP BACK OF CURB |
| TFC | = | TOP FACE OF CURB |
| TL | = | TELEPHONE LINE |
| TLMH | = | TELEPHONE MANHOLE |
| TLR | = | TELEPHONE RISER |
| TLV | = | TELEPHONE VAULT |
| TO | = | TOP OF |
| TOB | = | TOP OF BANK |
| TOE | = | TOE OF FEATURE |
| TOP | = | TOP OF FEATURE |
| TOW | = | TOE WALL |
| TPW | = | TOP WALL |
| TYP | = | TYPICAL |
| UP | = | UTILITY POLE |
| VERT | = | VERTICAL |
| W/ | = | WITH |
| W/O | = | WITHOUT |
| WL | = | UTILITY WATER LINE |
| WLM | = | WATER METER |
| WLMH | = | WATER MANHOLE |
| WLT | = | WATER TEE |
| WLV | = | WATER VALVE |
| WLVT | = | WATER VAULT |
| YPC | = | YELLOW PLASTIC CAP |
| +/- or ± | = | PLUS or MINUS |
| ° | = | DEGREES |

## 3. Civil/Structural Abbreviations

| | | |
|---|---|---|
| A.B. or A.B.'s | = | ANCHOR BOLT(S) |
| ADDL. | = | ADDITIONAL |
| A.F.F. | = | ABOVE FINISH FLOOR |
| ALT. | = | ALTERNATE |
| ARCH. | = | ARCHITECTURAL |
| BM. | = | BEAM |
| BMU | = | BRICK MASONRY UNIT |
| BLDG. | = | BUILDING |
| BLK. | = | BLOCK |
| BLKG. | = | BLOCKING |
| B.O. | = | BOTTOM OF |
| BOT. | = | BOTTOM |
| BRG. | = | BEARING |
| BTWN. | = | BETWEEN |
| C | = | CAMBER |
| C'SINK | = | COUNTERSINK |
| CB | = | CATCH BASIN |
| CC | = | CENTER TO CENTER |
| C.I.P. | = | CAST IN-PLACE |
| C.J. | = | CONSTRUCTION or COLD JOINT |
| CJP | = | COMPLETE JOINT PENETRATION |
| ℄ or CL | = | CENTER LINE |
| CLR. | = | CLEAR |
| CMU | = | CONCRETE MASONRY UNIT |
| CNTR. | = | CENTER |
| CNTR'D | = | CENTERED |
| C.O. | = | CLEAN OUT |
| COL. | = | COLUMN |
| CONC. | = | CONCRETE |
| CONN. | = | CONNECTION |
| CONT. | = | CONTINUOUS |
| CONT'D | = | CONTINUED |
| CONST. | = | CONSTRUCTION |
| DBA. | = | DEFORMED BAR ANCHOR |
| DBL. | = | DOUBLE |
| DTL. | = | DETAIL |
| D.F. | = | DOUGLAS FIR |
| DIA. or Ø | = | DIAMETER |
| DIAG. | = | DIAGONAL |
| DIM. | = | DIMENSION |
| DIR. | = | DIRECTION |
| DIST. | = | DISTANCE or DISTRUBUTED |
| D.L. | = | DEAD LOAD |
| DO. | = | DITTO |
| DP. | = | DEEP |
| DWG. | = | DRAWING |

## Civil/Structural Abbreviations (continued)

| | | |
|---|---|---|
| DWN. | = | DOWN |
| EA. | = | EACH |
| E.J. | = | EXPANSION JOINT |
| E.F. | = | EACH FACE |
| EL. or ELEV. | = | ELEVATION |
| EMBED. | = | EMBEDMENT |
| EQ. | = | EQUAL |
| EQUIP. | = | EQUIPMENT |
| E.W. | = | EACH WAY |
| EXP. | = | EXPANSION |
| EXIST. or (E) | = | EXISTING |
| EXT. | = | EXTERIOR |
| F.C.O. | = | FLOOR CLEAN OUT |
| FD. | = | FLOOR DRAIN |
| FDN. | = | FOUNDATION |
| F.F. | = | FINISH FLOOR |
| FIN. | = | FINISH |
| FLR. | = | FLOOR |
| FLNG. | = | FLANGE |
| F.O. | = | FACE OF |
| FRP. | = | FIBERGLASS REINFORCED PLASTIC |
| FS | = | FAR SIDE |
| FT. | = | FEET or FOOT |
| FTG. | = | FOOTING |
| GA. | = | GAGE or GAUGE |
| GALV. | = | GALVANIZED |
| GEN. | = | GENERAL |
| GEOTECH. | = | GEOTECHNICAL |
| GLB. | = | GLUE LAMINATED BEAM |
| GRD. | = | GRADE |
| GYP. WALL BD. | = | GYPSUM WALL BOARD |
| HD. | = | HOLDDOWN |
| HDR. | = | HEADER |
| H.F. | = | HEM-FIR |
| HGR. | = | HANGER |
| HORIZ. | = | HORIZONTAL |
| HSS. | = | HOLLOW STRUCTURAL SECTION |
| HT. | = | HEIGHT |
| IBC. | = | INTERNATIONAL BUILDING CODE |
| ID. | = | INTERIOR DIAMETER |
| I.E. | = | INVERT ELEVATION |
| I.F. | = | INSIDE FACE |
| IN. | = | INCH or INCHES |
| INFO. | = | INFORMATION |
| INT. | = | INTERIOR |
| JST. | = | JOIST |

## Civil/Structural Abbreviations (continued)

| | | |
|---|---|---|
| JT. | = | JOINT |
| k | = | KIPS |
| KSF. | = | KIPS PER SQUARE FOOT |
| L or ∠ | = | ANGLE |
| LBS. or #'s | = | POUNDS |
| L.F. | = | LINEAL FOOT |
| L.L. | = | LIVE LOAD |
| LLH. | = | LONG LEG HORIZONTAL |
| LLV. | = | LONG LEG VERTICAL |
| LONGIT. | = | LONGITUDINAL |
| LSL. | = | LAMINATED STRAND LUMBER |
| LVL. | = | LAMINATED VENEER LUMBER |
| LT. | = | LIGHT or LITE |
| L.V.F. | = | LOW VELOCITY FASTENER |
| MANUF. | = | MANUFACTURER |
| MBR. | = | MEMBER |
| MAT'L. | = | MATERIAL |
| MAX. | = | MAXIMUM |
| MECH. | = | MECHANICAL |
| MEZZ. | = | MEZZANINE |
| MFR. | = | MANUFACTURER |
| MH | = | MAN HOLE |
| MIN. | = | MINIMUM |
| MISC. | = | MISCELLANEOUS |
| (N) | = | NEW |
| N.I.C. | = | NOT IN CONTRACT |
| NOM. | = | NOMINAL |
| NS | = | NEAR SIDE |
| N-S | = | NON-SHRINK |
| N.T.S. | = | NOT TO SCALE |
| OC | = | ON CENTER |
| O.D. | = | OUTSIDE DIAMETER |
| O.F. | = | OUTSIDE FACE |
| O.H. | = | OVER HEAD |
| OPNG. | = | OPENING |
| OPP. | = | OPPOSITE |
| OWSJ | = | OPEN WEB STEEL JOIST |
| OWWJ | = | OPEN WEB WOOD JOIST |
| PCF | = | POUNDS PER CUBIC FOOT |
| PERP. | = | PERPENDICULAR |
| PJP | = | PARTIAL JOINT PENETRATION |
| PL | = | PLATE |
| PLYWD. | = | PLYWOOD |
| PROJ. | = | PROJECTION |
| PSF | = | POUNDS PER SQUARE FOOT |
| PSI | = | POUNDS PER SQUARE INCH |

## Civil/Structural Abbreviations (continued)

| | | |
|---|---|---|
| P.T. | = | PRESSURE TREATED |
| P-T | = | POST TENSIONED |
| R. or RAD. | = | RADIUS |
| REF. | = | REFER or REFERENCE |
| REINF. | = | REINFORCEMENT / REINFORCING |
| REQ'D. | = | REQUIRED |
| REV. | = | REVISION |
| SCHED. | = | SCHEDULE |
| SECT. | = | SECTION |
| SF | = | SQUARE FOOT or FEET |
| SHT. | = | SHEET |
| SIM | = | SIMILAR |
| S.O.G. | = | SLAB ON GRADE |
| SPEC. or SPEC'S. | = | SPECIFICATION(S) |
| SQ. | = | SQUARE |
| S.S. | = | STAINLESS STEEL |
| STD. | = | STANDARD |
| STIFF. | = | STIFFENER |
| STL. | = | STEEL |
| STRUCT. | = | STRUCTURAL |
| SWWJ. | = | SOLID WEB WOOD JOIST |
| SYMM. | = | SYMMETRICAL |
| T & B | = | TOP & BOTTOM |
| TC. AX. LD. | = | TOP CHORD AXIAL LOAD |
| TCX. | = | TOP CHORD EXTENSION |
| TDS. | = | TIE DOWN SYSTEM |
| T&G | = | TONGUE & GROOVE |
| THK'D. | = | THICKENED |
| THRD. | = | THREAD |
| THRU | = | THROUGH |
| T.O. | = | TOP OF |
| TRANSV. | = | TRANSVERSE |
| TYP | = | TYPICAL |
| U.N.O. | = | UNLESS NOTED OTHERWISE |
| VERT. | = | VERTICAL |
| W.J. | = | WET JOINT |
| WP | = | WORK POINT |
| WT. | = | WEIGHT |
| W.W.F. | = | WELDED WIRE FABRIC |
| W/ | = | WITH |
| W/O | = | WITHOUT |
| +/- or ± | = | PLUS or MINUS |
| ° | = | DEGREE(S) |

## 4. Electrical Abbreviations

| | | |
|---|---|---|
| ATS | = | AUTOMATIC TRANSFER SWITCH |
| AVR | = | AUTOMATIC |
| DCS | = | DISTRIBUTED CONTROL SYSTEM |
| EUH | = | ELECTRIC UNIT HEATER |
| PLC | = | PROGRAMMABLE LOGIC CONTROLLER |
| RTS | = | RELAY TRANSFER SWITCH |

### 4.1. Device Abbreviations

| | |
|---|---|
| AH | ALARM HIGH |
| AI | ALARM INDICATOR |
| AL | ALARM LOW |
| AO | ANALOG OUTPUT |
| AAH | ANALYZER ALARM HIGH |
| AAL | ANALYZER ALARM LOW |
| AY | ANALYZER COMPUTER |
| AC | ANALYZER CONTROLLER |
| AE | ANALYZER ELEMENT |
| AI | ANALYZER INDICATOR |
| AIC | ANALYZER INDICATOR CONTROLLER |
| AIT | ANALYZER INDICATOR TRANSMITTER |
| AW | ANALYZER PROBE |
| AR | ANALYZER RECORDER |
| ARC | ANALYZER RECORDER CONTROLLER |
| ART | ANALYZER RECORDER TRANSMITTER |
| ASH | ANALYZER SWITCH HIGH |
| ASHL | ANALYZER SWITCH HIGH LOW |
| ASL | ANALYZER SWITCH LOW |
| AP | ANALYZER TEST POINT |
| AT | ANALYZER TRANSMITTER |
| ATM | ATMOSPHERE |
| AWT | AUTOMATIC WELL TEST |
| AOJ | AUTO-OFF-JOG SELECTOR SWITCH |
| BPV | BACK PRESSURE VALVE |
| BDV | BLOW DOWN VALVE |
| B | BURNER |
| BY | BURNER COMPUTER |
| BC | BURNER CONTROLLER |
| BE | BURNER ELEMENT |
| BG | BURNER GLASS |
| BI | BURNER INDICATOR |
| BIC | BURNER INDICATOR CONTROLLER |
| BIT | BURNER INDICATOR TRANSMITTER |
| BW | BURNER PROBE |
| BR | BURNER RECORDER |
| BRC | BURNER RECORDER CONTROLLER |
| BRT | BURNER RECORDER TRANSMITTER |

**Device Abbreviations (continued)**

| | |
|---|---|
| BSH | BURNER SWITCH HIGH |
| BSHL | BURNER SWITCH HIGH LOW |
| BSL | BURNER SWITCH LOW |
| BT | BURNER TRANSMITTER |
| CS | CAR SEAL |
| CSC | CAR SEAL CLOSED |
| CSO | CAR SEAL OPEN |
| CAH | CONDUCTIVITY ALARM HIGH |
| CAL | CONDUCTIVITY ALARM LOW |
| CE | CONDUCTIVITY ELEMENT |
| CIT | CONDUCTIVITY INDICATING TRANSMITTER |
| CSH | CONDUCTIVITY SHUTDOWN HIGH |
| CSL | CONDUCTIVITY SHUTDOWN LOW |
| CS | CONDUCTIVITY SWITCH |
| CC | CORROSION COUPON |
| IY | CURRENT COMPUTER |
| IE | CURRENT ELEMENT |
| II | CURRENT INDICATOR |
| IIC | CURRENT INDICATOR CONTROLLER |
| IIT | CURRENT INDICATOR TRANSMITTER |
| IR | CURRENT RECORDER |
| IRC | CURRENT RECORDER CONTROLLER |
| IRT | CURRENT RECORDER TRANSMITTER |
| ISH | CURRENT SWITCH HIGH |
| ISHL | CURRENT SWITCH HIGH LOW |
| ISL | CURRENT SWITCH LOW |
| IT | CURRENT TRANSMITTER |
| CP | CUT PROBE |
| DE | DENSITY ELEMENT |
| DR | DENSITY RECORDER |
| DT | DENSITY TRANSMITTER |
| DPSH | DIFFERENTIAL PRESSURE SHUTDOWN HIGH |
| DPSL | DIFFERENTIAL PRESSURE SHUTDOWN LOW |
| DTT | DIFFERENTIAL TEMPERATURE TRANSMITTER |
| DI | DISCRETE INPUT (DIGITAL INPUT) |
| DO | DISCRETE OUTPUT (DIGITAL OUTPUT) |
| ESD | EMERGENCY SHUTDOWN |
| YY | EVENT COMPUTER |
| YC | EVENT CONTROLLER |
| YE | EVENT ELEMENT |
| YI | EVENT INDICATOR |
| YIC | EVENT INDICATOR CONTROLLER |
| YR | EVENT RECORDER |
| YSH | EVENT SWITCH HIGH |
| YSL | EVENT SWITCH LOW |
| YT | EVENT TRANSMITTER |

**Device Abbreviations (continued)**

| | |
|---|---|
| FC | FAIL CLOSED |
| FO | FAIL OPEN |
| FP | FAIL POSITION |
| FA | FIRE ALARM |
| FA | FLAME ARRESTOR |
| F | FLOW |
| FY | FLOW COMPUTER |
| FCV | FLOW CONTROL VALVE |
| FC | FLOW CONTROLLER |
| FE | FLOW ELEMENT |
| FG | FLOW GLASS |
| FI | FLOW INDICATOR |
| FIC | FLOW INDICATOR CONTROLLER |
| FIT | FLOW INDICATOR TRANSMITTER |
| FM | FLOW METER |
| FO | FLOW ORIFICE |
| FQY | FLOW QUALITY COMPUTER |
| FQE | FLOW QUALITY ELEMENT |
| FQI | FLOW QUALITY INDICATOR |
| FQIC | FLOW QUALITY INDICATOR CONTROLLER |
| FQIT | FLOW QUALITY INDICATOR TRANSMITTER |
| FQR | FLOW QUALITY RECORDER |
| FQRC | FLOW QUALITY RECORDER CONTROLLER |
| FQSH | FLOW QUALITY SWITCH HIGH |
| FQSL | FLOW QUALITY SWITCH LOW |
| FQT | FLOW QUALITY TRANSMITTER |
| FFC | FLOW RATIO CONTROLLER |
| FFI | FLOW RATIO INDICATOR |
| FFIC | FLOW RATIO INDICATOR CONTROLLER |
| FFR | FLOW RATIO RECORDER |
| FFRC | FLOW RATIO RECORDER CONTROLLER |
| FFSH | FLOW RATIO SWITCH HIGH |
| FFSL | FLOW RATIO SWITCH LOW |
| FR | FLOW RECORDER |
| FRC | FLOW RECORDER CONTROLLER |
| FRT | FLOW RECORDER TRANSMITTER |
| FSV | FLOW SAFETY VALVE |
| FS | FLOW SWITCH |
| FP | FLOW TEST POINT |
| FT | FLOW TRANSMITTER |
| GDE | GAS DETECTOR ELEMENT |
| ZDY | GAUGE DEVIATION COMPUTER |
| ZDCV | GAUGE DEVIATION CONTROL VALVE |
| ZDC | GAUGE DEVIATION CONTROLLER |
| ZDE | GAUGE DEVIATION ELEMENT |
| ZDI | GAUGE DEVIATION INDICATOR |

**Device Abbreviations (continued)**

| | |
|---|---|
| ZDIC | GAUGE DEVIATION INDICATOR CONTROLLER |
| ZDIT | GAUGE DEVIATION INDICATOR TRANSMITTER |
| ZDR | GAUGE DEVIATION RECORDER |
| ZDRC | GAUGE DEVIATION RECORDER CONTROLLER |
| ZDRT | GAUGE DEVIATION RECORDER TRANSMITTER |
| ZDSH | GAUGE DEVIATION SWITCH HIGH |
| ZDSL | GAUGE DEVIATION SWITCH LOW |
| ZDT | GAUGE DEVIATION TRANSMITTER |
| HC | HAND CONTROLLER |
| HIC | HAND INDICATOR CONTROLLER |
| HS | HAND SWITCH |
| HOA | HAND-OFF-AUTOMATIC SELECTOR SWITCH |
| IA | INSTRUMENT AIR |
| LACT | LEASE AUTOMATIC CUSTODY TRANSFER |
| L | LEVEL |
| LAD | LEVEL ALARM DEVICE |
| LAHI | LEVEL ALARM HIGH INTERFACE |
| LY | LEVEL COMPUTER |
| LCV | LEVEL CONTROL VALVE |
| LCVI | LEVEL CONTROL VALVE INTERFACE |
| LC | LEVEL CONTROLLER |
| LCI | LEVEL CONTROLLER INTERFACE |
| LD | LEVEL DIFFERENTIAL |
| LE | LEVEL ELEMENT |
| LEI | LEVEL ELEMENT INTERFACE |
| LG | LEVEL GLASS |
| LI | LEVEL INDICATOR |
| LIC | LEVEL INDICATOR CONTROLLER |
| LICI | LEVEL INDICATOR CONTROLLER INTERFACE |
| LIT | LEVEL INDICATOR TRANSMITTER |
| LW | LEVEL PROBE |
| LR | LEVEL RECORDER |
| LRC | LEVEL RECORDER CONTROLLER |
| LRT | LEVEL RECORDER TRANSMITTER |
| LSHI | LEVEL SHUTDOWN HIGH INDICATOR |
| LSL | LEVEL SHUTDOWN LOW |
| LSLI | LEVEL SHUTDOWN LOW INDICATOR |
| LS | LEVEL SWITCH |
| LSHH | LEVEL SWITCH HIGH HIGH |
| LSL | LEVEL SWITCH LOW |
| LSLL | LEVEL SWITCH LOW LOW |
| LT | LEVEL TRANSMITTER |
| LTI | LEVEL TRANSMITTER INTERFACE |
| LL | LIQUID LEVEL |
| LLC | LIQUID LEVEL CONTROLLER |
| LLG | LIQUID LEVEL GAUGE |

**Device Abbreviations (continued)**

| | |
|---|---|
| LC | LOCK CLOSED |
| LO | LOCK OPEN |
| UY | MULTIVARIABLE COMPUTER |
| UI | MULTIVARIABLE INDICATOR |
| UR | MULTIVARIABLE RECORDER |
| NOC | NET OIL COMPUTER |
| NC | NORMALLY CLOSED |
| NO | NORMALLY OPEN |
| OWD | OIL WATER DETECTOR |
| OM | ORIFICE METER |
| ZY | POSITION COMPUTER |
| ZCV | POSITION CONTROL VALVE |
| ZC | POSITION CONTROLLER |
| ZE | POSITION ELEMENT |
| ZI | POSITION INDICATOR |
| ZIC | POSITION INDICATOR CONTROLLER |
| ZIT | POSITION INDICATOR TRANSMITTER |
| ZR | POSITION RECORDER |
| ZRC | POSITION RECORDER CONTROLLER |
| ZRT | POSITION RECORDER TRANSMITTER |
| ZS | POSITION SWITCH |
| ZSC | POSITION SWITCH CLOSED |
| ZSHL | POSITION SWITCH HIGH LOW |
| ZSO | POSITION SWITCH OPEN |
| ZT | POSITION TRANSMITTER |
| JY | POWER COMPUTER |
| JE | POWER ELEMENT |
| JI | POWER INDICATOR |
| JIC | POWER INDICATOR CONTROLLER |
| JIT | POWER INDICATOR TRANSMITTER |
| JR | POWER RECORDER |
| JRC | POWER RECORDER CONTROLLER |
| JRT | POWER RECORDER TRANSMITTER |
| JSH | POWER SWITCH HIGH |
| JSHL | POWER SWITCH HIGH LOW |
| JSL | POWER SWITCH LOW |
| JT | POWER TRANSMITTER |
| PAD | PRESSURE ALARM DEVICE |
| PY | PRESSURE COMPUTER |
| PCV | PRESSURE CONTROL VALVE |
| PC | PRESSURE CONTROLLER |
| PDAH | PRESSURE DIFFERENTIAL ALARM HIGH |
| PDY | PRESSURE DIFFERENTIAL COMPUTER |
| PDCV | PRESSURE DIFFERENTIAL CONTROL VALVE |
| PDC | PRESSURE DIFFERENTIAL CONTROLLER |
| PDI | PRESSURE DIFFERENTIAL INDICATOR |

**Device Abbreviations (continued)**

| | |
|---|---|
| PDIC | PRESSURE DIFFERENTIAL INDICATOR CONTROLLER |
| PDIT | PRESSURE DIFFERENTIAL INDICATOR TRANSMITTER |
| PDR | PRESSURE DIFFERENTIAL RECORDER |
| PDRC | PRESSURE DIFFERENTIAL RECORDER CONTROLLER |
| PDRT | PRESSURE DIFFERENTIAL RECORDER TRANSMITTER |
| PDS | PRESSURE DIFFERENTIAL SWITCH |
| PDSH | PRESSURE DIFFERENTIAL SWITCH HIGH |
| PDSL | PRESSURE DIFFERENTIAL SWITCH LOW |
| PDT | PRESSURE DIFFERENTIAL TRANSMITTER |
| PE | PRESSURE ELEMENT |
| PIT | PRESSURE INDICATING TRANSMITTER |
| PI | PRESSURE INDICATOR |
| PIC | PRESSURE INDICATOR CONTROLLER |
| PR | PRESSURE RECORDER |
| PRC | PRESSURE RECORDER CONTROLLER |
| PRT | PRESSURE RECORDER TRANSMITTER |
| PSE | PRESSURE SAFETY ELEMENT |
| PSV | PRESSURE SAFETY VALVE |
| PSH | PRESSURE SHUTDOWN HIGH |
| PSL | PRESSURE SHUTDOWN LOW |
| PS | PRESSURE SWITCH |
| PP | PRESSURE TEST POINT |
| PT | PRESSURE TRANSMITTER |
| PV | PRESSURE VALVE |
| PLC | PROGRAMMABLE LOGIC CONTROLLER |
| QY | QUALITY COMPUTER |
| QE | QUALITY ELEMENT |
| QI | QUALITY INDICATOR |
| QIC | QUALITY INDICATOR CONTROLLER |
| QIT | QUALITY INDICATOR TRANSMITTER |
| QR | QUALITY RECORDER |
| QRC | QUALITY RECORDER CONTROLLER |
| QRT | QUALITY RECORDER TRANSMITTER |
| QSH | QUALITY SWITCH HIGH |
| QSHL | QUALITY SWITCH HIGH LOW |
| QSL | QUALITY SWITCH LOW |
| QT | QUALITY TRANSMITTER |
| RY | RADIATION COMPUTER |
| RC | RADIATION CONTROLLER |
| RE | RADIATION ELEMENT |
| RI | RADIATION INDICATOR |
| RIC | RADIATION INDICATOR CONTROLLER |
| RIT | RADIATION INDICATOR TRANSMITTER |
| RW | RADIATION PROBE |
| RR | RADIATION RECORDER |
| RRC | RADIATION RECORDER CONTROLLER |

**Device Abbreviations (continued)**

| | |
|---|---|
| RRT | RADIATION RECORDER TRANSMITTER |
| RSH | RADIATION SWITCH HIGH |
| RSHL | RADIATION SWITCH HIGH LOW |
| RSL | RADIATION SWITCH LOW |
| RT | RADIATION TRANSMITTER |
| R | RECORDER |
| RTD | RESISTANCE TEMPERATURE DETECTOR |
| RO | RESTRICTION ORIFICE |
| SRV | SAFETY RELIEF VALVE |
| SP | SET POINT |
| SD | SHUTDOWN |
| SDV | SHUTDOWN VALVE |
| SP | SPARE |
| SAH | SPEED ALARM HIGH |
| SY | SPEED COMPUTER |
| SCV | SPEED CONTROL VALVE |
| SC | SPEED CONTROLLER |
| SE | SPEED FREQUENCY ELEMENT |
| SI | SPEED INDICATOR |
| SIC | SPEED INDICATOR CONTROLLER |
| SIT | SPEED INDICATOR TRANSMITTER |
| SR | SPEED RECORDER |
| SRC | SPEED RECORDER CONTROLLER |
| SRT | SPEED RECORDER TRANSMITTER |
| SSH | SPEED SWITCH HIGH |
| SSHL | SPEED SWITCH HIGH LOW |
| SSL | SPEED SWITCH LOW |
| ST | SPEED TRANSMITTER |
| SLO | STATION LOCK OUT |
| SSV | SURFACE SAFETY VALVE |
| S | SWITCH |
| TY | TEMPERATURE COMPUTER |
| TCV | TEMPERATURE CONTROL VALVE |
| TC | TEMPERATURE CONTROLLER |
| TDI | TEMPERATURE DIFFEREMTIAL INDICATOR |
| TDR | TEMPERATURE DIFFEREMTIAL RECORDER |
| TD | TEMPERATURE DIFFERENTIAL |
| TDY | TEMPERATURE DIFFERENTIAL COMPUTER |
| TDCV | TEMPERATURE DIFFERENTIAL CONTROL VALVE |
| TDC | TEMPERATURE DIFFERENTIAL CONTROLLER |
| TDIC | TEMPERATURE DIFFERENTIAL INDICATOR CONTROLLER |
| TDIT | TEMPERATURE DIFFERENTIAL INDICATOR TRANSMITTER |
| TDRC | TEMPERATURE DIFFERENTIAL RECORDER CONTROLLER |
| TDRT | TEMPERATURE DIFFERENTIAL RECORDER TRANSMITTER |
| TDT | TEMPERATURE DIFFERENTIAL TRANSMITTER |
| TE | TEMPERATURE ELEMENT |

**Device Abbreviations (continued)**

| | |
|---|---|
| TI | TEMPERATURE INDICATOR |
| TIC | TEMPERATURE INDICATOR CONTROLLER |
| TIS | TEMPERATURE INDICATOR SWITCH |
| TISHL | TEMPERATURE INDICATOR SWITCH HIGH LOW |
| TIT | TEMPERATURE INDICATOR TRANSMITTER |
| TW | TEMPERATURE PROBE |
| TR | TEMPERATURE RECORDER |
| TRC | TEMPERATURE RECORDER CONTROLLER |
| TRS | TEMPERATURE RECORDER SWITCH |
| TRT | TEMPERATURE RECORDER TRANSMITTER |
| TSE | TEMPERATURE SAFETY ELEMENT |
| TS | TEMPERATURE SWITCH |
| TP | TEMPERATURE TEST POINT |
| TT | TEMPERATURE TRANSMITTER |
| TW | THERMOWELL |
| KY | TIME COMPUTER |
| KCV | TIME CONTROL VALVE |
| KC | TIME CONTROLLER |
| KE | TIME ELEMENT |
| KI | TIME INDICATOR |
| KIC | TIME INDICATOR CONTROLLER |
| KIT | TIME INDICATOR TRANSMITTER |
| KR | TIME RECORDER |
| KRC | TIME RECORDER CONTROLLER |
| KRT | TIME RECORDER TRANSMITTER |
| KSH | TIME SWITCH HIGH |
| KSHL | TIME SWITCH HIGH LOW |
| KSL | TIME SWITCH LOW |
| KT | TIME TRANSMITTER |
| T | TRANSMITTER |
| ULO | UNIT LOCK OUT |
| USD | UNIT SHUT DOWN |
| VFD | VARIABLE FREQUENCY DRIVE |
| V | VENT |
| VTA | VENT TO AIR |
| VAHH | VIBRATION ALARM HIGH HIGH |
| VY | VIBRATION COMPUTER |
| VE | VIBRATION ELEMENT |
| VI | VIBRATION INDICATOR |
| VIT | VIBRATION INDICATOR TRANSMITTER |
| VR | VIBRATION RECORDER |
| VRT | VIBRATION RECORDING TRANSMITTER |
| VS | VIBRATION SWITCH |
| VT | VIBRATION TRANSMITTER |
| EY | VOLTAGE COMPUTER |
| EC | VOLTAGE CONTROLLER |

**Device Abbreviations (continued)**

| | |
|---|---|
| EE | VOLTAGE ELEMENT |
| EI | VOLTAGE INDICATOR |
| EIC | VOLTAGE INDICATOR CONTROLLER |
| EIT | VOLTAGE INDICATOR TRANSMITTER |
| ER | VOLTAGE RECORDER |
| ERC | VOLTAGE RECORDER CONTROLLER |
| ERT | VOLTAGE RECORDER TRANSMITTER |
| ESH | VOLTAGE SWITCH HIGH |
| ESHL | VOLTAGE SWITCH HIGH LOW |
| ESL | VOLTAGE SWITCH LOW |
| ET | VOLTAGE TRANSMITTER |
| WY | WEIGHT COMPUTER |
| WCV | WEIGHT CONTROL VALVE |
| WC | WEIGHT CONTROLLER |
| WDC | WEIGHT DIFFERENTIAL COMPUTER |
| WDCV | WEIGHT DIFFERENTIAL CONTROL VALVE |
| WDC | WEIGHT DIFFERENTIAL CONTROLLER |
| WDI | WEIGHT DIFFERENTIAL INDICATOR |
| WDIC | WEIGHT DIFFERENTIAL INDICATOR CONTROLLER |
| WDIT | WEIGHT DIFFERENTIAL INDICATOR TRANSMITTER |
| WDR | WEIGHT DIFFERENTIAL RECORDER |
| WDRC | WEIGHT DIFFERENTIAL RECORDER CONTROLLER |
| WDRT | WEIGHT DIFFERENTIAL RECORDER TRANSMITTER |
| WDSH | WEIGHT DIFFERENTIAL SWITCH HIGH |
| WDSL | WEIGHT DIFFERENTIAL SWITCH LOW |
| WDT | WEIGHT DIFFERENTIAL TRANSMITTER |
| WE | WEIGHT ELEMENT |
| WI | WEIGHT INDICATOR |
| WIC | WEIGHT INDICATOR CONTROLLER |
| WIT | WEIGHT INDICATOR TRANSMITTER |
| WR | WEIGHT RECORDER |
| WEC | WEIGHT RECORDER CONTROLLER |
| WRT | WEIGHT RECORDER TRANSMITTER |
| WSH | WEIGHT SWITCH HIGH |
| WSHL | WEIGHT SWITCH HIGH LOW |
| WSL | WEIGHT SWITCH LOW |

## 5. Mechanical Abbreviations

### 5.1. System Designation

| | | |
|---|---|---|
| AA | = | ATOMIZING AIR |
| AB | = | AUXILIARY BOILER |
| AC | = | AUXILIARY COOLING WATER |
| AD | = | ASH DISPOSAL |
| AE | = | AIR EVACUATION |
| AI | = | ACID INJECTION |
| AP | = | AIR PREHEATER WATER SUPPLY & RETURN |
| AR | = | CONDENSOR AIR REMOVAL |
| AS | = | AUXILIARY STEAM |
| AW | = | ASH WATER |
| B | = | BLOWDOWN |
| BD | = | BOILER DRAIN |
| BF | = | BOILER FEEDWATER |
| BP | = | BOILER FEED PUMP LUBE OIL |
| BS | = | BOILER START-UP |
| BW | = | BEARING COOLING WATER |
| CA | = | GAS TURBINE COOLING & SEAL AIR |
| CC | = | CLOSED COOLING WATER |
| CD | = | CONDENSATE |
| CF | = | CHEMICAL FEED |
| CH | = | CHEMICAL UNLOADING |
| CI | = | BOILER CHEMICAL INJECTION |
| CL | = | CHLORINE INJECTION |
| CM | = | CONTINUOUS EMISSION MONITORING SYSTEM |
| CO | = | CONDENSATE |
| CRH | = | COLD REHEAT |
| CS | = | CAUSTIC SYSTEM |
| CT | = | COOLING TOWER FAN GEAR LUBE OIL |
| CW | = | CIRCULATING WATER OR CIRCULATING WATER & CHEMICAL INJECTION |
| CX | = | CARBON DIOXIDE |
| DC | = | DEMULSIFIER CHEMICAL |
| DW | = | DEMINERALIZED WATER |
| EG | = | EXHAUST GAS |
| EH | = | STEAM TURBINE GENERATOR EHC |
| ES | = | EXTRACTION STEAM |
| FC | = | FUEL OIL CONDITIONING |
| FG | = | FUEL GAS |
| FO | = | FUEL OIL |
| FLO | = | FEEDWATER PUMP LUBE OIL |
| FP | = | FIRE PROTECTION |
| FW | = | BOILER FEED WATER |
| GC | = | GAS TURBINE COOLING WATER & HVAC |
| GD | = | GAS TURBINE DRAINS |
| GH | = | GENERATOR HYDROGEN |

**Mechanical Abbreviations: System Designations (continued)**

| | | |
|---|---|---|
| GLO | = | GAS TURBINE LUBE OIL |
| GP | = | GAS PATH SOOTBLOWER & EMISSIONS MONITOR |
| GS | = | GLAND STEAM |
| GT | = | GAS TURBINE/PACKAGE |
| GV | = | GAS TURBINE VENTILATION |
| HVAC | | HEATING AND AIR CONDITION SYSTEMS |
| HD | = | HEATER DRAINS |
| HP | = | HRSG SAMPLE PANELS |
| HRH | = | HOT REHEAT STEAM |
| HS | = | THERMINOL HEATING |
| IA | = | INSTRUMENT AIR |
| IG | = | IGNITION GAS |
| IO | = | IGNITION OIL |
| LO | = | LUBE OIL |
| MD | = | MISCELLANEOUS DRAINS |
| MS | = | MAIN STEAM |
| NS | = | NITROGEN SYSTEM |
| *PH | | PIPE HANGERS *=STYSTEM (EXAMPLE MSPH=MAIN STEAM PIPE HANGER) |
| PW | = | POTABLE WATER |
| RS | = | DEMINERALIZED REGENERATION |
| SA | = | STATION AIR |
| SB | = | SOOT BLOWING AIR |
| SE | = | SEWAGE TREATMENT |
| SP | = | STEAM TURBINE SAMPLE |
| SS | = | STEAM TURBINE SHAFT SEAL & GLAND EXHAUST |
| SW | = | SERVICE WATER |
| TH | = | GAS TURBINE HYDRAULIC OIL |
| TL | = | GAS TURBINE LUBE OIL |
| TW | = | TREATED WATER |
| V | = | VENTS |
| VC | = | VAN INHIBITOR CHEMICAL |
| WI | = | WATER INJECTION |
| WT | = | PERMUTIT SERVICE WATER PRETREATMENT |
| WW | = | WATER WASH |

## Mechanical Abbreviations (continued)

### 5.2. Valves

| | | |
|---|---|---|
| NRV | = | STOP CHECK VALVE (ANGLE TYPE) |
| ARC | = | COMBINED CHECK/RECIRC VALVE |
| AV | = | ANGLE VALVE |
| BFV | = | BUTTERFLY VALVE |
| BV | = | BALL VALVE |
| CV | = | CHECK VALVE |
| DPV | = | DIAPHRAGM VALVE |
| EFV | = | EXCESS FLOW CHECK VALVE |
| GLV | = | GLOBE VALVE |
| GTV | = | GATE VALVE |
| NDV | = | NEEDLE VALVE |
| PCV | = | STOP CHECK VALVE (STRAIGHT THROUGH TYPE) |
| PGV | = | PLUG VALVE |
| PRV | = | PRESSURE REDUCING LETDOWN VALVE |
| RCV | = | REVERSE CURRENT VALVE |
| RV | = | SAFETY RELIEF VALVE / RELIEF VALVE |
| SC | = | SILENT CHECK VALVE |
| TWV | = | THREE WAY VALVE |
| WC | = | WAFER CHECK VALVE |

## Mechanical Abbreviations: (continued)

### 5.3. Specialties

| | | |
|---|---|---|
| ST | = | BASKET STRAINER (DUPLEX) |
| ST | = | BASKET STRAINER (SIMPLEX) |
| ST | = | Y TYPE STRAINER |
| ST | = | TEMPORARY PLATE STRAINER |
| ST | = | TEMPORARY CONICAL STRAINER |
| ST | = | TEMPORARY "T" STRAINER |
| ST | = | SEPARATOR/STRAINER |
| T | = | TRAP |
| TA | = | TRAP WITH BY-PASS ASSEMBLY |
| F | = | FILTER |
| DS | = | DESUPERHEATER (ATTEMPERATOR) |
| FE | = | PLATE ORIFICE (FLOW MEASUREMENT) |
| RO | = | RESTRICTION ORIFICE |
| RO | = | MULTIPLE PRESSURE BREAKDOWN ORIFICE |
| D | = | DIAPHRAGM SEAL |
| RD | = | RUPTURE DISC |
| FH | = | FLEXIBLE HOSE |
| FE | = | FLOW VENTURI |
| FE | = | FLOW NOZZLE |
| FE | = | INSERTION FLOW ELEMENT |
| FE | = | V-CONE TYPE FLOW ELEMENT |
| FE | = | POSITIVE DISPLACEMENT FLOW METER |
| FE | = | TURBINE FLOW METER |
| J | = | EXPANSION JOINT |
| VB | = | VACUUM BREAKER |
| AV | = | AUTOMATIC AIR VENT |
| LG | = | LEVEL GAUGE |
| SG | = | SIGHT GLASS |
| EJ | = | MIXER OR EJECTOR |
| SL | = | SILENCER |
| CC | = | CATION CONDUCTIVITY |
| CE | = | CONDUCTIVITY |
| CI | = | CHEMICAL INJECTION POINT |
| DO | = | DISSOLVED OXYGEN |
| pH | = | HYDROGEN ION CONCENTRATION (PH) |
| SP | = | SAMPLE POINT |

# XIII. DRAWING SAMPLES

**1. See Appendix**

# XIV. DRAWING SCALE

All PSES drawings shall be drawn in real-world dimensions (full scale; 1 to 1) in Modelspace. In some instances, it is necessary to plot out the drawing in a manner that will allow users to scale off dimensions from the paper copy. Care should be taken when doing this to avoid confusion when copies or reductions of the original plot are made. The borders shall be inserted in Paperspace (layout) at a coordinate of 0.0 and full scale (1:1).

## TEXT, SCALE AND ZOOM RATIOS

**Table 14.1 - Drawing Scales (in feet)**

| Drawing | | Text Factor | |
|---|---|---|---|
| Scale | Scale Factor | Size 0.09375 | Size 0.125 |
| 1'=10' | 10 | 0.9375 | 1.25 |
| 1'= 20' | 20 | 1.875 | 2.5 |
| 1'=30' | 30 | 2.8125 | 3.75 |
| 1'=40' | 40 | 3.75 | 5 |
| 1'=50' | 50 | 4.6875 | 6.25 |
| 1'=100' | 100 | 9.375 | 12.5 |
| 1'=200' | 200 | 18.75 | 25 |
| 1'=400' | 400 | 37.5 | 50 |
| 1'=600' | 600 | 56.25 | 75 |
| 1'=800' | 800 | 75 | 100 |

**Text Scale Calculation Formula (for all text):**
Standard Text size (3/32 text): Scale factor x 0.1
Title Text size (1/8 text): Scale factor x 0.125
Title Text size (5/32 text): Scale factor x 0.15625
Block Insertion Scale = 1 / Scale factor

**Table 14.2 - Drawing Scales (in inches)**

| Drawing | | Text Factor | | Text |
|---|---|---|---|---|
| Scale | Scale Factor | Size 0.09375 | Size 0.125 | Inverse Multiplier XP factor |
| 3/4"=1" | 1.33 | 0.125 | 0.17 | 0.7500 |
| 5/8"=1" | 1.6 | 0.15 | 0.2 | 0.6250 |
| 1/2"=1" | 2 | 0.1875 | 0.25 | 0.5000 |
| 3/8"=1" | 2.67 | 0.25 | 0.33 | 0.3750 |
| 1/4"=1" | 4 | 0.375 | 0.5 | 0.2500 |
| 1/8"=1" | 8 | 0.75 | 1 | 0.1250 |
| 1/16"=1" | 16 | 1.5 | 2 | 0.0625 |
| 1"=1" | 1 | 0.09375 | 0.125 | 1.0000 |
| 1/16"=1' | 192 | 18 | 24 | 0.02167 |
| 3/32"=1' | 128 | 12 | 16 | 0.00780 |
| 1/8"=1' | 96 | 9 | 12 | 0.010467 |
| 3/16"=1' | 64 | 6 | 8 | 0.15625 |
| 1/4"=1' | 48 | 4.5 | 6 | 0.02083 |
| 3/8"=1' | 32 | 3 | 4 | 0.03125 |
| 1/2"=1' | 24 | 2.25 | 3 | 0.04167 |
| 3/4"=1' | 16 | 1.5 | 2 | 0.06250 |
| 1"=1' | 12 | 1.125 | 1.5 | 0.08333 |
| 1–1/2"=1' | 8 | 0.75 | 1 | 0.1250 |
| 2"=1' | 6 | 0.5625 | 0.75 | 0.16667 |
| 3"=1' | 4 | 0.375 | 0.5 | 0.2500 |
| 1"=10' | 120 | 11.25 | 15 | 0.00833 |
| 1"=20' | 240 | 22.5 | 30 | 0.004167 |
| 1"=30' | 360 | 33.75 | 45 | 0.002778 |
| 1"=40' | 480 | 45 | 60 | 0.00208 |
| 1"=50' | 600 | 56.25 | 75 | 0.001667 |
| 1"=100' | 1200 | 112.5 | 150 | 0.000833 |
| 1"=200' | 2400 | 225 | 300 | 0.000417 |
| 1"=400' | 4800 | 450 | 600 | 0.000208 |
| 1"=600' | 7200 | 675 | 900 | 0.000139 |
| 1"=800' | 9600 | 900 | 1200 | 0.0001047 |
| 1"=1000' | 12000 | 1125 | 1500 | 0.0000083 |

**APPENDIX G1**
**ATTACHMENT 02**
**EXHIBIT 01**

# GENERAL CIVIL REQUIREMENTS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
| | | | | | | |
| | | | | | | |
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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. For details on wind or solar specifications, refer to Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications, respectively.

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

## 1.2 DOCUMENT REVIEW

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

1. Historical and current aerial imagery
2. Regional geologic maps
3. Soil survey reports
4. Groundwater hydrology data and maps
5. Landslide hazard maps (as applicable)
6. Karst hazard (sinkhole) maps (as applicable)
7. Mine subsidence maps (as applicable)
8. Seismic hazard maps
9. Other geologic/geotechnical hazard maps (as applicable)
10. 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, 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 Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications, respectively.

Given that the design requirements and scope of geotechnical exploration for foundation systems supporting wind turbines are different than those for foundation systems supporting solar arrays, refer to Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications, for wind or solar power plants, respectively.

## 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 may be necessary over a minimum year 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 in the soil laboratory testing program to support foundation design and electrical design activities:

1. Moisture content and unit weight (all relatively undisturbed samples).
2. Atterberg Limits.
3. Grain size analysis.
4. Soil shear strength (unconfined, triaxial, direct shear, vane shear, etc.).
5. Consolidation/settlement characteristics.
6. Compaction characteristics (maximum unit weight, optimum moisture content, etc.).

7. Hydrocollapse (as appropriate).
8. Corrosion characteristics (Sulfate, chloride, pH, resistivity, etc.).
9. Minimum resistivity.
10. Soil Thermal resistivity including dry-out curves including 0% moisture. 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. 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
2. Design groundwater level and recommendations for construction dewatering
3. Earthwork, subgrade, compaction, final grading, testing requirements
4. Mitigation measures for difficult 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 infrastructure
9. Recommendations for site drainage
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. Any other pertinent geotechnical recommendations for the project as identified by the Geotechnical Engineer of Record

# 2.0 CIVIL WORKS

The design shall suit the requirements for construction access for long loads, heavy equipment and cranes, as well as ongoing access for operation and maintenance facilities. Design and construction of civil works shall comply with agreements between Owner and local authorities and be designed per the project 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 100-year storm and 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 Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications, for wind or solar power plants, respectively.

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, 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.

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 Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications, for wind or solar power plants, respectively.

Restoration shall be in accordance with the Permits and planning and environmental constraints on the Project.

## 2.1 CONCRETE WORKS AND BATCHING PLANT

Contractor shall provide a detailed method statement for quality control and concrete batching and transport.

Concrete shall be transported, placed, compacted and cured in accordance with Applicable Standards.

Concrete mix design, cement, aggregate, admixtures, and trial batch test result shall be provided for owner approval prior to concrete placement.

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).

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.

Unformed concrete finish on the surface of the concrete shall be screeded and finished neatly to be uniform and non-slip when wet.

Adequate precautions shall be implemented in finishing to prevent plastic shrinkage cracking. Methods to be used for plastic shrinkage cracking shall be provided to Owner prior to placement of concrete.

A hot and/or cold weather concreting plan shall be prepared in accordance with ACI 305R and ACI 306R, as applicable to anticipated project site temperatures.

## 2.2 CONCRETE AND GROUT STRENGTH

As a minimum, concrete and grout shall have a minimum 28 day compressive strength of 4000 psi, or greater as specified by the foundation designer.

Concrete constituents shall meet the requirements listed in Table 1, below:

**Table 1 Concrete Material Standards**

| Material | Requirement |
|---|---|
| Water | Clean, Potable, free from acid/alkali, oil, petroleum products, organic material or other deleterious substances |
| Portland Cement | ASTM C150, Type I, II, or V<br>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 |

| Material | Requirement |
|---|---|
| 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 |

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 and ASTM C231.

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.

Testing shall also conform to Appendix G2 Attachment 01 Exhibit 03 – Wind Pre-Operational Startup and Testing .

## 2.3 OFF-SITE ROAD IMPROVEMENTS

Contractor shall establish any off-site road or public highway improvements that are required to:

1. Comply with agreements between Owner and the local Authorities
2. Permit full access for the project
3. Permit delivery of all plant and equipment required for the project, and
4. Permit delivery and supply of all other plant items, construction materials and equipment required to complete the Power Plant.

Contractor, with respect to the Work, shall be responsible for obtaining any relevant encroachment permits or other permits or authorizations and reaching any relevant agreements required with Government Authorities and third parties.

Contractor shall maintain off-site roads in as good or better than original condition throughout construction.

## 2.4 SITE ENTRANCE AND ACCESS ROADS

Contractor, with respect to the Work, shall be responsible for obtaining any relevant permits or authorizations and reaching any relevant agreements required with Government Authorities and third parties in relation to access:

1. Except where explicitly agreed as being within Owner's scope
2. Except in the case of approvals or agreements with landowners which shall be obtained through Owner

Contractor shall be responsible for establishing the extent to which improvements are required to any existing and new site entrance and access roads to facilitate the Project.

Contractor shall be responsible for establishing the site entrance and access roads to facilitate the Work including, but not limited to:

1. Delivery and installation of Project equipment and components in accordance with the equipment manufacturer's requirements.
2. Crane and heavy equipment access for the installation of Project components.
3. Two-way traffic for construction access
4. All-weather emergency vehicle access to work areas and site locations

Access road geometry shall conform to the following criteria, the Project component requirements, and permit requirements:

1. Road width shall be a minimum of 16 feet
2. If the design road width is less than 32 feet, passing areas shall be provided every 1500 feet. Passing areas shall be a minimum of 16 feet wide in addition to the road width, and a minimum of 200 feet long.
3. Road cross-fall gradient shall be between 1 and 4 percent
4. Maximum road longitudinal gradient shall be 10 percent
5. Turn radii shall be as specified by the Project equipment supplier

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.

Contractor shall repair the Site roads and access roads to the required standard 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

## 2.5 UNDERGROUND CABLE RUNS

Underground cable runs, including SCADA communication cables and earth conductors, shall be located at an appropriate depth to meet Applicable Standards, Owner's requirements as set forth in the Agreement and this document, and industry best practices.

Where appropriate, cables or cable conduits shall be laid during access road construction in order to avoid disturbing reinstated ground. Cables shall be suitably protected in conduit where they cross roads.

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

To prevent damage, all direct buried cables shall be laid on a bed of not less than 2 inches of sand or friable soil free of sharp stone and covered by not less than 2 inches of the same material.

Cables shall be installed in accordance with Applicable Standards including requirements for mechanical protection, warning and locating tape, and depths of burial.

All trenches are to be backfilled and compacted on completion and original levels restored to a minimum level of compaction and tested as specified by the Geotechnical Engineer. No surplus soil piles or stockpiles are to be left on the Site.

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. 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.

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 crossing and fence crossing.

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 and electronic markers.

All trenched fiber cables shall be protected against rodent damage by use of PVC conduit, Pest Duct or armored fiber installation as chosen by the contractor and approved by Owner.

## 2.6 FENCES, GATES, ENTRANCES, CATTLE GRIDS

All fences and entrances shall be in accordance with Applicable Standards and Applicable Permits.

All fences, gates, entrances, and cattle grids 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.

## 2.7 DRAINAGE

Drainage shall be provided by Contractor and shall prevent erosion, consistent with:

1. Federal, state and local laws and regulations
2. The design assumptions and criteria of the foundations, and other elements of the Civil Infrastructure
3. The absolute requirement to maintain adequate soil cover over the WTG 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 25-year return period flood event for the road and drainage infrastructure, and
2. A 100-year return period flood with sufficient freeboard for the Project infrastructure, substation and permanent buildings.

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.

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.

## 2.8 DISPOSAL OF EXCESS MATERIAL

Surplus soil and excavated materials may be disposed of on-Site to the extent this is consistent with Applicable Permits and planning and environmental constraints on the Project.

Other wastes including chemical waste shall be removed from the Site and disposed in an appropriately registered facility in accordance with federal, state and local laws and regulations. If immediate removal is impractical the wastes are to be temporarily stored in accordance with the Laws and applicable standards.

All permits and authorizations required for the temporary storage of waste on site shall be obtained by Contractor.

No litter or construction related waste is to be left on the Site.

## 2.9 RECLAMATION

Contractor shall reclaim all areas which have been disturbed during the Work by replanting and indigenous seeding, including conformance with the requirements of any Permits and any Project Agreements.

The seed mix and plant species are to be approved by Owner prior to re-seeding.

Reclamation shall be in accordance with the Permits and planning and environmental constraints on the Project.

**APPENDIX G1**
**ATTACHMENT 02**
**EXHIBIT 02**

# GENERAL ON SITE BUILDINGS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | SPF | Sean Flak |
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## 1.0 TEMPORARY CONSTRUCTION COMPOUND

Contractor shall be responsible for the design, construction, security, operation, maintenance, dismantling, removal and reclamation of the construction compound or compounds.

The construction compound shall house the temporary site offices, health and safety facilities, storage/laydown area and all office, toilet and washing accommodation required to execute the Project. A construction trailer, suitable for Owner's site management, environmental compliance, and safety personnel, shall be provided for Owner for the duration of the Project construction.

Toilets shall be of a type to ensure that all discharges are contained and removed from Site. Toilets shall be outfitted for weather conditions (i.e. space heater in winter).

24-hour security for the Project and temporary construction compound shall also be provided by Contractor.

Contractor shall provide, install, and maintain one (1) 24-foot by 60-foot double-wide office trailer for Owner's exclusive use. Each trailer shall be located at the Project Site laydown area and shall be installed and ready-to-use no later than the Contractor mobilization date. All office trailers shall be located at the same laydown yard.

1. Each trailer shall include at least four (4) offices, and Contractor shall furnish each such office in Owner's trailers with two (2) desks, two (2) two-drawer file cabinets, two (2) rolling arm chairs, two (2) visitor chairs, and one (1) 2-foot by 3-foot white board.

2. Each trailer shall include at least one (1) conference area, and Contractor shall furnish each such conference area in Owner's trailers with six (6) 8-foot-long tables, 16 chairs, and one (1) 4-foot by 6-foot white board.

3. Each trailer shall include at least one (1) unisex restroom, each complete with running water, one (1) flushable toilet, and one (1) flushable urinal.

4. Contractor shall furnish each Owner trailer with one (1) full-size drawing table, one (1) full-size drawing rack, and two (2) 4-foot by 6-foot bookshelves.

5. Contractor shall furnish each Owner trailer with one (1) new, full-size refrigerator with freezer and one (1) new, full-size microwave.

6. Contractor shall furnish each Owner trailer with central HVAC.

7. Contractor shall furnish each Owner trailer with one (1) first aid kit and one (1) fully-charged fire extinguisher. Contractor shall maintain and recharge such fire extinguishers throughout the duration of the construction activities, as required.

8. Contractor shall provide and install phone service, broadband internet service, electric service, and running water for each Owner trailer, including connection of all communications (phone and internet) to the jobsite. Phone service shall include at least one (1) four-line phone system up to the wall jacks in each trailer. Internet service shall include high-speed internet infrastructure wiring up to the wall jacks in each trailer and high-speed wireless internet service (wifi) throughout the trailer compound, respectively. All utility services shall include use and service charges to Contractor's account, including for Owner's trailers.

9. Contractor shall furnish bottled water and ice in each Owner trailer and for Owner's exclusive use throughout the duration of the construction activities

10. Contractor shall provide daily cleaning services within each Owner trailer throughout the duration of the Work. This shall include cleaning restrooms and trash collection, pickup, and removal, respectively.

Contractor shall provide separate office trailers for their own use (including for the OEM supplier). Contractor shall be solely responsible for furnishing his trailer(s), including any utility services.

Contractor shall furnish, install, and maintain portable chemical toilets for use by site construction personnel, including Owner, OEM supplier, and subcontractors. This shall include cleaning (at least weekly), emptying, and disposal of such toilets through substantial completion of the Project or Contractor demobilization, whichever occurs last. Following such date, Contractor shall remove all such toilets from the Project Site.

Contractor shall design, permit, furnish, construct, and maintain, as required, any temporary fuel containment facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last.

Contractor shall design, permit, furnish, construct, and maintain (including disposal), as required, any hazardous materials/waste facilities required to support ongoing construction activities. This shall include removal of all such facilities following substantial completion of the Project or Contractor demobilization, whichever occurs last. Contractor shall provide Owner with a copy of all hazardous material manifests.

As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain batch plant(s) at the Project Site, including all necessary labor and materials related to the operation of the batch plant, and removal of the batch plant at the conclusion of the Work. The batch plant shall be removed from the Project Site by Contractor within 30 days of the final foundation completion date. Power to operate the batch plant shall be the sole responsibility of Contractor.

As required to perform the Work, Contractor shall procure, permit, install, construct, and maintain fixed and/or mobile rock crusher(s) at the Project Site, including all necessary labor and materials related to the operation of the rock crusher(s), and removal of the

rock crusher(s) at the conclusion of the Work. The location of any fixed rock crusher(s) shall be at the temporary facility areas, and the location of any mobile rock crusher(s) shall remain within the designated disturbance areas. Power to operate the rock crusher(s) shall be the sole responsibility of Contractor.

## 2.0 OPERATIONS AND MAINTENANCE BUILDING

The O&M building shall be sized in accordance with Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications or with Appendix G3 Attachment 01 Exhibit 01 – Solar Plant Specifications, as appropriate, to provide the following facilities:

- Housing of SCADA equipment, capable of being qualified NERC critical infrastructure protection (CIP) compliant;
    - General office area/control room;
    - Any additional control room/facility requirements of the TSP.

The power shall be supplied from the MV Switchroom's LV power supply. Contractor shall provide a backup generator (i.e. 30 kW gas generator, maximum load current at 240 V, 125 A) for critical functions of the facility, such as the servers and emergency lighting. In a power outage, a dual 200 Amp/Split 400 Amp automatic transfer switch shall automatically transfer power to the backup generator. If substation is located adjacent to switchyard, an acceptable alternate source is the substation medium-voltage bus.

The location and minimum accommodation and size requirements of the O&M building shall meet the requirements of all applicable planning Permits and all other Applicable Permits.

If the MV Switchroom is not part of the O&M building design, a separate MV substation building shall be sized to provide the MV switchroom.

Access and security to equipment and rooms shall be in accordance with Appendix G1 Attachment 01 Exhibit 07 – Compliance and Security Requirements.

## 3.0 PRE-ENGINEERED METAL BUILDINGS (PEMB)

### 3.1 GENERAL

The work under this section consists of furnishing all supervision, labor, material, equipment, and related services necessary to design, supply and erect the project building as specified herein.

## 3.2 WORK ITEMS

The work under these specifications shall include designing, furnishing and erecting the building shells and miscellaneous accessories specified herein.

Below is a summary scope of work covered under this technical specification:

1. Design, furnish, unload, protect, and erect the structural steel frames, wall panels, roof panels, insulation, interior liner panels, roof purlins, wall girts, structural roof and wall bracing, bridging, side wall eaves and endwall rake purlins, miscellaneous roof and wall opening framing, lighting and HVAC.

2. Furnish and erect the exterior personnel doors, frames, transoms, hardware, windows, skylights, and louvers.

3. Furnish and erect the motor operated overhead rolling metal doors including motor controls, accessories closures, trim, flashing, and bollards.

4. Furnish and erect the complete roof and wall system including accessories, gutters, downspouts, vents, flashing, trim, closure trim, and roof equipment curbs and related crickets.

5. Provide detailed structural drawings showing overall size and configuration of the building including structural member sizes.

6. Shop metal preparation, prime coating, and field touchup painting of the shop prime painted structural steel.

7. Design, furnish and erect miscellaneous steel framing, flashing, as required for framed penetrations.

8. All design drawings, specifications, fabrication (shop) drawings, and erection drawings including connection design, shall be sealed by a Professional Engineer licensed to practice in the State of Oregon.

9. For Pre-engineered Building HVAC, Plumbing and Electrical requirements, see Appendix G1, Attachment 02, Exhibit 02, Annex 1.

10. For Fire Protection requirements, see Appendix G1 Attachment 03 Exhibit 01 Fire Protection System.

The following work is not included with the metal building furnishing and erection work and will be provided by EPC Contractor:

1. Supply of column anchor bolts
2. Concrete foundations
3. Plant process mechanical work

4. Plant process electrical work (not including convenience outlets and welding/480v receptacles)

The following work is provided by the Owner:

- Security and communication systems

### 3.2.1 Submittals

Submit the following documents according to the requirements of Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

1. Detailed shop and erection drawings and product data including the following:

    a. Profile, sizes, spacing and locations of structural members, connections, attachments, openings, cambers, etc.
    b. Welded connections, using AWS welding symbols including net weld lengths.
    c. Wall and roof system dimensions, panel layout, general construction details, and methods of connection and anchorage, and methods of installation.
    d. Details of roof curbs and fastening.
    e. Details of door, window, louver openings.
    f. Color chips of coating colors for Owner approval prior to coating metals.

2. Foundation loads, anchor bolt setting diagrams, and details of required anchorage to concrete foundations; include value for each foundation load (i.e., DL, LL, E, wind, etc). Submit within 1 week after award of Contract.

3. All calculations used in the development of building and anchor bolt design and of fabrication drawings.

## 3.3 STRUCTURAL SYSTEMS AND DESIGN CRITERIA

1. The Contractor shall determine the appropriate structural system and details that will satisfy clearance dimensions provided and should accommodate the foundation outline.

2. The structural systems may be braced frame, rigid frame or self-framing depending on size and economy for each building. Horizontal loads not resisted by the main frame shall be resisted by rod, cable, diaphragm, portal frame or fixed base columns. However, the arrangement of structural lateral bracing shall accommodate the drawing arrangement, louver/fan assemblies and wall openings.

3. Clearance height shall be interpreted as the height from the floor to the underside (lowest point) of horizontal or tapered beam roof framing.

4. Design building to resist specified and applicable vertical and horizontal loads, including dead, live, snow, wind, and seismic loads as presented in the governing code. Apply design loads to the structures according to the governing codes. Use AISC specification to determine design stresses and fabrication of structural steel. Prepare designs under the supervision of, and have drawings sealed by a registered professional engineer certified in the local jurisdiction.

5. Governing Building Code: State of Oregon Structural Specialty Code, based on International Building Code. All references to code editions, standards, and design values stated herein shall be updated at contract issuance to meet jurisdictionally approved editions.

### 3.3.1 Design Loads (per OSSC):

Wind, snow, and seismic loading of the Project Site shall be provided in accordance with State of Oregon Structural Specialty Code, based on International Building Code. All references to code editions, standards, and design values stated herein shall be updated at contract issuance to meet jurisdictionally approved editions.

### 3.3.2 Performance and Design Requirements

Performance and design requirements for pre-engineered metal buildings are indicated in Section 3.1.5 and 3.2. In addition, the wall and roof panels shall meet the acoustical design requirements as necessary to comply with the overall site permit noise emissions guarantee.

### 3.3.3 Codes and Standards

Work performed under these specifications shall be done in accordance with the applicable governing edition of the Oregon Structural Specialty Code, which is based on the International Building Code, IBC. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply. These references shall govern the work except where they conflict with the specifications. In case of conflict, the latter shall govern to the extent of such difference:

| Work | In Accordance With |
|---|---|
| Roof seismic loading and performance criteria | Section 1.1 under Building Codes of UL 580 - Test for Uplift Resistance of Roof Assemblies |

| Work | In Accordance With |
|---|---|
| Building design | MBMA - Metal Building Manufacturers Association Low Rise Building Systems<br>AISC - Steel Design Guide No. 3- Serviceability Design Considerations for Low Rise Buildings |
| Steel design | AISC Specification for Structural Steel Buildings, AISC 360, with Commentary and Supplements. AISC 341, with Commentary and Supplements. |
| Light gauge structural steel design | AISI - Specifications for the Design of Cold Formed Structural Members |
| Wind loading criteria | Section 1.1 under Building Codes of<br>UL 580 - Tests for Uplift Resistance of Roof Assemblies |
| Deflections and drift of the structural system | AISC - Steel Design Guide No. 3 - Serviceability Design Considerations for Steel Buildings |
| Concrete design | ACI 318 - Building Code Requirements for Structural Concrete |
| Welding and related operations for structural steel and low alloy steel | AWS D1.1 - Structural Welding Code-Steel |
| Welder qualifications | AWS D1.1 - Structural Welding Code-Steel |

### 3.3.4 Materials

The following materials shall be used:

| General | |
|---|---|
| **Component** | **Material** |
| Roof panel, wall panel, trim, and flashing | ASTM A924, Grade B |
| Roof and wall panel galvanizing | ASTM A653, Designation G90 |
| Aluminum zinc alloy coating in place of galvanizing | ASTM A792, Class AZ55 |
| Structural members less than 1/4 inch (6 mm) thick | ASTM A1008 and ASTM A1011 for steel used to form members on built-up sections |
| Hot-dip zinc coating of structural members | ASTM A653 or A924 |
| Shop prime coating of structural members | Air dried rust inhibitive alkyd primer, containing at least 40 percent solids by volume |
| Structural members | ASTM specification A36 or ASTM A572 Grade 50 or ASTM A992 |
| Column anchor bolts and nuts | ASTM A36 or A307, Grade A conforming to requirements of ASTM A36 |
| Structural bolts and nuts | ASTM A325 |
| Other bolts and nuts | ASTM A307 galvanized in accordance with ASTM B633 |
| Stainless steel sheet metal screws and self-tapping screws | US Federal Specification QQ-S-763E, Class 410 stainless steel |
| Motors | NEMA and ANSI standards |
| Door hardware | Door hardware shall be in accordance with ANSI/BHMA A156 and the following requirements |
| Butts | 1-1/2 pair per leaf, 4-1/2 in. (114 mm) by 4-1/2 in. (114 mm), full mortised, template type, non-removable pin, ball bearing, extra heavy-duty, bronze US10; two pair for 8 ft (2,438 mm) door height |
| Locksets | Key-in-knob, pin tumbler cylinder type, bronze US10. Master key all-keyed locksets, two keys per lock. ANSI/BHMA A156.2 Series 4000, Grade 1 |
| Latch set | Similar to lockset (no key) |

| General | |
|---|---|
| **Component** | **Material** |
| Closers | Fed Spec FF-H-121D, US Government Type 3009VH for 3 ft (914 mm) by 7 ft (2,133 mm) exterior, Type 3009 VIH for 3 ft (914 mm) by 8 ft (2,438 mm) exterior, hold-open-arm, bronze finish |
| Thresholds | Extruded aluminum saddle type, 3-1/2 in. (89 mm) by 5/8 in. (16 mm). Door, when closed, shall seal against threshold. |
| Weatherstripping | Extruded vinyl in an extruded aluminum keeper for head and jambs. Extruded vinyl sweep in an extruded aluminum keeper for door bottoms |
| Kickplates | Stainless steel, door width less 2 in. (50 mm) by 10 in. (250 mm); centered on push side surfaces of door 1 in. (25 mm) above door bottom |
| Flush bolts | Stainless steel top and bottom of inactive leaf of pairs of doors |
| Astragal | Provide at meeting edge of all pairs of doors. When attached to inactive leaf, provide minimum 1-1/8 inch (29 mm) clearance at knob |
| Caulking | |
| Exposed joints | Low modulus, one component moisture curing modified polyurethane joint sealant. Fed Spec TT-S-00230C, Type II, Class A |
| Consealed joints | Polybutene nondrying, non-skimming sealant |
| Caulking tape | Reinforced poly-isobutylene |
| Finish | Polyvinylidene fluoride, minimum of 70 percent Kynar 500 or Hylar 5000 resin by weight |

| Specific | |
|---|---|
| **Building Systems/Accessories** | |
| Lighting | Provided by PEMB Contractor. Lighting required above all doors. All lighting shall be LED. Motion detecting light switches are not permitted. |
| Heating | Provided by PEMB Contractor |
| Ventilation | |
| Air conditioning | Provided by PEMB Contractor |
| **Wall System** | |
| Insulated | Yes |
| Fire rated | Yes |
| Acoustical | Yes |
| Air Infiltration | Air infiltration of the assembly shall be limited to 0.06 cfm/sq ft (0.018 cm.m/sq m) at a positive pressure differential of 1.57 psf (7.7 kg/sq m) per ASTM E283. |
| Water Penetration | Water penetration of assembly at a positive pressure differential of 6.4 psf (30 kg/sq m) shall be 0 per ASTM E331. |
| **Roof System** | |
| Insulated | Yes |
| Fire rated | Yes |
| Acoustical | Yes |
| Air Infiltration | Air infiltration of the assembly shall not be measurable at a positive pressure differential of 4 psf (19 kg/sq m) per ASTM E1680. |
| Water Penetration | Water penetration of the assembly at a positive pressure differential of 6.4 psf (30 kg/sq m) shall be 0 per ASTM E1646. |
| **Exterior Columns (no flange braces)** | Straight or Tapered |
| **Minimum Design Loads** | As defined in Design Basis Document and supplemented below. |
| Wind uplift rating | UL 580 |

| Specific | |
|---|---|
| Other collateral loads (Crane and others) | For crane/hoist requirements see Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications or Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications |
| **Roof Slope** | 1 in 12 |
| **Roof and Wall Covering** | |
| Exterior metal wall panel | Yes |
| Metal roof panel | |
| Embossed | Yes |
| Nonembossed | No |
| Liner panels | |
| Wall | Yes |
| Roof | No, unless required to meet noise/ acoustical criteria |
| Trim and flashing | Yes |
| **Wall Accessories** | |
| Light transmitting panels | No |
| Doors | Yes |
| Windows | Yes |
| Framed opening | Yes |
| Standard fixed blade drainable louvers | Yes, as required |
| Vertical stormproof louvers | Yes, as required |
| Canopies/facades | Yes, as required |
| Spandrel | |
| Above doors | No |
| Above windows | No |
| Below windows | No |
| **Roof Accessories** | |
| Gutters | Yes |
| Downspouts | Yes |
| Light transmitting panels | No |
| Vents | Yes, as required |
| Equipment curbs | Yes, as required |

| Specific | | |
|---|---|---|
| Pipe flashing | Yes, as required | |
| Canopies | Yes, as required | |
| Facades | No | |
| Hatches | Yes, as required | |
| **Acoustical Performance** | STC | NRC |
| Boiler Feed Pump Building | No | No |
| **Insulation** | | |
| Exterior wall insulation | | |
| R-Value, F·h·ft$^2$/Btu in. (m$^2$·K/W) | 19 | |
| U-Value, Btu/F·h·ft$^2$ in. (W/m$^2$·K) | Not greater than 0.052 | |
| Thickness, micro-inch (µm) or (mm) | TBD | |
| Roof insulation | | |
| R-Value, F·h·ft$^2$/Btu in. (m$^2$·K/W) | 30 | |
| U-Value, Btu/F·h·ft$^2$ in. (W/m$^2$·K) | Not greater than 0.033 | |
| Thickness, micro-inch (µm)or (mm) | TBD | |
| **Exterior Finish of Roof and Wall Panels, Flashings, and Trim** | | |
| Polyvinylidene fluoride with 70 percent PVDF resin | Yes | |
| **Interior Finish of Liner Panels, Flashings, and Trim** | | |
| Manufacturer's standard finish | Yes | |
| Warranties | | |
| Roof panels, years | 30 | |
| Wall panels, years | 30 | |
| Color | | |
| Wall panels | | |
| Manufacturer | Later | |
| Color | Later | |
| Roof panels | | |
| Manufacturer | Later | |
| Color | Later | |
| Liner panels | | |
| Manufacturer | Later | |
| Color | Later | |

| Specific | |
|---|---|
| Trim and flashing | |
| Manufacturer | Later |
| Color | Later |
| Gutters and downspouts | |
| Manufacturer | Later |
| Color | Later |
| Doors/windows and frames | Later |
| **Exterior Doors** | |
| Hollow metal | Yes |
| Fire rated, hours | 1.5 |
| Seamless | Yes |
| Flush top | Yes |
| Flush bottom | Manuf. Std. |
| Insulated | Yes |
| Door glazing | |
| Full | No |
| Half | No |
| Other | No |
| Other accessories | Provisions for electrified handset and transfer hinge (Owner to approve) |
| **Door Frame** | |
| Hollow metal | Yes |
| Other | No |
| **Removable transoms** | |
| Removable | Yes |
| Solid panel | Yes |
| Glass | No |
| Other | No |
| Finish hardware | Yes |
| **Rolling Metal Doors** | |
| Design wind pressure | See Wind Design Information, above |
| Operation | Motor operated with hand chain override |
| Curtain and hood | Galvanized steel |

| Specific | |
|---|---|
| Insulated | Yes |
| Power requirements | 208/430/460V - 3 |
| Fire rated | 1-1/2 hour |
| **Windows** | |
| Projecting | No |
| Horizontal sliding | Yes |
| Fixed | No |
| Screens | 18-16 aluminum |

### 3.3.5 Acceptable Manufacturers of Components

The manufacturers that are acceptable to Owner are listed in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers. Contractor may propose additional not-listed manufacturers. In such case, supporting documentation shall be provided as proof that the alternate component satisfies the requirements of this specification. Acceptance of the manufacturer as a substitute is at the discretion of the Owner.

### 3.3.6 Test Requirements

The following testing shall be conducted in accordance with the specified source. The Contractor is responsible for all costs associated with correcting deficiencies and retesting in the event of a test failure:

| Tests | In Accordance With | Conducted By |
|---|---|---|
| Standard louver water penetration test | AMCA Standard 500 | Contractor |
| Vertical stormproof louver testing and certification | AMCA Standard 500-L-99 | Contractor |

## 3.4 PRODUCTS

Each pre-engineered building package shall include all required primary and secondary structural framing; bracing; connectors and fasteners; wall and roof covering systems; insulation; trim and flashing; wall, roof, and building accessories and systems; and all miscellaneous items required to make a complete and weather-tight building.

### 3.4.1 Design

Design shall comply with the required minimum design loads, codes, and standards, and shall be performed and certified by a registered professional engineer.

Columns shall be designed as unsupported members. Flange braces or supports between columns and girts shall not be permitted. Full rigid frames or manufacturer's standard frames shall be furnished at building end walls with intermediate supports for required girt framing. Columns shall be tapered or straight.

Deflections and drift of the structural system shall conform to the requirements specified in Section 3.3.3. Strength shall be based on a 50 year wind, and performance shall be based on a 10 year wind with the 10 year wind force being 75 percent of the 50 year wind force.

#### 3.4.1.1 Collateral Roof Uniform Area Loads

Collateral roof uniform area loads are area loads applied to account for unanticipated loads from piping and equipment.

Collateral roof uniform area loads shall be treated as a uniform load per unit area and shall be carried to the columns and foundations as dead loads. The uniform roof area loads shall not be considered as reliable dead load for uplift. The roof uniform area loads shall be applied to all roof beams, girders & purlins. The “span” of the load shall be perpendicular to the roof purlins.

All roof areas shall be designed for collateral roof uniform area loads of 5 psf minimum, unless loads larger than 5 psf are required.

#### 3.4.1.2 Collateral Roof Phantom Loads

Phantom loads are concentrated loads applied to individual members to account for unanticipated loads from piping and equipment.

Collateral roof phantom loads shall be applied at the center for the purpose of sizing the member and at either end for the purpose of sizing the member’s connection. The phantom load shall not be carried over to the sizing of other members. The phantom load shall be applied to all roof beams, girders & purlins.

All roof areas shall be designed for collateral roof phantom loads of 0.5 kips minimum, unless loads larger than 0.5 kips are required.

### 3.4.2 Steel Fabrication

Primary framing, roof beams, purlins, girts, eave struts, bases, posts, opening frames, and other structural members shall be accurately factory punched for easy and rapid assembly by field bolting, except where shop connections are used. Field welding shall not be permitted.

#### 3.4.2.1 Coatings

Structural members 1/4 inch (6 mm) or less in thickness shall be shop prime painted or zinc coated. Structural members with a thickness larger than 1/4 inch (6 mm) shall be shop prime painted.

### 3.4.3 Materials

Steel components for wall, roof, trim, and flashing shall have the following minimum thicknesses:

| Thickness (US Standard gauge, uncoated metal thickness) | |
|---|---|
| Exterior metal wall panel | 24 gauge (0.024 in., 0.61 mm) |
| Metal roof panel | 24 gauge (0.024 in., 0.61 mm) |
| Liner panels | 26 gauge (0.018 in., 0.46 mm) |
| Base channel | 14 gauge (0.0747 in., 1.90 mm) |
| Gutters and downspouts | 26 gauge (0.018 in., 0.46 mm) |

#### 3.4.3.1 Wall Panels

Configuration of panels shall be manufacturer's standard nominal 1-1/2 inch (38 mm) deep rib. Panels shall be approximately 36 inches (900 mm) wide. Wall panels shall be continuous for the building height with minimum horizontal joints. Laps at joints shall be a minimum of 4 inches (100 mm). Interior wall panels shall dampen acoustic noise.

#### 3.4.3.2 Roof Panels

Panels shall be an interlocking standing seam type that can be joined without a special joining machine. Panels shall be continuous from ridge to eave of roof. Where joints are required, they shall have a minimum 6 inch (150 mm) lap.

#### 3.4.3.3 Trim, Flashing, and Gutters

Trim and flashing members, including gutters and downspouts, shall be fabricated of the same material as the wall panels. Members shall be the building manufacturer's standard profiles for the use intended.

### 3.4.4 Fluoropolymer Finish

Baked-on exterior polyvinylidene fluoride finish, as specified in Section 3.3.4, shall carry the specified guarantee against crazing, chipping, cracking, peeling, and loss of color. The interior surfaces of metal wall, roof, and trim panels shall be finished with the manufacturer's standard white paint, unless otherwise specified.

### 3.4.5 Insulation

Insulation shall be noncombustible mineral wool or glass fiber blankets of 0.6 pound (0.272 kg) density with 4 mil (0.10 mm) vinyl film facing carrying an Underwriters Laboratories Inc. (UL) fire hazard rating indicating a flame spread rating of 25 or less. Joints in film facing shall be cemented or taped to provide a continuous vapor barrier.

### 3.4.6 Roof and Wall Panel Fasteners and Washers

Fasteners for roof panels (where exposed) and wall panels shall be coated to match the color of the panels. Neoprene washers shall be provided between the fastener head and the panel. Washers shall be capable of withstanding temperatures from minus 40° F to plus 180° F (-4° C to +82° C), and shall have a tensile strength of not less than 1,200 psi (8,270 kPa). Washers shall have a hardness of 55 to 65 as determined by a durometer test.

### 3.4.7 Closures

Manufacturer's standard wall and roof panel profile metal and flexible closures, and caulking tape shall be provided.

### 3.4.8 Doors and Frames

Swing doors shall be 1-3/4 inch (44 mm) thick and of the sizes indicated. Hollow metal doors and frames shall be of 16 gauge (0.0598 in., 1.52 mm) metal. Doors and frames shall be straight and true, and shall be installed to swing. Doors and frames shall be shop prime coated for onsite finish painting.

### 3.4.9 Windows

Windows shall be building manufacturer's standard for the type. Openings shall be provided with screens.

#### 3.4.9.1 Steel Frames

Steel frame and sash members shall be galvanized and shop prime coated.

#### 3.4.9.2 Aluminum Frames

Aluminum frame and sash members shall be 6063 alloy, minimum 0.062 inch (1.57 mm) thick extrusions, mill finish.

#### 3.4.9.3 Spandrel Panels

Panels shall be insulated with 5/8 inch (16 mm) of rigid urethane foam or other material providing equivalent U-value. Faces and backs of panels shall be minimum 22 gauge (0.030 in., 0.76 mm, uncoated metal thickness) galvanized steel laminated to urethane core, finished the same as the wall panels, and of the colors selected.

### 3.4.10 Glazing

Glass shall be 1/4 inch (6 mm) thick and shall be provided as defined below. Glass at other locations shall be:

1. Clear glass--Interior doors and windows.
2. Tinted glass--Exterior doors and windows.
3. Tempered glass or laminated glass--Windows and sidelighting within 18 inches (457 mm) of a floor.
4. Wire glass--Fire rated doors and windows.
5. Sound control glass--as required.
6. 1/2 inch (13 mm) insulating glass [1/8 inch (3 mm) glazing]--Exterior locations.
7. 1 inch (25 mm) insulating glass [1/4 inch (6 mm) glazing]--Exterior locations.

### 3.4.11 Gutters and Downspouts

Gutters and downspouts shall be sized for the geographic location of the building.

Gutters shall provide a minimum cross-sectional area of 33 $in.^2$ (0.0213 $m^2$). The gutter apron shall extend under the roof panels to provide positive counterflashing. The outside face of the gutter shall be supported with 16 gauge (1.61 mm, minimum uncoated metal thickness) straps attached to the eave member at a maximum spacing of 3 feet (900 mm).

Downspouts shall be of a rectangular configuration with a minimum cross-sectional area of 18 $in.^2$ (0.0116 $m^2$). Each downspout shall discharge above ground or connect to the underground collection system. Downspouts shall be supported with minimum 24 gauge (0.61 mm, uncoated metal thickness) clincher bands attached to the wall covering at a maximum spacing of 10 feet (3,050 mm).

Finish coating for gutters and downspouts shall be the same as that for wall panels.

### 3.4.12 Fixed Drainable Blade Louvers

Louvers shall be manufacturer's standard stormproof, fixed blade, drainable louvers 6 inches (100 mm) deep and shall be as manufactured by one of the manufacturers listed in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers or an acceptable substitute. Louvers shall provide a minimum of 45 percent free area.

Louvers shall be furnished with aluminum bird screens mounted in extruded aluminum removable frames.

Louvers shall be free of scratches and blemishes, and shall be finished as specified for wall panels.

### 3.4.13 Vertical Stormproof Louvers

Vertical stormproof louvers shall be as manufactured by one of the manufacturers listed in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers . Louvers with sinusoidal blade spacing greater than 1 inch (25 mm) shall include an aluminum or stainless steel birdscreen.

Vertical stormproof louvers shall incorporate a sinusoidal blade profile with flow enhancers as necessary to increase water removal efficiency. The louver frames, blades, blade supports, and drain pans shall be extruded aluminum construction. The blades shall be supported and aligned with heavy gauge extruded aluminum blade braces and welded to a structural support frame. The structural support frame may be assembled with aluminum and/or stainless steel fastenings. The louvers shall be factory assembled.

The spacing between blades shall be maintained throughout the vertical height by bracing, stiffeners, and/or clips. During operation, blade deformation shall not exceed 10 percent of the design spacing. Mist eliminator blades shall be at least 0.075 inch (1.9 mm) thick, excluding any efficiency enhancement projection on the blades. Blade spacing shall not exceed 1-1/3 inch (34 mm) pitch.

The bottom structural support shall also be the drain pan. The drain pan shall drain to the outside face of the building through horizontal slots located in the outside face of the drain pan. If intermediate drain pans are required, internal piping shall be provided to drain the pans to the lowest pan. Piping sections shall be flanged or otherwise connected to allow easy disassembly. Screwed fittings are not acceptable. Piping shall be installed to be self-draining.

The louvers shall be coated. All components shall be coated with polyvinylidene fluoride as specified in Section 3.3.4. Materials shall be prepared and coated in accordance with the coating manufacturer's recommendation. Color shall be selected by the Owner.

Vertical stormproof louvers shall be tested and certified according to the requirements specified in Section 3.3.6. Vertical stormproof louvers shall have a Class A certification with an effectiveness of 1 to 0.99 at 8 inch (200 mm) rainfall and 50 mph (22 m/s) wind velocity.

### 3.4.14 Commercial Door Frames

Commercial door frames shall be manufacturer's standard size as indicated for framing openings at roll-up doors. Assembly shall be complete with jambs, header girt, lintel, and fasteners. All roll formed parts shall be galvanized steel of scheduled gauge for the size opening required.

## 3.4.15 Rolling Metal Doors

### 3.4.15.1 Mounting

Doors shall be surface mounted with hood concealed above the head of the opening.

### 3.4.15.2 Curtains

Curtains shall be formed of interlocking flat galvanized steel slats and shall be designed to resist the specified wind pressure. Each curtain shall roll up on a drum supported at the head of the opening and shall be balanced by helical springs. Slats shall be as follows:

| Door Width | Slat Gauge (uncoated metal thickness) |
|---|---|
| Under 12 feet (3,650 mm) | 22 (0.030 in., 0.76 mm) |
| 12 to 18 feet (3,650 to 5,480 mm) | 20 (0.036 in., 0.912 mm) |
| Over 18 feet (5,480 mm) | 18 (0.048 in., 1.21 mm) |

The ends of each slat shall have combination end locks and wind locks. Combination end locks and wind locks shall have flat surfaces engaging a seal of metal or other suitable material mounted on or in the guides to provide an effective wind and water seal.

A bottom bar consisting of two equal weight angles shall be secured to the bottom of the curtain and positioned to suit sill construction. Each exterior door shall be equipped with a replaceable, compressible weather seal attached to the bottom bar.

### 3.4.15.3 Guides

Guides shall form a pocket of sufficient depth to retain the curtain in place under the specified wind pressure. Guides shall be attached to adjacent construction with 3/8 inch (9 mm) diameter bolts near each end and at intermediate spacing not to exceed 30 inches (760 mm).

### 3.4.15.4 Hood

The hood shall be fabricated from 24 gauge (0.024 in., 0.61 mm, uncoated metal thickness) galvanized steel, formed to fit contours of end brackets. Hoods shall be reinforced with steel rods, rolled beads, or stiffening flange at top and bottom edges. Intermediate supporting brackets shall be provided for hoods at openings which exceed 12 feet (3,658 mm) in width. A flexible weather baffle shall be provided at the hood, mounted internally or externally, to prevent airflow around the coil.

Hoods mounted on structural steel girt framing shall be provided with 24 gauge (0.024 in., 0.61 mm, uncoated metal thickness) thick galvanized steel backs. Backs shall be stiffened as required and securely fastened to the top and bottom edges of hoods.

### 3.4.15.5 Finish

The curtain slats, hood, and bottom rails of doors shall be galvanized and given a shop prime coat. All other exposed metal parts of doors and accessories, except bearings and chains, shall be given a shop prime coat.

Galvanized surfaces shall be phosphatized or otherwise treated to assure paint adherence.

### 3.4.15.6 Manual Door Operation

Each manually operated door shall have one lifting handle on each side attached to the bottom rail. Pulldown straps or pole hooks shall be attached to the bottom rail of doors over 7 feet (2,130 mm) high. One pole shall be furnished for each door having pole hooks. Doors shall be counterbalanced and adjusted to provide easy operation with a maximum pull of 20 pounds (90 N) required for lift handle operation.

### 3.4.15.7 Manual Chain Operated Door

Each chain gear operated door shall have an endless chain operating over a sprocket and extending to within 2 feet (600 mm) of the floor. Reduction gearing shall be designed to reduce pull required on hand chain to 20 pounds (90 N) maximum under full wind load conditions.

### 3.4.15.8 Locking Device

Manually operated doors shall be fitted with a chain or bar type locking device. The locking device shall be designed to receive a padlock.

### 3.4.15.9 Motor Operators

Each operator shall be a prewired UL listed assembly, and shall be furnished complete with electric motor, machine cut reduction gears, brake system, overload protection, brackets, push-button controls, limit switches, magnetic reversing starters, and other accessories required for proper operation. Each operator shall be designed so that the motor may be removed without disturbing the limit switch adjustment and without affecting the emergency auxiliary chain operators. Provisions shall be made for immediate emergency manual operation of doors in case of electrical failure. The emergency operating mechanism shall be arranged so that it may be placed in and out of operation from the floor, and its use shall not affect the adjustment of the limit switches. The motor shall be disconnected from the manual operating mechanism whenever the mechanism is engaged.

### 3.4.15.9.1 Motors

Motors shall be of sufficient horsepower to move doors in either direction from any position and produce a travel of 1 foot (300 mm) per second maximum and 1/2 foot (150 mm) per second minimum when operating under full wind load conditions.

Motors shall be suitable for full voltage starting of the inertia loads of the door, and shall have adequate torque at 90 percent of rated voltage to accelerate the connected load to operating speed under maximum design loading conditions.

### 3.4.15.9.2 Control system

Doors shall be equipped with an automatic control system arranged to control the opening, closing, and stopping of curtain travel, and to automatically reverse closing travel when the lower edge of the door curtain meets an obstruction. The control system shall be mounted in NEMA enclosures of a type suitable for the service requirements.

All manual or automatic control devices necessary for the proper operation of doors shall be provided herein. Motors and accessories shall be factory prewired as much as practicable, with connections brought to terminal strips in the controller enclosure.

### 3.4.16 Roof Curbs

Roof curbs shall be designed and fabricated to allow nesting of the curb flashing to the particular roof panel configuration.

## 3.5 EXECUTION

### 3.5.1 General

The Contractor is responsible for handling and protecting building components on the Project Site until the Owner accepts the erected buildings.

Loss or damage to a building before acceptance by the Owner shall be remedied promptly by the Contractor. The Owner will be the final judge on what is acceptable related to damage repair or loss replacement.

Verify the dimensions of foundations and locations of anchor bolts or other embedments placed by others to assure that they are in accordance with reviewed setting drawings. If deviations are found, advise the Owner to have the deviations corrected.

### 3.5.2 Erection

Framing members shall be accurately set, plumbed, and aligned. All joints and anchorage shall be securely bolted.

Erect building framing, in accordance with the MBMA Low Rise Building Systems Manual and the manufacturers erection drawings. Do not field cut or alter structural members without approval of the manufacturer. After erection prime paint welds, abrasions and other surfaces that are not prime painted.

Verify that openings for components to be installed after the building erection are adequately sized for the installation before erecting wall and roof systems.

Erect wall systems and roof systems in accordance with the manufacturers' erection drawings and installation instructions. Exercise care when cutting pre-finished material to ensure cutting do not remain on finish surfaces. Install flashing and trim straight and neat, and avoid excessive exposed sealant. Flash and seal all joints including those to adjacent construction provided by others.

Finish interior joints to ensure continuous insulation and vapor retarder membranes. Upon completion, clean all exposed pre-finished surfaces.

Install gutters and downspouts with rigid supports. Slope all gutters to downspouts. Where storm water sewers are provided, connect downspouts and seal openings, otherwise install bottom elbows and precast concrete splash blocks.

### 3.5.3 Wall Panels

Wall panels shall be continuous from base to eave or to rake line of roof. Horizontal joints shall be kept to a minimum. Panel shall be lapped at least 4 inches (102 mm). Wall panel assembly shall develop the strength to resist the design wind pressures.

### 3.5.4 Roof Panels

Roof panels shall be continuous from ridge to eave. Where laps are required, the upper panel shall overlap the lower by at least 6 inches (150 mm). Panels shall be adequately fastened at eaves, purlins, and ridge, and shall be properly flashed and caulked at ridge, eaves, facia, and where trim is otherwise required.

Roof panels shall extend beyond the wall line on all four sides of the building shall be adequately supported by a bracket at all four corners. The ends of roof panels shall have a drip angle attached.

Flashing for openings shall be designed to positively direct water around each flashed area.

Roof panel joints shall be maintained in correct alignment to ensure adequate expansion and contraction between components. Sliding flashings shall be installed at the panel side and roof edge interface to allow adequate movement.

Panels shall be locked together using the manufacturer's standard joint detail. Clips and other support units shall be installed in strict accordance with the manufacturer's instructions. Panels shall be rigidly fastened only in those areas required by the manufacturer's design.

Roof curbs shall be installed, nesting with the roof panel configuration, and caulked and fastened as recommended by the manufacturer. Installation shall be weather-tight from normal roof runoff and wind driven rain.

Notched and flexible closures and caulking tape shall be installed as otherwise required by the panel manufacturer for an airtight, moisture-tight, and dust-tight roof.

### 3.5.5 Caulking and Flashing

Caulking and flashing shall be provided at all bases, lap seams, corners, eaves, doors, and other openings to provide a completely weather-tight installation. Exterior flashing shall be finished in the same color as the section to which it is attached.

### 3.5.6 Weather Integrity

Completed structures shall be completely weather-tight under all weather conditions. Leaks which occur during the Warranty Period, whether through roofs, walls, doors, windows, or accessory equipment or materials, shall be repaired to the satisfaction of the Contractor at no additional cost.

### 3.5.7 Inspection and Examination

The Work is subject to inspection and examination by Owner at the project site, for full compliance with all requirements for the work.

Owner will retain, and pay for, the services of an independent testing or inspection agency to perform inspections and examinations. Owner's testing agency will not be available for Owner's use. Owner’s inspection and testing service shall conform to the inspection and examination requirements in accordance with the provisions of Chapter 17 in the 2014 Oregon Structural Specialty Code (2014 OSSC), which is titled “Structural Tests and Special Inspections”.

Contractor shall provide, and pay for, access and all rigging required by Owner or its inspection agency and for all personnel required to assist them.

Acceptance of Work by Owner or its Testing and Inspection Agency shall not relieve the Contractor in any manner from full responsibility for the Work.

**APPENDIX G1**
**ATTACHMENT 02**
**EXHIBIT 02**
**ANNEX 01**

# HVAC, PLUMBING, AND ELECTRICAL REQUIREMENTS

**PORTLAND GENERAL ELECTRIC**

**2018**

**REQUEST FOR PROPOSAL**

# HEATING, VENTILATING, AND AIR CONDITIONING (HVAC) REQUIREMENTS

## General Description

A new HVAC system shall be provided for permanently occupied on-site Buildings.

The design work and construction shall conform to the latest ASHRAE manuals and standards, the Oregon Mechanical Specialty Code (OMSC), and standards

All mechanical equipment shall be of commercial quality with a minimum average expected life of 20 years. Ductwork, piping, valves, and accessories shall be of high grade and quality and consistent with requirements of similar installations of this nature.

Ductwork shall be sheet metal, fabricated, constructed, seismically braced, reinforced, insulated, installed, supported, and sealed in accordance with SMACNA standards. Aluminum ductwork shall be utilized in moisture laden areas such as showers, locker rooms, etc.

All heating and cooling piping, including run-out piping, ductwork, equipment, and accessories, shall have a vapor barrier jacket and shall be insulated consistent with minimum requirements of
ASHRAE 90.1-2007. Exterior ductwork shall be designed to prevent water entry during adverse weather. Exterior insulation shall be protected with a weatherproof jacket.

All applicable equipment shall be Energy Star rated and have programmable thermostats.

## Design References

Unless specifically noted otherwise, follow all requirements of:
Oregon Structural Specialty Code, 2010 Edition
Oregon Fire Code (OFC), 2010 Edition
Oregon Plumbing Specialty Code (OPSC), 2008 Edition
Oregon Mechanical Specialty Code (OMSC), 2010 Edition
Oregon Energy Efficiency Code, 2010 Edition

## Design Conditions

A. Indoor Air Temperatures

## All Spaces

Summer 78 degrees F dry bulb (cooling system shall be sized to achieve an indoor temperature of 65 degrees F)
Winter 70 degrees F dry bulb

## HVAC

The HVAC system shall provide mechanical cooling and heating to the Office Building

The HVAC system shall provide mechanical heating and cooling to a minimum of ten (min. 6) zones: Provide digital wall mounted thermostats for each zone. Comm. room to have separate zone with thermostat.

Exhaust fans, unit heaters and split-system AC units, with Electric heating shall be provided.

Electric heating elements shall be provided where heating is required except as noted below.
Code-required access shall be provided for service for all equipment installed on the project.

The Office building will be served by a split-system air conditioning units that are operational 24 hours a day, 7 days a week. The condensing unit of each split system shall be located per plan. All split systems shall be on standby power. No piping shall be permitted to pass through any telecom room in. The proposed units shall be manufactured by Trane or Carrier and a minimum of 16 SEER units. Provide clean air effects electronic filters.

Independent exhaust fans shall be provided for areas requiring special exhaust as required by code (ensure that exhaust fans can be controlled by a switch). The locker room shall have a dedicated exhaust fan.

Adequate space for maintenance access shall be provided for HVAC equipment. Maintain all Manufacturer’s recommended clearances.

The Office shall be equipped with electric furnaces. The furnaces shall be sized to meet current code.

The warehouse shall be on a separate HVAC system from the building. In conjunction to the provided HVAC system please provide (6) electric ceiling mounted shop heaters with thermostats.

The vestibule (if applicable) or small enclosed area between the sets of entrance doors shall have a wall mounted thermostat controlled cadet heater.

## Ventilation

Mechanical ventilation of filtered and tempered outside air shall be provided to each occupied area to satisfy the minimum ventilation rates set forth in the Oregon Mechanical Specialty Code. Demand control ventilation via carbon dioxide monitoring shall be used in

high density areas to maintain adequate outdoor air supply while minimizing energy consumption. CO2 sensors shall be installed.

Supply, return, and exhaust air shall be ducted. Flexible ductwork shall not be allowed over hard ceiling areas.

External insulation shall be used on all supply air ductwork to comply with minimum requirements of ASHRAE 90.1-2007.

Fire and smoke separations shall be maintained per NFPA with required fire and/or fire/smoke dampers.

The locker room shall have a dedicated operable vent/exhaust fan.

All outside air intakes shall be located to avoid recirculation of the exhausted air and shall be at least 10 feet above ground. Intake openings shall be 10 feet from noxious contaminant sources including streets and vents as required by the IMC.

**Exhaust Systems**

**General**

All ductwork serving shower areas shall be sloped and shall use aluminum welded or soldered ductwork to prevent water leakage and corrosion. Low points in the duct shall be piped to an indirect drain with a trap in the pipe to prevent air leakage.

The Office Building shall be mechanically exhausted into the warehouse at a minimum of 10 air changes per hour (ACH).

The exhaust fans for the building shall be located on the roof and shall be capable of continuous operation. The locker room shall have its own exhaust fan that is controlled by a wall switch.

**Testing and Balancing**

All systems and equipment shall be balanced and adjusted to provide the specified operation.

**Operations and Maintenance Manuals**

Operations and Maintenance Manuals shall be provided to the owner

**Identification**

All piping, valves, and mechanical equipment shall be labeled in accordance with ASME A13.1. all valves or controls shall be in an accessible location or have a mechanical hatch/door.

## Training

Provide instruction to personnel for all HVAC systems and equipment.

# PLUMBING REQUIREMENTS

## General Description

A new plumbing system shall be provided for the permanent on-site Buildings. Design and construction work shall conform to the applicable requirements of the Oregon Plumbing Specialty Code (OPSC). Accessible fixtures shall be provided as required by the Oregon Structural Specialty Code and OPSC.

Water shall be supplied by potable water main system.
Plumbing fixtures shall be provided as indicated on drawings. Access panels shall be provided for all concealed plumbing equipment, valves or other accessories that require adjustment or maintenance.

All piping, valves, and equipment shall be labeled in accord with ASME A13.1 requirements.

Drain, waste, and vent piping shall conform to the IPC. Waste piping shall be cast iron, no-hub type. Waste pipe and fittings shall include the trademark of the Cast Iron Soil Pipe Institute (CISPI). Vent piping shall be either cast iron or galvanized steel. Acid-resistant waste lines, vent lines, and floor drains shall be provided in mechanical rooms for corrosive condensate from condensing type hot water heaters

Water piping shall conform to the IPC. Domestic water piping shall be Type L copper for above grade piping and Type K copper for all below grade piping. Solder shall be lead free. Provide water hammer arresters as required. All water piping shall be insulated per ASHRAE 90.1-2007.
Waste from the buildings shall be gravity drained to existing lift stations on the base.

The contractor shall verify the water pressure at the facility. Flush valve type fixtures require a minimum delivered pressure at the fixture of 30 psig. Shutoff valves shall be provided.

Rainleader piping shall conform to the IPC and be cast iron, no-hub type or steel with Victaulic connections.

## Design Preferences

Unless specifically noted, follow all requirements of:
Oregon Structural Specialty Code, 2010 Edition (OSSC)
Oregon Plumbing Specialty Code (OPSC), 2009 Edition
International Energy Code, 2009 Edition

## Fixtures

Lavatories, Urinals, and Water Closets: White vitreous china, ultra-low-flow type shall be provided. Fixtures shall be complete with fittings and chromium or nickel-plated brass (polished bright) trim. All shutoff valves shall be metal construction. All fixtures, fittings, and trim in the building shall be by the same manufacturer and shall have the same finish. Sensor activated fixtures, if used, shall be hard-wired.

Water Closets: American Standard: Madera FloWise with manual Flowise toilet valve. Provide elongated open front toilet seat

Urinals: American Standard: Washbrook FloWise 0.5 gpf urinal with Selectronic urinal flush valve.

Restroom Lavatories: American Standard: Ovalyn with Ceratronic sensor faucet hard wired to electrical power. Provide with thermostatic mixing valve.

ADA Shower: Sterling ADA Compliant shower Receptor and Surround with Bradley Antimicrobial L-shaped seat and American standard Commercial shower system

Break room and Locker room Sink: Moen Excalibur. 22 Ga. 6.5” deep. Provide Moen Chateau faucet.

Utility Sink: American Standard: All purpose sink with Exposed yoke wall mounted utility faucet.

Drinking fountains: Elkay model # EZTL8C ADA compliant drinking

Floor Drains: At a minimum, provide floor drains with trap primers in the restrooms.

Hose Bibbs: Provide exterior freeze-proof hose bibbs with integral vacuum breakers. Provide enough hose bibbs that all points along the perimeter can be reached with a 50-foot-long hose. A hose bibb with integral vacuum breaker shall be installed on each of the three docks for ease of boat maintenance and located to prevent damage from operations or boat ties. The cold water pipes serving these bibs shall be designed to allow the system to be isolated and drained in the winter. Exterior piping shall be insulated. All hose bibs shall be frost free.

Water Meter and Back Flow Preventer: Provide backflow prevention and meter assemblies for building water supply.

Appliance Plumbing Connections (dishwasher, ice machine(locker room and kitchen), coffee maker (kitchen and large conference room), etc.): Provide appropriate connections for all appliances and any other items requiring water, drain connections, or vent. The Contractor shall coordinate appliance connections with room layouts. A reduced pressure backflow preventer shall be provided for appliances as required.

Provide eye wash station in the warehouse per OSHA requirements.

## Domestic Hot Water Systems

Hot water shall be available to all fixtures at 120 degrees F within 10 seconds during building operating hours.

a. Office Buildin1g: Provide a high efficiency, Electric storage type hot water heater sized to provide hot water to the fixtures. Provide direct vent to the outside, circulating pump sized to ensure hot water delivery to all fixtures within 10 seconds and bladder-type expansion tank.

## Access Panels

Keyed access panels shall be provided for all concealed plumbing that requires adjustment or maintenance.

## Operations and Maintenance Manuals

Provide operation and maintenance manuals for all plumbing systems.

## Testing

Systems shall be cleaned and tested in accordance with IPC, NFPA 54, NFPA 30, and NFPA 303.

## Training

Provide instruction to personnel for all plumbing equipment.

# ELECTRICAL REQUIREMENTS

## General:

Electrical system design and construction for the permanent on-site buildings shall comply with NEC and current electrical code, as applicable. Install materials and equipment in compliance with applicable codes and manufacturers printed instructions.

The design for all new buildings shall provide building services independent of any existing buildings.

## References, Codes, and Standards

Design and construction shall, at a minimum, be in accordance with the following documents to the extent cited in the text. Codes, standards and publications are referenced in the text by their basic designation only. The editions adopted by the authority having jurisdiction or the latest editions (if not subject to AHJ adoption), at the time of bid proposal shall be used, unless otherwise noted.

International Code Council
Oregon Structural Specialty Code (OSSC), 2010 Edition
Oregon Energy Efficiency Code (OEEFC), 2010 Edition
Oregon Fire Code (OFC), 2010 Edition

National Fire Protection Association (NFPA)
NFPA 101, National Life Safety Code - 2009
NFPA 70, National Electrical Code - 2008
NFPA 72, National Fire Alarm Code - 2007

Institute of Electrical and Electronics Engineers
National Electrical Safety Code (NESC) - 2007

National Electrical Contractors Association (NECA)
National Electrical Installation Standards (NEIS) - 2000

## Exterior Electrical Services

Electrical service to the Office building is the responsibility of the contractor.. Make all arrangements with the local electric utility and provide all documents, calculations, materials as required by the electric utility for connection or modification of the electrical service. Contractor shall
coordinate all power outage and modifications to the service. This includes service for the temporary construction trailers.

## Interior Electrical Systems:

Provide a system of panelboards, feeders and branch circuits as required to provide electrical power to equipment and outlets. Provide a main circuit breaker. Provide heavy-duty type disconnect switches where switches are rated higher than 240 volts and for double throw switches. General purpose lighting shall be 277V and receptacle circuits shall be 20 ampere, 120 volt unless noted otherwise.

Short circuit analysis and coordination and protective device study shall be provided showing devices and settings. Equipment shall be fully coordinated above 0.1 seconds. Calibrate, adjust, set and test each new adjustable circuit protective device to ensure that they will function properly prior to the initial energization of the new power system. Short circuit current rating and bracing of equipment shall be selected based on calculated fault current values; use the infinite bus method if actual system values are not available.

**Panelboards:**

Provide bolt-on circuit breaker type panelboards. Provide minimum 25% spare capacity, 10% spare circuit breakers, and 15% space only for all panelboards. Do not use series rated circuit breakers. Do not use fuses. Provide a minimum of two spare conduits to accessible areas from flush mounted panelboards. Directory cards shall identify load locations by room number or name. Panelboards should be located in dedicated electrical rooms, as practical. There shall be a single panel dedicated for critical elements of the building for future transfer switch and generator. Please propose the configuration for Owner’s review and approval.

**Wiring methods:**

All wiring shall be meet minimum code requirements, fire alarm, and other systems except where larger sizes are recommended by equipment manufacturers or required for code compliance; cable tray or bundled hangers may be used to carry telecommunications and other low voltage cable, Type MC cable may be used for branch circuit wiring run above suspended ceilings. Wiring shall be run concealed or above suspended ceilings in finished spaces and may be run exposed elsewhere. Provide a green color insulated equipment grounding conductor in all raceway with ungrounded conductors. Provide a separate neutral conductor in all raceways with ungrounded conductors. Provide a separate neutral conductor with each branch circuit in offices and computer workstation areas. Provide an exposed main ground bus in each new building (minimum 12” long by 2” wide).

**Receptacles and Equipment Connections:**

Provide electrical receptacle outlets and hard-wired equipment connections as: required for specific equipment items; required by the National Electrical Code (NFPA 70); required by the Space Criteria Sheets; as a minimum in accordance with the following general criteria; and as otherwise specified. Receptacle outlets shall be specification grade, heavy duty, grounding type, wall mounted 18” above the finished floor unless specified otherwise. Receptacle outlets shall be 20 ampere, 120 volt NEMA 5-20R duplex type

unless otherwise specified; no more than six duplex or three quad receptacles shall be connected on a single branch circuit. Provide special purpose receptacle outlets for cord and plug connected equipment with configurations to match equipment plug requirements. Provide GFCI and AFCI protected outlets per NFPA 70 and as specified. Power receptacles shall have twelve inch minimum separation from data receptacles.

**Room Criteria (as applicable):**

a) Private offices: Provide one duplex outlet for every 10 feet of wall space measured at the floor line with a minimum of one outlet on the three non-entry walls.

b) Open offices: Provide wall mounted duplex receptacle outlets at each workstation or desk shown on the RFP drawings. Provide additional duplex outlets so that no point in any wall space is more than six feet from a wall receptacle outlet. Provide power connections to/for systems furniture in open office areas using wall, floor or ceiling outlet/distribution boxes as required for connection to or wiring of systems furniture wall panels. Provide an overall minimum of one circuit for every three systems furniture workstations, with a maximum of three ungrounded conductors per homerun to the panel board.

c) Conference room: Provide one duplex outlet for every 10 feet of wall space at the floor line. Provide one duplex outlet at projector and CATV outlet locations, as applicable.

d) Break room: Provide one general purpose outlet for every 3 feet of countertop, but not less than one per countertop. Provide one duplex outlet for each 10 feet of wall space at the floor line, excluding counter top areas. All outlets shall be GFCI protected. Provide additional dedicated circuits and outlets as specific equipment items, with dedicated circuits as specified.

e) Halls/Lobby: Provide a minimum of one general-purpose hospital grade NEMA 520R,duplex outlet for every 40 feet of corridor length with a minimum of one outlet per corridor. Connect receptacles serving lobbies/corridor receptacles on circuits separate from those serving office areas.

f) Storage/Janitor: Provide a minimum of one GFCI protected outlet per space.

g) Toilet Rooms/Locker/Wet rooms: Provide a minimum of one GFCI protected outlet per sink; locate outlets adjacent to each sink, 6 inches above the counter top or top of the sink.

h) Warehouse spaces: All duplex outlets in shop spaces shall be either GFCI type or GFCI protected.

i) Provide duplex outlets on walls with a minimum of one outlet per 20 feet of wall length, mounted 42” aff.

i) Telecommunications room: Provide a dedicated power panel, dedicated to the room loads. Provide three duplex outlets on each wall. Do not combine Telecomm, CATV, or CCTV equipment on the same receptacle circuit - provide additional circuits and receptacles as required.

j) Electrical and Mechanical Equipment rooms: Provide one duplex outlet for every 20 feet of wall length with a minimum of one outlet per wall space. Provide outlets for all the mechanical equipment as required.

k) Storage Rooms: Provide one outlet for every 20 feet of wall length, with a minimum of one outlet per space, located near the entry door.

l) Other spaces: Provide one outlet for every 20 feet of wall length, with minimum of one outlet per space.

**Exterior:**

Provide one GFCI or GFCI protected outlet every 150 feet of exterior wall length, with outlets preferably located near entrances. Outlets provided per NFPA 70 requirements for HVAC equipment maintenance may be counted as a required outlet.

**Provide a duplex NEMA 5-20R receptacle outlet with dedicated circuit for the following equipment:**

Copiers
Plotters/Printer
Water Coolers
Vending Machines
Microwaves
Ice Makers
Coffee Makers
Refrigerator
Oven/Stove
Waterheater

Provide an outlet adjacent to CATV outlets located at 48 inches or higher above finished floors, intended for wall bracket mounted televisions.

Provide a duplex outlet between 12 and 18 inches from each quad telecommunications outlet. Partitioned outlet boxes intended for electrical and telecommunication terminations within the same outlet box shall not be used.

Provide power connections for control panels as required for special systems such as the fire detection and alarm system, intrusion detection, and other system control panels requiring electrical power.

Provide a duplex outlet adjacent to overhead projector mounting locations.

**Lighting:**

General Requirements: Interior illumination shall be provided by fluorescent, LED and/or HID type lamps. Minimize the number of different lamp types utilized. Provide dimming and multilevel switching for lighting of areas where tasking requires varying illumination levels (e.g., multi-purpose room). Use compact fluorescent lighting rather than incandescent lighting except where incandescent lighting is the only type available for the specific application. Use the following design target maintained illuminated levels for the spaces listed; use IESNA recommendations for other spaces; base calculations on the 36 month LDD factor for the category of luminaire. Illumination levels for interior spaces will initially follow recommended levels based on IESNA RP-1-04 Office Lighting and IESNA Lighting Handbook, 9th Edition. Light levels may need to be adjusted to comply with ANSI/ASHRAE/IESNA 90.1-2007.
Telecom spaces shall be designed to come as close to the ANSI/TIA/EIA-569-B recommended 50 foot-candle at 3 ft. above floor as achievable within ASHRAE.

| Space | FC Level |
|---|---|
| Unoccupied spaces | 10 FC |
| Storage and Attic | 5 FC |
| Corridors | 10 FC |
| Mech. & Elec. Rooms | 15 FC |
| Telecom | 50 FC |
| Rest Rooms (toilets), Locker rooms | 20 FC |
| Vestibule/ Lobby, | 15 FC |
| Offices | 30 FC |
| Conference | 30 FC (dimmable and multi-level) |
| Warehouse | 30 FC |
| Break room | 15 FC |

**Interior Lighting (as applicable):**

a) Offices:

1) Private offices: Provide 2x4 architectural lensed troffer fixture recessed in grid ceiling. Lithonia CPES8P. All switches shall have motion switches.

2) Open offices: Provide 2x4 architectural lensed troffer fixture recessed in grid ceiling. Lithonia CPES8P. Provide exit signs and nighttime/emergency egress lighting with select fixtures with emergency battery backup.

b) Conference rooms: Provide 2x4 architectural lensed troffer fixture recessed in grid ceiling with bi-level switching. Lithonia CPES8P. Provide exit signs and nighttime/emergency egress lighting with select fixtures with emergency battery backup.

c) Break room: Provide 2x4 architectural lensed troffer fixture recessed in grid ceiling. Lithonia CPES8P.

d) Entry/Vestibule: Recessed LED 6'' can lighting. Lithonia DOM 6. Provide exit signs and nighttime/emergency egress lighting with select fixtures with emergency battery backup.

e) Janitor's Closet: 2x4 architectural lensed troffer fixture recessed in grid ceiling. Lithonia CPES8P

f) Toilet Rooms/Locker/Wet rooms: Recessed LED 6'' can lighting. Lithonia DOM 6. Provide one light with emergency critical panels.

g) Warehouse spaces: Lithonia Contractor Select Heavy Duty Strips (T12H0)

h) Telecommunications room: Lithonia Contractor Select Heavy Duty Strips (T12H0)

i) Storage Rooms: Lithonia Contractor Select Heavy Duty Strips (T12H0)

Exit signs shall be LED type with emergency battery back-up; lettering shall be red.

Provide emergency battery lighting to illuminate paths of egress and in rooms and other areas where loss of light could present immediate personnel danger upon loss of illumination. Emergency battery lighting shall be provided either by separate battery pack type fixtures or by use of battery packs in standard lighting fixtures. Battery pack type fixtures shall have maintenance free nickel cadmium or lead acid batteries.

Provide lighting controls as required by the Oregon Energy Efficiency Code.

Coordinate location of lighting fixtures in mechanical, electrical and telecommunications rooms with locations of equipment, duct, piping, cable trays and conduit runs to avoid blocking illumination from fixtures and to provide illumination of panelboards, equipment racks, controllers, equipment access locations, schematic diagrams, etc.

**Exterior/Site Lighting:**

Provide exterior building mounted wall pack lighting for illumination of all building entries and for illumination of adjacent approaches and sidewalks. Building lights: Lithonia MRW wall mounted light.

**Standby Power:**

Electrical panels shall be separated into critical and non-critical panels. The critical panel shall be designed such that in the future a transfer switch and emergency generator may be used.

(2) two exterior lights shall be provided at the flagpole to keep the flag lit during evening hours. Should be on a light sensor.

Please provide submittals for light poles and foundation design. d

**Grounding and Lightning Protection:**

Per NEC requirements

Coordinate electrical grounding and bonding with Telecomm required grounding requirements for an integrated system.

**Fire Alarm System:**

Contractor to install a fire alarm system for the building with the capacity to expand to (4)additional zones. The fire alarm system shall have an open format software for owner programming. Alarms shall be connected with the mag-locks on the fire separation doors so that they release during an alarm. Install the fire alarm panel in the comm. room. The building shall be equipped with flashing LED battery powered fire exit signals and an audible alarm. Please submit for Owner’s approval.

**Testing:**

Provide tests and inspection of electrical systems. Tests shall include: Lighting performance (lux/fc) and control, insulation resistance of wiring; ground resistance of grounding systems; load test of generator; automatic transfer switch operation; access control system operation, security system operation, ups operation, and operational tests of all electrical equipment. Tests shall include those recommended by the equipment manufacturer and those required by applicable codes. Equipment shall not be placed in service until testing has been completed and test results have been evaluated.

**Operations and Maintenance Manual:**

Provide Operations and Maintenance Manual for electrical equipment.

**Training:**

Provide training for operation and maintenance of power distribution and lighting systems.

**APPENDIX G1**
**ATTACHMENT 03**
**EXHIBIT 01**

# FIRE PROTECTION SYSTEMS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| E | 14 Dec 17 | Issued for Implementation | DNV -GL | DS | SPF | Sean flak |
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# 1.0 GENERAL

## 1.1 WORK INCLUDED

1.1.1 This specification covers the technical and associated requirements for designing, furnishing and erecting the complete fire protection system for the Project operations and maintenance building, substation control room, and any other primary building associated with the Project.

1.1.2 It is not the Owner's intent to specify all systems or technical requirements or to set forth those requirements adequately covered by applicable codes and standards. Contractor shall furnish high quality equipment meeting the requirements of this specification, industry standards, and local requirements.

1.1.3 In the event of any apparent conflict between standards, codes, this specification and/or any of the documents included in the EPC Agreement, the Contractor shall list the conflict(s) for resolution before final design.

1.1.4 The Contractor shall provide a Fire Risk Evaluation and Design Basis Document in accordance with NFPA 850 and provide related NFPA and FM calculations as required.

1.1.5 The Contractor shall provide the fire protection system design to the Owner and the local authority having jurisdiction for review.

## 1.2 FIRE PROTECTION SYSTEMS

1.2.1 Operations and Maintenance Building

- The Contractor shall evaluate building design and determine if automatic sprinkler systems are required by applicable codes and standards. At minimum, a fire detection system shall be installed.

1.2.2 Substation Control Room

- A non-water, non-conductive, clean agent fire suppression system shall be installed in the substation control room.

1.2.3 Main Power Transformers

- Oil insulated main power transformers, located within switchyards and substations, shall be separated from adjacent structures and from each other by fire walls, spatial separation, or other approved means to limit spread and damage from a transformer fire.

- Consideration shall be given to water spray fire protection for main power transformers. Analysis and justification shall be documented in the Fire Risk Evaluation.

1.2.4 Wind Turbines

- Permanently mounted fire extinguishers are to be located with the base of each tower and inside each nacelle.

- Wind turbine pad mount transformer layout shall incorporate physical separation or barriers and oil containment measures.

## 1.3 WORK COVERED BY THIS SPECIFICATION

1.3.1 The Contractor shall design, furnish, erect, and test complete fire suppression systems including, but not limited to, the following: all spray nozzles, sprinkler heads, heat and smoke detection devices, strainers, OS&Y valves, nonrising stem gate valves with wall post indicator valves, sprinkler and spray system piping, fittings, strainers, fire department connections, pipe hangers and supports, expansion joints, nuts, bolts, gaskets, special fasteners, backing rings, etc., between components and equipment furnished under these specifications, all necessary connections for the piping and instruments alarms, controls, local control panels, wiring, conduit, fire detection devices, and instrumentation as required for complete systems from fire protection water supply connections through sprinkler heads and/or nozzles. Where necessary, an enclosure designed to house the system valve stations and local control panels shall be furnished. Each system shall be designed to provide the required protection for the specific hazard.

1.3.2 Training and Services Requirements

Prior to completion of the project, the Contractor shall train the Owner on the site regarding all supplied equipment and manuals (operation, testing, and maintenance). Services necessary to turnover for startup and commissioning shall be included as part of this contract.

1.3.3 Installation:

- Construction facilities.
- Furnish all materials, tools, equipment, vehicles, supplies, services, labor supervision, and licenses, required to perform the complete erection, checkout, and testing of the equipment and materials for the fire protection systems.
- Furnish all jigs, fixtures, rigging, man-lifts, scaffolding and tools required to perform the Work.
- Provide labor for steel receiving, unloading, placing into construction lay down area, and onsite hauling.
- Provide materials required for erection including grout, shims, wedges, dowels, self-drilling anchors, supports, bolting, gaskets, packing, welding rod, and consumable gases.
- Install piping and mechanical equipment.
- Field modify pipe to resolve interferences.
- Cut and drill penetrations for grating, floors, walls, or casings including suitable bending and restoration. Penetrations in finished areas shall be restored to same level of appearance as before the hole was made. Penetrations in rated surfaces shall have seals that maintain the original rating of the surface.
- Furnish, install, and remove hydrostatic and/or pneumatic testing materials, tools, instruments, blocking, bracing, bulkheads, and blanking plates.
- Furnish labor required for hydrostatic and/or pneumatic testing.
- Finish and touch up painting.
- Interconnecting wiring of devices to local fire alarm panels.
- Termination of interconnecting wiring of FAAP to local fire alarm panels.
- Correct minor misfits.
- Special tools required for erection of the equipment, exclusive of the maintenance tools specified to be furnished.

- All equipment and systems designed supplied, or installed shall be appropriate for the area and shall take into account the plant electrical hazardous requirements.

- All conductors shall be in dedicated fire protection conduit. Conductors shall not be permitted in trays.

- Alarm and trouble signals from fire alarm panels shall be routed to the control room.

1.3.4 Documentation that shall be provided as a minimum.

- Fire Risk Evaluation/Fire Protection Design Basis Document

- Complete and detailed design drawings for each system. Drawings shall clearly indicate all wiring and equipment that is supplied or installed by Contractor. Drawing shall call out any design and material requirements (manufacture and code/standard). Contractor is responsible for reviewing materials and designs as part of the overall fire protection system, to ensure compliance with codes, standards and manufacturers' requirements.

- Site fire protection plan drawings

- Hydraulic calculations

- Room integrity test results for clean agent suppression systems

- Detailed control panel drawings

- Detailed communication drawings

- Operation and Maintenance manuals shall be provided.

- Complete all required documentation and obtain necessary inspection required for the fire protection systems to be operated. Signed and filled out test forms shall be provided for each system provided.

- As built drawings

- All drawings shall bear the seal of said registered professional engineer. All calculations or submittals other than drawings shall be submitted as securely bound documents and shall also bear the seal of said registered professional engineer.

## 2.0 CODES AND STANDARDS

Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply.

| Work | In Accordance With (Minimum) |
|---|---|
| Overall design | NFPA, AHJ, Oregon Building and Fire Code, Oregon Structural Specialty Code, , and applicable codes |
| Fire detection system equipment components | NFPA, FM*, FM Global Property Loss Prevention Data Sheets, UL*, ANSI, ASME, ASTM, NEMA, IEEE, AWS, AWWA, and DOT |
| Smoke detection | NFPA 70, 72, 90A, and 850, FM Global Property Loss Prevention Data Sheets 5-40, 5-48 |
| Heat detection | NFPA 70, 72, and 850, FM Global Property Loss Prevention Data Sheets 5-40, 5-48 |
| Manual pull stations | NFPA 70, 72, and applicable codes, FM Global Property Loss Prevention Data Sheets 5-40, 5-48 |
| Indicating devices | NFPA 70, 72, and 850, FM Global Property Loss Prevention Data Sheets 5-40, 5-48 |
| Sprinkler system, includes all sprinkler types applicable | NFPA 13 and 850, FM Global Property Loss Prevention Data Sheets 7-101, 2-8, 2-8N |
| Water spray fixed system | NFPA 15 and 850, FM Global Property Loss Prevention Data Sheets 4-1N, 5-4, 1-6 |
| Control panel initiating and indicating devices | NFPA 70, 72, and 850 |
| Deluge piping | ASTM A53 and A106, FM Global Property Loss Prevention Data Sheets 4-1N, 5-4, 1-6 |
| Pipe Supports | NFPA 13 and 15, FM Global Property Loss Prevention Data Sheet 2-8N |
| Pipe thread tolerances | NFPA 13, FM Global Property Loss Prevention Data Sheet 2-8N, and ANSI B1.20 Pipe Threads |

| Work | In Accordance With (Minimum) |
|---|---|
| Anchor bolts | Federal Specification FF-S-325, Group II, Type 4, Class 1 or 2 |
| Combustion Turbine Fire Protection | NFPA 750 and 850; FM Global Property Loss Prevention Data Sheet 7-79 |
| Fire hydrants | NFPA 24, FM, UL Standard 246, FM Global Property Loss Prevention Data Sheet 3-10 |
| Extinguishers | NFPA 10 |
| Hose systems | NFPA 14, FM Global Property Loss Prevention Data Sheets 3-10, 4-4N, UBC 1997 |
| Rotating lights and site fire alarm warning horns | UL, NFPA 70 and 72 |
| Fire alarm system wiring (initiating devices, notification appliances, solenoids, signaling line circuits) | NFPA, AHJ, and applicable codes |
| Wiring and installation work | National Electrical Code, NFPA 72 |
| Clean Agent Fire Extinguishing Systems | NFPA 2001 |

*Equipment supplied shall be included in the Approval Guide as published by Factory Mutual (FM) Engineering. Where FM-approval is not available, equipment listed by Underwriters Laboratories Inc. (UL).Equipment shall be considered as FM-approved only if it conforms to the characteristics and limitations of the individual component approvals and if those components are used in the service intended by the Approval Guide.

2.1.1 Any conflict between referenced codes or standards, or between the standards and these specifications, shall be referred immediately in writing to the Owner who shall determine which standard or specification requirements shall govern. The Owner shall be the authority having jurisdiction over interpretation of non-mandatory NFPA standards, codes, and recommended practices.

2.1.2 In addition to the above codes and standards, Contractor shall comply with all applicable Federal, State and local laws, codes and regulations.

# 3.0 TECHNICAL REQUIREMENTS

## 3.1 MATERIALS

The following materials shall be used as a minimum:

| Component | Material |
|---|---|
| Piping | |
| Sprinkler/Spray piping (downstream of isolation gate valve) | ASTM A53, Grade A or B, galvanized, seamless or welded (ERW); or ASTM A106, Grade B, galvanized. Minimum Schedule 40 |
| Dry-pipe and preaction systems (downstream of isolation gate valve) | ASTM A53, Grade A or B, galvanized; seamless or welded (ERW); ASTM A106, Grade B, galvanized (no copper or brass tubing or piping). Minimum Schedule 40 |
| Wet-pipe systems | Galvanized piping not required. Minimum Schedule 40 |
| Dry pilot piping | Galvanized ASTM A53, seamless or welded (ERW), Schedule 80, Grade A or B |
| Air piping | Minimum 0.5 inch (13 mm) outside diameter |
| Piping upstream of the sprinkler and spray systems | Black steel, ASTM A53, Grade B, seamless; or ASTM A106, Grade B, seamless. Minimum Schedule 40 |
| Flanges | |
| Flanges | Hot-dip galvanized following welding when connected to galvanized pipe (see Section 13902.2.1.7.2) |
| Piping 2 inches (50 mm) and smaller | Screwed or shop welded. (UL or FM Listed grooved style fittings are acceptable except where piping is attached to the turbine pedestal.) |
| Piping larger than 2 inches (50 mm) | Welded flanges or shop welded connections. (UL or FM Listed grooved style fittings are acceptable except where piping is attached to the turbine pedestal.) |
| Pipe accessories | |
| Dry pilot fittings | Cast iron, galvanized, ANSI B16.4 Class 250; or malleable iron, galvanized, ANSI B16.3 Class 150 with threaded ends |
| Dry pilot unions | Brass to iron seats |
| Sprinkler and spray fittings (threaded or flanged: tees, couplings, elbows, caps, and reducers) | ANSI B16.3 or B16.1 malleable iron, Class 150 (mitered fittings are not acceptable) |
| Sprinkler and spray fittings (except wet-pipe) | Galvanized, ASTM A153; no bushing, slip type, or clamp-on rubber gasketed fittings |
| Plugs (sprinkler system) | Square head, dissimilar to the fitting to which they are attached |

| Component | Material |
|---|---|
| Gaskets | Red rubber sheets, 1/16 inch (1.6 mm) thick, full face, ASTM D2000, No. 2AA705A13L14 |
| Thread sealant | Teflon ribbon, Optional for gas suppression piping: Locktite 592 sealant and primer NF-73656 |
| Thread tolerances | NFPA 13 and ANSI B1.20.1 pipe threads |
| Bolts and nuts | Steel machine bolts |
| Plugs | Square heads and of a metal dissimilar to fitting to which they are attached |
| Piping supports | Per NFPA 13 and 15 |
| Supplementary support beams (pipe support) | ASTM A36, fireproof construction |
| Riser lugs | ASME B31.1 |
| Hanger rods | Per NFPA 13 |
| Water shields | Viking model B-1, or equivalent. |
| Valves | |
| Gate valves | OS&Y type, flanged ends |
| Control panels (local) | NEMA 4 |
| Control panels (FAAP) | NEMA 12 (manufacturers standard panel will be considered in rooms with no water suppression and not likely to see any abnormal dust conditions) |

## 3.2 SPRINKLER AND SPRAY SYSTEMS

3.2.1 If sprinkler and spray fire suppression systems are determined to be required for plant design, this article covers the minimum requirements to be designed, furnished, and installed under these specifications.

3.2.2 The Contractor shall furnish complete fire suppression systems, including all spray nozzles, sprinkler heads, heat and smoke detecting devices, valves, piping, fittings, strainers, pipe supports, expansion joints, alarms, controls, control panels, wiring, conduit, and instrumentation as required for complete systems, from the piping connections as indicated on the drawings through sprinkler heads and/or spray nozzles. Each system shall be designed to provide the required protection for the specific hazard. All equipment and devices furnished shall be designed to meet code requirements specified herein.

3.2.3 System Requirements

The fire protection equipment shall be arranged to adequately protect the plant and equipment in the event of fire. The minimum type of system to be provided for protection of equipment and areas as required by the Owner.

### 3.2.4 Arrangement

The Contractor will develop pertinent building, structural steel, ductbank, lighting, piping composite, electrical enclosure arrangement and wiring diagrams, and area drawings for use in constructing the project. The Contractor shall develop and update the fire suppression system design and drawings as required to accommodate the plant design indicated by the drawings, including subsequent changes made as work progresses.

#### 3.2.4.1 Piping Arrangement

The Contractor's piping arrangement shall take into consideration and provide for such adjustment as may be required to avoid interference with the separately specified piping and equipment as indicated on the originally submitted drawings and subsequent revised drawings thereafter.

Automatic or manual fire protection valves shall be located in the areas indicated on the drawings.

Prior to installation, the Contractor's piping arrangement, spray nozzles, heat detection devices, and design data shall be submitted to the Owner for review and acceptance in accordance with the submittal requirements.

The installation of the fire protection piping shall allow for the installation of freeze protection on piping located above grade outdoors.

The Contractor's piping shall be arranged with adequate slope and valved vents and drains so as to be completely drainable.

The Contractor shall furnish all piping, pipe supports, valves, and fittings required for complete fire protection systems in compliance with code and these specifications.

Field joint locations and configuration of the section shall be selected with consideration given to field erection problems. Wherever possible, field joints shall be placed in convenient locations.

Consideration shall be given for the arrangement of test header, inspector test valves, and main drains for the ease of recurring testing.

#### 3.2.4.2 Detection Arrangement

Detectors used to actuate preaction and deluge systems shall be arranged in accordance with NFPA 72, FM Global Property Loss Prevention Data Sheet 5-48, and the applicable FM Approval listing for the specific device being considered. Prior to detector installation, detector arrangement shall be submitted for review and acceptance.

### 3.2.5 Fire Water Supply

Fire water, if required, shall be supplied to the systems at the minimum pressures determined to be available by Contractor during detailed design. The Contractor shall propose a fire water source. Systems shall be designed to adequately cover the areas to be protected at these minimum supply pressures.

### 3.2.6 Design Requirements

The following design requirements apply to the design of fire suppression systems.

#### 3.2.6.1 Qualifications

The fire suppression and detection systems shall be designed by or under the direct supervision of a registered professional engineer qualified to practice fire protection engineering. Such qualification shall be evidenced by either of the following:

Having successfully passed a professional engineering license examination in the discipline of fire protection engineering.

Holding the qualification of Member Grade in the Society of Fire Protection Engineers.

#### 3.2.6.2 Environment

Each system shall take into account the site location, temperature, seismic, and environmental conditions that can be seen.

#### 3.2.6.3 Design Parameters

The Contractor shall design each sprinkler and spray system to meet or exceed the requirements of these specifications and the required codes and standards. Each system shall be designed for the specific hazard and shall have FM-approved equipment and devices when available. Where FM-approval is not available, UL-listing shall be acceptable. Special emphasis shall be given to the design of the fire suppression systems to prevent water supply and dry pilot piping and nozzles from interfering with required plant repairs or routine maintenance.

Valves installed between alarm initiating devices intended to signal activation of a system and the fire suppression system shall be electrically supervised. All valves shall be electrically supervised as required by applicable codes and standards.

Maximum water velocity in sprinkler and spray system piping shall be 20 ft/s (6 m/s).

The Contractor shall verify that the physical locations of automatic or manual valves with respect to the proximity and elevation of the branches are acceptable to avoid hydraulic shock when the valves are actuated.

All components in fire protection water systems shall be able to operate at 175 psig (1207 kPag), or at a higher design pressure.

### 3.2.7 System Types

The following are various types of sprinkler and spray systems that can be selected. Each system can be designed for manual or automatic activation.

| Sprinkler Systems | Spray Systems |
|---|---|
| Dry-pipe | Deluge |
| Wet-pipe | Preaction |

#### 3.2.7.1 Dry-pipe Sprinkler Systems

The dry-pipe sprinkler systems shall be in accordance with the following requirements:

Piping design shall be for a branched or "tree" type system. Looped or gridded dry-pipe systems shall not be allowed.

Dry-pipe valves shall be provided with an approved quick opening device where system capacity exceeds 500 gallons (1,900 liters).

Trouble horn and fire alarm bell shall operate on low voltage dc.

The following equipment shall be provided for each system:

Isolation gate valve with tamper switch when there is more than one system per header.

One minimum 4 inch (100 mm) fire department connection (FDC) in accordance with NFPA 13, complete with check valve, automatic drip, siamese connection, and caps [for each system exceeding 2,000 $ft^2$ (609.6 $m^2$)]. Only one FDC required per header. FDC connection points shall be specified based on responding Fire Departments hose connection.

Strainer (one per header) and check valve (if FDC required).

Manufacturer's standard differential dry-pipe valve with trimmings and quick opening device where required by system capacity.

Fixed piping system with all necessary pipe, fittings, quartzoid bulb sprinkler heads, and pipe supports.

Drains and other appurtenances required, including drain piping. Drains and drain piping terminated 12 inches (300 mm) above grade.

Supervisory panel with distinctive supervisory, trouble, and alarm signals in accordance with the article entitled Local Supervisory Panel (Panel may be common with other systems).

Inspector's test connection in accordance with NFPA 13, at the end of most remote branch.

Connecting wiring, raceway, supports, and junction boxes for all electrical devices.

3.2.7.2 Wet-pipe Sprinkler Systems

The wet-pipe sprinkler systems shall be in accordance with the following requirements:

Trouble horn and fire alarm bell shall operate on low voltage dc.

Looped or gridded wet-pipe systems are not acceptable.

The following equipment shall be provided for each wet-pipe sprinkler system:

Isolation gate valve with tamper switch.

One minimum 4 inch (100 mm) FDC in accordance with NFPA 13, complete with check valve, automatic drip, siamese connection, and caps [for each system exceeding 2,000 $ft^2$ (609.6 $m^2$)]. Only one FDC required per header. FDC connection points shall be specified based on responding Fire Departments hose connection.

Strainer (one per header).

Alarm check valve with retard chamber and trim.

Pressure type flow switches in each cross main, for multi-zone systems only.

Fixed piping system with all necessary pipe, fittings, sprinkler heads, and pipe supports.

Supervisory panel with distinctive supervisory, trouble, and alarm signals in accordance with the article entitled Local Supervisory Panel.

Drains and other appurtenances required, including drain piping and isolation valves from system equipment including strainers.

Drains and drain piping terminated 12 inches (300 mm) above grade unless specified otherwise.

Inspector's test connection(s) at the end of most remote branch for each flow switch zone.

Trouble alarm horn and fire alarm bell.

Connecting wiring and raceway for all electrical devices.

3.2.7.3 Water Spray (Deluge) Systems - Automatic Dry Pilot Actuation

Each water spray (deluge) system shall be designed to provide the coverage density required by applicable codes and standards. The coverage densities shall be applied over the projected area of a rectangular prism envelope for the protected equipment and its appurtenances, including the floor or ground surface area measured 3 feet (1 meter) horizontally from the equipment envelope. The following equipment shall be provided for each system:

Manufacturer's standard deluge valve with dry pilot trim and pressure switches.

Isolation gate valve with tamper switch.

Valve station header with strainer (one per header).

Fixed piping system with all required pipe, fittings, nozzles, dry pilot detectors, and pipe supports.

Drains and other appurtenances required, including drain piping and isolation valves from system equipment including strainers.

Supervisory panel with distinctive supervisory, trouble, and alarm signals in accordance with the article entitled Local Supervisory Panel (Panel may be common with other systems).

Trouble alarm horn and fire alarm bell (may be common with other systems and shall operate on low voltage dc).

Connecting wiring and raceway for all electrical devices.

Special care shall be used in designing transformer deluge systems to prevent damage to energized bushings and lightning arresters, i.e., nozzles shall not be aimed or directed at these devices. Also, provisions shall be furnished on the control panel to de-energize the protected transformer when the deluge valve actuates. Deluge piping, conduit, wiring, and supports at transformers shall be designed and installed such that they are easily removable and can be disassembled to remove the transformer. All fire related piping shall be located near the top of the oil tank in a location that will not limit access for maintenance and repair.

3.2.7.4 Preaction Water Spray Systems - Automatic Actuation

The systems shall be designed in accordance with Code requirements. Closed spray nozzles shall be directed, and shielding provided, so that heated metal surfaces and electrical controls or equipment shall not sustain damage from discharged water.

Actuation of the system deluge preaction valves shall be from spot type heat detectors, Fenwal Model 27121-0, high temperature with rate compensation. Heat detectors shall be located near each spray nozzle, and each detector shall be furnished with a heat collector canopy approximately 12 inches (300 mm) in diameter and 2 inches (50 mm) deep. Consideration shall be given for ventilation and the potential for cooling or rerouting of air from either natural or forced ventilation. This cooling or rerouting can delay system activation. Detection conduit shall be routed similar to system pipe routing. The following equipment shall be provided for each system:

Isolation gate valve with tamper switch.

Strainer (one per header).

Manufacturer's standard deluge preaction valve with solenoid trim.

Heat detection system in accordance with the Fire Protection and Detection Systems Specification Sheets.

Fixed piping system with all necessary piping, fittings, closed spray heads, and pipe supports.

Drains and other appurtenances required, including drain piping and isolation valves from system equipment including strainers.

Air maintenance device (separate for each system).

Preaction system piping shall be supervised with air. Preaction detector circuits and solenoid circuit shall be supervised.

Trouble alarm horn and fire bell (may be common with other systems and shall operate on low voltage dc).

Supervisory panel with distinctive supervisory, trouble, and alarm signals in accordance with the article entitled Local Supervisory Panel (Panel may be common with other systems).

Connection wiring and raceway for all electrical devices and detectors.

### 3.2.8 Manufacturing and Material Requirements

Manufacturing and material requirements shall be specified herein.

#### 3.2.8.1 Sprinkler and Spray Fittings

Fittings such as tees, coupling, crosses, elbows, cap, and reducers shall be used for changes in direction, intersections, size changes, and end closures of piping. Bushings or similar fittings are not acceptable.

#### 3.2.8.2 Flanges

Welded or threaded steel flanges shall be provided at sprinkler riser branches, valves, strainers, automatic and manual fire protection valves, and other connections which may require disassembly for maintenance of components of the fire suppression system. Flanges welded to galvanized pipe shall be hot-dip galvanized following welding. Grooved flanges are acceptable only on open head deluge fire suppression systems downstream of the deluge valve.

Flanges, fittings, and valves manufactured in the People's Republic of China shall meet following requirements.

Manufacturer's quality system shall be in accordance with ISO 9001 and the manufacturer shall hold a valid ISO 9001 certificate issued by the certified ISO 9000 certification organization.

Manufacturer shall hold a manufacture license issued by the Center of Boiler and Pressure Vessel Inspection and Research (CBPVI) under General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ).

Products shall have markings as required by ANSI B16.1, ANSI B16.5, ANSI B16.9, ANSI B16.10, ANSI B16.11, B16.25, or ANSI B16.34 as applicable.

The final quality certificate and quality inspection documents shall bear the official stamp of CBPVI or its branches.

3.2.8.3 Strainers

An FM-approved strainer shall be furnished for the main water supply to each system or set of systems as indicated on the flow diagrams. Strainer shall be of the pipeline, self-cleaning type, complete with blowoff valves and flanged ends.

3.2.8.4 Gate Valves

Water supply gate valves shall be of the OS&Y type with flanged ends. All system isolation and header isolation valves shall be furnished with tamper switches wired to the local supervisory panel. All sectional isolation valves on loop piping shall be furnished with tamper switches.

3.2.8.5 Deluge Valves

Deluge valves shall be FM-approved and furnished complete with trim for automatic valve operation, system testing alarms, drains, and gauge and pressure switch connections. Each deluge valve shall be furnished with a manual control station.

Each deluge valve shall have a pressure switch to indicate system actuation (water flow). The alarm pressure switch shall have an adjustable range of 2 to 20 psi (0.1 to 1.4 bar) with differential of plus or minus 2 psi (0.1 bar). Proof pressure shall be 300 psi

(20.7 bar). The pressure switch shall have two single-pole, double-throw, snap-action switches.

Deluge valves for water spray systems shall be furnished with actuation trim as described below.

The dry pilot trim shall include an air pressure supervisory and alarm switch. Air pressure in the dry pilot detection system will be maintained at 30 psi (2.0 bar). The supervisory pressure switch shall send distinctive high and low alarms at 40 psi (2.8 bar) and 24 psi (1.7 bar), respectively. The alarm (low-low) pressure switch shall alarm at 15 psi (1.0 bar).

The wet pilot trim shall include pressure supervisory and alarm switch. The supervisory pressure switch shall send distinctive high and low alarms. The alarm (low-low) pressure switch shall be included.

The electric solenoid trim shall include supervision of circuit.

A permanently attached placard shall be provided on each valve indicating the location and all hydraulic information as required by NFPA 13.

3.2.8.6 Alarm Check Valves

Alarm check valves shall be installed complete with trim including retard chambers. Each valve shall have a pressure switch to indicate system actuation.

The alarm pressure switch shall have an adjustable range of 2 to 20 psi (0.1 to 1.4 bar) with differential of plus or minus 2 psi (0.1 bar).

A permanently attached placard shall be provided on each valve indicating the location and all hydraulic information as required by NFPA 13.

3.2.8.7 Dry-Pipe Valves

Dry-pipe valves shall be installed complete with trim including priming cup. Accelerators and/or exhausters shall be provided as specified in NFPA 13. The valves shall have pressure operated electric switches for fire alarm indication, high air pressure (trouble), and low air pressure (trouble). The valves shall be manufactured by GEM or acceptable equal.

A permanently attached placard shall be provided on each valve indicating the location and all hydraulic information as required by NFPA 13.

3.2.8.8 Air Maintenance Device

Each individual system which uses compressed air for control or supervision, including dry pilot operated deluge and dry-pipe systems, shall have an air maintenance device.

Interconnecting piping, valves, and appurtenances from the compressed air supply to the Contractor's air maintenance devices at the deluge valves shall be furnished and erected. A manual shutoff valve at the tee in the compressed air supply line shall be provided.

3.2.8.9 Sprinklers

Sprinklers for wet-pipe or dry-pipe systems shall be 1/2 inch (13 mm) quartzoid bulb type, FM-approved for the intended service.

3.2.8.10 Spray Nozzles

Open head spray nozzles shall be FM-approved for the intended service, and materials of construction shall be standard FM-approved for the intended service.

3.2.8.11 Dry Pilot Heads

Heads for dry pilot systems shall be FM-approved quartzoid bulb sprinkler heads.

3.2.8.12 Spot Type Heat Detectors

Spot heat detectors shall be FM-approved, self-resetting, rate-compensated, Fenwal Model 027121-0 (where acceptable per listings) or acceptable equal.

3.2.8.13 Ionization Detectors

Ionization detectors shall be dual chamber type and shall employ light emitting diodes for indicating normal, unstable, and alarm conditions. The unit shall be UL-listed and FM-approved. Detectors shall be self-resetting when the chambers are cleared of smoke. The ionization and photoelectric detectors shall be from the same manufacturer and shall be mounted on the same bases so they are interchangeable.

3.2.8.14 Photoelectric Smoke Detectors

Photoelectric smoke detectors shall be of the light scattering type, and shall employ light emitting diodes for indicating normal, unstable, and alarm conditions. The detectors shall self-reset when cleared of smoke. The unit shall be UL-listed and FM-approved.

3.2.8.15 Heat Collectors

Every closed sprinkler head and every pilot head which are not installed close to a solid flat ceiling or which are subject to impingement from other nozzles or heads shall have a heat collector/spray deflector attached. This includes, but is not limited to, pilot heads installed outside and all sprinkler heads installed under grating floors. Each heat collector shall be manufactured of minimum 20 gauge galvanized sheet metal with dimensions of 12 inches by 12 inches by 2 inches (300 mm by 300 mm by 50 mm).

3.2.8.16 Plugs

Sprinkler system plugs shall have square heads and shall be of a metal dissimilar to the fitting to which they are attached.

3.2.8.17 Piping Supports

The Contractor shall furnish and install all required supports for piping erected under these specifications. The term "piping supports" includes all assemblies such as hangers, floorstands, anchors, brackets, and any supplementary steel required to attach piping supports. All pipe supports shall meet the minimum requirements of NFPA 13 and 15.

Centering type beam clamps shall be used instead of end clamps for all piping 2 inches (50 mm) and above.

3.2.8.18 Fire Department Connections

Fire department connections (FDC) shall be double-clapper, siamese type, FM-approved for sprinkler systems, with 2-1/2 inch (63.5 mm) connections and internal swivel fittings having National Hose Standard threads. Branding or wall plate shall be provided in accordance with NFPA 13. FDC locations shall be as shown on drawings and shall be accessible from outside the structure. FDC connection points shall be specified based on responding Fire Departments hose connection.

3.2.9 Inspection and Testing

Inspection and testing of the fabricated piping assemblies and piping base materials shall be as stated herein. Documentation of these inspections and tests shall be maintained and supplied to Owner. Documents shall be signed by appropriate parties to ensure completion and acceptance by Owner and necessary personnel. Defects found by these inspections and tests shall be reinspected following repair by the same method and technique which originally identified the defect. Acceptance shall be based on identical acceptance criteria. Inspection and tests shall be in accordance with NFPA and as stated herein.

3.2.9.1 Hydrostatic Tests

Testing shall be performed on all water system piping and valves in accordance with NFPA 13. Each test shall be conducted for 2 hours at 200 psi (13.9 bar) or at 50 psi (3.5 bar) above the maximum static pressure, whichever is greater. The systems shall be visually inspected during the tests. There shall be no visible leakage or drop in gauge pressure during the tests.

The valves shall be tested along with the piping. Any blind flanges or removable plugs required for openings not closed by the valves and piping provided shall be furnished.

Any water remaining in piping after testing shall be protected from freezing until the system is placed into service.

3.2.9.2 Air Tests

In addition to hydrostatic tests, air pressure tests shall be performed on all air pressurized (preaction and dry pilot systems) piping and valves. Air pressure of 40 psi (2.8 bar) shall be established, and the pressure drop shall be measured. The pressure drop shall not exceed 1-1/2 psi (0.1 bar) in 24 hours.

3.2.9.3 Flow Tests

Each preaction and deluge fire suppression system shall be flow tested. Flow through the preaction systems shall be monitored at the inspector's test connection to verify adequate flow, proper alarm, and annunciation. The time to exhaust air and achieve continuous water flow shall not exceed 60 seconds. The results of these tests shall be recorded and submitted with the Contractor's Materials and Test Certificate. Deluge systems shall be flow tested to ensure adequate hazard coverage and proper alarm and annunciation.

3.2.9.4 Initiating/Indicating System Tests

Each system shall be tested in accordance with NFPA 72 by the Contractor after installation has been completed. All initiating/indicating devices shall be tested.

Testing of the detectors shall be by manufacturer's recommendations. Upon detector actuation, visual and audible annunciation of the independent detection system at the local supervisory panel shall be verified. Each alarm circuit at the local supervisory panel shall be tested to verify proper operation. Final test acceptance shall be determined by Owner. Contractor shall supply Owner with complete documentation of functional and acceptance testing.

3.2.10 Welds

Welding methods that comply with all of the requirements of AWS D10.9 (Specification for Qualification of Welding Procedures and Welders for Piping and Tubing), Level AR-3, are acceptable means of joining fire protection piping. Welds shall be inspected visually. This inspection shall assure that all welds are free of defects and comply with acceptable conditions as defined in NFPA 13, Figure A-2-5.2(b). This visual inspection shall also assure that all the requirements of these contract documents have been met. Personnel performing visual inspection of welds shall be qualified and certified as a Certified Welding Inspector (CWI) in accordance with AWS D10.9, Level AR-3, Standard for Qualification and Certification of Welding Inspector.

Holes in piping for outlets shall be cut to the full inside diameter of the fittings prior to the fittings being welded in place.

Disks shall be retrieved.

Openings cut into piping shall be smooth bore, and all internal slag and welding residue shall be removed.

Fittings shall not penetrate the internal diameter of the piping.

Steel plates shall not be welded to the ends of piping or fittings.

Fittings shall not be modified.

Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings.

Welders or welding machine operators shall, upon completion of each weld, stamp an imprint of their identification into the side of the pipe adjacent to the weld.

### 3.2.11 Protection During Shipment

Open ends and branches of shop fabricated pipe shall be securely closed to protect the interior cleanliness and end surfaces during shipment.

All materials shall be shipped in a manner to ensure that no damage occurs to items. All materials that are not in new condition or damaged shall be replaced, not reworked or repaired.

Weld ends larger than 2 inches (50 mm) shall be protected with suitable metal caps that have ends lined with 3/4 inch (19 mm) soft wood. The caps shall be securely attached and sealed with waterproof tape.

Nonflanged openings 2 inches (50 mm) and smaller shall be protected as follows:

Female openings, such as sockolets, shall be sealed using pressed-in light metal inserts retained with a seal of waterproof tape.

Nipples shall be sealed with light metal cap retained with a seal of waterproof tape.

Flanged openings shall be sealed with waterproof disks at least 1/2 inch (13 mm) thick bolted to the flange. A 1/8 inch (3 mm) thick rubber gasket shall be provided for sealing. Bolts used for securing the disk shall be a least 1/2 inch (13 mm) diameter, and at least one-half the required bolting shall be used.

Miscellaneous loose items shall be suitably packed in heavy wooden boxes with waterproof linings.

### 3.2.12 Local Supervisory Panel

A local supervisory panel shall be furnished for each of the sprinkler/spray system valve stations, as indicated on the drawings. Local supervisory panels shall be power limited type. Local supervisory panels shall be tagged and located next to valve stations. Maximum space allocated for each local panel is 30 inches (762 mm) wide, 48 inches (1,219 mm) high, and 12 inches (300 mm) deep. Fire alarm panels with a digital display

shall be installed between 5 ft and 6 ft above grade level. All local supervisory panels shall be capable of operation as a stand-alone system. Any Local Supervisory Panel in a location not continuously attended shall have a smoke detector located above panel as required by NFPA 72. Alarm or trouble signals from local fire alarm panels shall be routed to the existing Fire Alarm Annunciator Panel (FAAP) in the control room.

Included as part of the contract, Contractor shall provide all necessary instrument, power, and control wiring and raceways integral to any equipment furnished under these specifications. This shall include terminal blocks and internal wiring to these terminal blocks for equipment requiring external connection.

All equipment and systems designed, supplied, or installed shall be appropriate for the area and shall take into account the plant electrical hazardous requirements. Communication between local panels and field devices shall be via an addressable signaling line (style 6 or 7).

3.2.12.1 Enclosures

Enclosures for each local supervisory panel shall be manufacturer's standard or shall meet the NEMA requirements as specified. Enclosures subject to potential water spray or environmental conditions not designed for by the manufacturer shall be within a NEMA 4 enclosure. When a NEMA rated enclosure is required, the system shall maintain its listings and/or approvals.

Enclosures shall be installed for the remote contact monitoring modules that monitor the status of local supervisory panels and shall meet the NEMA requirements as specified.

Internal devices shall be factory wired to terminal blocks for all external wires brought to panel for landing all field wiring. When a manufacturer's panel is used, a junction box shall be located near the panel to house the terminal blocks. When a NEMA rated enclosure is supplied, sufficient space shall be allocated to conveniently locate the terminal blocks on the back or bottom of the enclosure. The contacts and wiring shall be arranged to ensure that power limited and non-power limited circuits are separated in accordance with code and manufacturer requirements. NEMA enclosures shall be easily opened without special tools.

3.2.12.2 System Design Functions

Each local supervisory panel shall continuously monitor its associated fire suppression system(s) for fire alarms, supervisory trouble alarms, and circuit trouble alarms. Upon receipt of a fire alarm, the given panel shall activate appropriate system valves, auxiliary relay, and a fire alarm bell in the area or zone affected. Upon receipt of a trouble or supervisory alarm, the panel shall activate individual alarm indicating lamps on the panel and a trouble horn at or near the panel. Trouble and supervisory alarms shall be distinctive, i.e., the mixing of two or more alarms on one circuit is not allowed.

Auxiliary shutdown functions required for individual systems will be determined during detailed design by the Owner.

Contacts for auxiliary shutdown functions shall be rated 2.0 amperes at 125 volts dc and 10 amperes at 120 volts ac.

Local panel shall include a surge suppressor with junction box wired to panel on all wiring that leaves the building/structure. Surge suppressor shall be located at entrance and exit locations of building/enclosure. Wiring in building/enclosure between surge suppressor and panel shall be by Contractor.

Wiring and raceway between local supervisory panels and remote relay (where required) (such as cooling tower fans, transformers, HVAC systems, or steam turbine) auxiliary contacts will be furnished and installed by the Contractor. All shut down relays shall be located within 3 ft of the equipment or equipment controller being shut down. Wiring between auxiliary contacts and equipment controller shall be furnished and installed under separate contact.

Minimum panel control functions and individual fire and trouble alarms for each type of sprinkler and spray system are specified later in this document. Panel control functions for fire detection and alarm systems are specified in Article 3.2.

In addition to other codes and standards, fire alarms for detection or suppression systems in office and general use areas shall be designed in accordance with 36 CFR Part 1911, Americans with Disabilities Act (ADA) of 1990, corrected January 14, 1992.

Upon receipt of any fire alarm signal from a fire detector, suppression system, flow switch, or pull station, the local alarm panel shall activate all interior and exterior fire alarm horns/strobes for the building containing the device where the signal originated.

3.2.12.2.1 Dry-pipe Sprinkler Systems

Dry-pipe systems are self-actuated by mechanical devices and there is no automatic action required from the control panel for these systems to be operated. Control panels shall be provided, however, to monitor off-normal conditions necessary to ensure the availability and proper operation of each system and annunciate fire and trouble alarms as appropriate. Panel will initiate required shutdown functions.

The following distinctive alarms shall be provided at the local panel for each dry-pipe sprinkler system:

| **Alarm Condition** | **Source** | **Type of Alarm** |
|---|---|---|
| Fire (water flow) | Water pressure switch (Style B) | Fire |
| Low air pressure in sprinkler piping | Air pressure switch (Style B) | Supervisory |
| High air pressure in sprinkler piping | Air pressure switch (Style B) | Supervisory |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Fire alarm bell circuit trouble* | Open or ground in wiring to bell (Style Y) | Trouble |
| Water pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Low air pressure circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| High air pressure circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| System isolation gate valve (or alarm isolation valve) not fully open | Tamper switches (Style B) | Supervisory |
| System isolation tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Header isolation gate valve not fully open* | Tamper switch (Style B) | Supervisory |
| Header gate valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Loss of primary power at panel/battery in use* | Local panel | Trouble |
| Battery voltage low | Low voltage in battery | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits | Trouble |
| System normal | Local panel | N/A |
| Lamp test | N/A | |
| Acknowledge | N/A | Switch |
| System reset | N/A | Switch |
| *These alarms need not be duplicated when two or more suppression systems are controlled by one panel. | | |

3.2.12.2.2 Preaction Sprinkler Systems - Automatic Actuation

Deluge preaction valves shall be actuated (opened) electrically upon receipt at the panel of fire indication from the detection system for the given hazard, and the control panel shall concurrently produce a fire alarm and initiate any required auxiliary shutdown functions that may be specified.

The panel for each preaction sprinkler system shall also continuously monitor the off-normal conditions necessary to ensure the availability and proper operation of each

system and to annunciate trouble, fire, and supervisory alarms as appropriate. Panel will initiate required shutdown functions.

The following distinctive alarms shall be provided at the local panel for each preaction sprinkler system:

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Fire detected | Heat detectors or photoelectric smoke detectors (Style D) | Fire |
| Solenoid energized | Local panel (Style B) | Fire |
| Water flow | Water pressure switch (Style B) | Fire |
| System isolation gate valve (or alarm isolation valve) not fully open | Tamper switches (Style B) | Supervisory |
| Header isolation gate valve not fully open* | Tamper switch (Style B) | Supervisory |
| Low air pressure in sprinkler piping | Air pressure switch (Style B) | Supervisory |
| High air pressure in sprinkler piping | Air pressure switch (Style B) | Supervisory |
| Solenoid trouble | Open or ground in wiring to solenoid (Style B) | Trouble |
| Fire alarm bell circuit trouble* | Open or ground in wiring to bell (Style Y) | Trouble |
| Water pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Low air pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| High air pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Fire detector circuit trouble | Open or ground in detector wiring (Style D) | Trouble |
| System isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Header isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Loss of primary power at panel/battery in use* | Local panel | Trouble |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Battery voltage low | Low voltage in battery | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits | Trouble |
| System normal | Local panel | N/A |
| Lamp test | N/A | Switch |
| Acknowledge | N/A | Switch |
| System reset | N/A | Switch |
| *These alarms need not be duplicated when two or more suppression systems are controlled by one panel. | | |

3.2.12.2.3 Wet-pipe Sprinkler Systems

Wet-pipe systems are self-actuated by mechanical devices, and there is no automatic action required from the control panel for these systems to be operated. Control panels shall be provided, however, to monitor off-normal conditions necessary to ensure the availability and proper operation of each system and annunciate fire and trouble alarms as appropriate. Panel will initiate required shutdown functions.

The following distinctive alarms shall be provided at the local panel for each wet-pipe sprinkler system:

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Fire (water flow) | Water pressure switch (Style B) | Fire |
| System isolation gate valve (or alarm isolation valve) not fully open | Tamper switches (Style B) | Supervisory |
| Header isolation gate valve not fully open* | Tamper switches (Style B) | Supervisory |
| Fire alarm bell circuit trouble* | Open or ground in wiring to bell (Style B) | Trouble |
| Water pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| System isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Header isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Loss of primary power at panel/battery in use* | Local panel | Trouble |
| Battery voltage low | Low voltage in battery | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits | Trouble |
| System normal | Local panel | N/A |
| Lamp test | N/A | Switch |
| Acknowledge | N/A | Switch |
| System reset | N/A | Switch |
| *These alarms need not be duplicated when two or more suppression systems are controlled by one panel. | | |

3.2.12.2.4 Water Spray (Deluge) Systems - Dry or Wet Pilot Actuation

All water spray systems specified shall be actuated by mechanical devices (dry or wet pilot system) and no automatic action is required from the control panel for system operation. Control panels shall be provided, however, to monitor off-normal conditions necessary to ensure the availability and proper operation of each system, annunciate fire and trouble alarms as appropriate, and initiate any required auxiliary shutdown functions that may be specified.

The following distinctive alarms shall be provided at the local panel for each spray deluge system:

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Low-low pressure in dry pilot system | Air pressure switch (Style B) | Fire |
| Fire (water flow) | Water pressure switch (Style B) | Fire |
| Low air pressure in pilot system | Air pressure switch (Style B) | Trouble |
| High air pressure in pilot system | Air pressure switch (Style B) | Trouble |
| System isolation gate valve (or alarm isolation valve) not fully open | Tamper switches (Style B) | Trouble |
| Header isolation gate valve not fully open* | Tamper switches (Style B) | Trouble |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Fire alarm bell circuit trouble* | Open or ground in wiring to bell (Style Y) | Trouble |
| Water pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Low-low pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Low-pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| High-pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| System isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Header isolation valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Loss of primary power at panel/battery in use* | Local panel | Trouble |
| Battery voltage low | Low voltage in battery | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits | Trouble |
| System normal | Local panel | N/A |
| Lamp test | N/A | Switch |
| Acknowledge | N/A | Switch |
| System reset | N/A | Switch |
| *These alarms need not be duplicated when two or more suppression systems are controlled by one panel. | | |

3.2.12.2.5 Preaction Water Spray Systems – Automatic Actuation

Deluge (preaction) valves shall be actuated (opened) electrically upon receipt at the panel of fire indication from the detection system for the given hazard, and the control panel shall concurrently produce a fire alarm and initiate any required auxiliary shutdown functions that may be specified.

The panel for each preaction sprinkler system shall also continuously monitor the off-normal conditions necessary to ensure the availability and proper operation of each system and to annunciate trouble alarms as appropriate.

The following distinctive alarms shall be provided at the local panel for each preaction sprinkler system:

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Fire detected | Heat detectors (Style D) | Fire |
| Solenoid energized | Local panel (Style B) | Fire |
| Fire (water flow) | Water pressure switch (Style B) | Fire |
| Low air pressure in spray piping | Air pressure switch (Style B) | Supervisory |
| High air pressure in spray piping | Air pressure switch (Style B) | Supervisory |
| Fire alarm bell circuit trouble* | Open or ground in wiring to bell (Style Y) | Trouble |
| Solenoid trouble | Open or ground in wiring to solenoid (Style B) | Trouble |
| Fire detector circuit trouble | Open or ground in detector wiring (Style D) | Trouble |
| Water pressure switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Low air pressure circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| High air pressure circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| System isolation gate valve (or alarm isolation valve) not fully open | Tamper switches (Style B) | Supervisory |
| System isolation tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Header isolation gate valve not fully open* | Tamper switches (Style B) | Supervisory |
| Header gate valve tamper switch circuit trouble | Open or ground in wiring to switch (Style B) | Trouble |
| Loss of primary power at panel/battery in use* | Local panel | Trouble |
| Battery voltage low | Low voltage in battery | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits (Style B) | Trouble |
| System normal | Local panel | N/A |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Lamp test | N/A | Switch |
| Acknowledge | N/A | Switch |
| System reset | N/A | Switch |
| *These alarms need not be duplicated when two or more suppression systems are controlled by one panel. | | |

3.2.12.3 Remote Annunciation Requirements

Upon receipt of any fire alarm, each local panel shall send the information via network which will be used for operating remote alarms in the main control room.

Annunciation equipment for the FAAP is to be furnished and installed by the Contractor.

The auxiliary contacts required shall be two single-pole normally closed contacts with simple conversion to the opposite configuration, and a rating of 2.0 amperes at 125 volts dc and 10 amperes at 110 volts ac.

3.2.12.4 Panel Wiring

Each panel shall be designed for Styles B, D, or Y wiring of all local device circuits, as specified in Articles 3.1.9.2.1 through 3.1.9.2.8.

3.2.12.5 Backup Battery

Each supervisory panel shall be provided with a backup battery arranged in accordance with NFPA 72 and FM requirements. Batteries for panels which automatically release fire suppression systems shall as a minimum be capable of operating all systems under maximum normal load for 90 hours and then sounding all fire alarm devices for 10 minutes. Batteries for panels which perform only supervisory and alarm functions shall as a minimum be sized for 24 hours of system normal and 10 minutes of full alarm.

3.2.12.6 Lamps and Switches

Indicating lamps and switches shall be furnished for the local supervisory panels for the individual alarms specified in Article 3.1.9.2. Where NEMA enclosures are supplied, LCD displays, lamps, and switches shall be viewable through door. When the manufacturer's enclosure is supplied, the indicators can be located on the junction box for the terminal blocks. Fire alarm indicators shall be red, and trouble and supervisory alarm indicators shall be amber. System normal indicators shall be green.

The NEMA 4 enclosure shall be located in such a manner to protect it from tampering by installing a lock on the panel door that is accessible only to authorized building personnel.

3.2.12.7 Alarm Devices

Fire alarm bells and trouble alarm horns shall be located as required by codes and standards. A fire alarm bell shall be sounded when any system actuates. The minimum sound output for each fire alarm bell shall be 85 dB at 10 feet (3.05 meters) from the device. All outdoor notification appliances shall be weatherproof.

Visible alarm signaling appliances within office areas shall meet ADA criteria. Strobes shall be xenon type lamp or equivalent, with a clear or nominal white lamp color. Intensity of visible signaling appliances shall conform to NFPA 72 for the size and arrangement of the protected space. Flash rate shall be minimum 1 hertz and maximum 3 hertz. Pulse duration shall be 0.2 second with a maximum duty cycle of 40 percent.

An acknowledge push button shall be provided on the panel to silence audible annunciation of fire and trouble alarms. The circuit for this switch shall permit audible annunciation of additional incoming alarms.

Alarm test and reset push buttons shall be provided.

As a minimum, the following switches shall be key-operated: Acknowledge, Alarm Test, and Reset.

## 3.3 CLEAN AGENT FIRE EXTINGUISHING SYSTEMS

3.3.1 The Contractor shall design, supply, install, and test the clean agent system in accordance with NFPA 2001 and the local authority having jurisdiction.

3.3.2 The Contractor shall size the system and perform hydraulic calculations to ensure manufacturer defined concentration and discharge time for the protected space.

3.3.3 The Contractor shall provide all materials required to install a clean agent fire suppression system. This includes but is not limited to: clean agent tank fill, tank, control panel, piping, fittings, supports, wiring, materials required for maintaining room integrity, smoke detectors, strobes, and signs.

3.3.4 All piping shall be rigidly supported by a combination of pipe hangers and rigid support brackets. Pipe hangers are used to support the dead load of the piping systems and shall be spaced at intervals not exceeding 15 feet. Rigid supports are required to support the live load of the piping system during discharge. Rigid bracing is required at each directional change, tee and nozzle. All 180 degree nozzles require back bracing in the opposite direction of the discharge pattern. Earthquake bracing shall be used where required by local code.

3.3.5 Trouble and Alarm signals shall be routed to a continuously monitored station. Typically the System Control Center.

3.3.6 The Contractor shall perform building modifications necessary to ensure "air tightness" of the protected space. This includes but it not limited to integrated HVAC shutdowns, dampers, and door seals.

3.3.7 The Contractor shall perform a pressure test of the protected space in accordance with NPA 2001.

## 3.4 FIRE DETECTION AND ALARM SYSTEMS

3.4.1 General

The following articles cover the minimum design, shop fabrication, and installation and testing requirements of the independent fire detection and alarm systems to be furnished and installed.

In addition to other codes and standards, fire alarms for independent fire detection systems in all office areas shall be designed in accordance with 36 CFR Part 1911, Americans with Disabilities Act (ADA) of 1990, corrected January 14, 1992.

3.4.2 Scope of Work

Complete fire detection and alarm systems, including but not limited to, initiating devices (detectors, manual pulls, etc.), indicating devices (bells, horns, strobes, etc.), controls,

wiring, conduit, instrumentation, and testing equipment as required for complete systems shall be designed, furnished, installed, and tested.

### 3.4.3 Arrangement

The Contractor's detection arrangement/installation drawings shall be to scale and shall include all interior architectural features of the room and/or building covered such as walls, doors, stairs, corridors, HVAC diffusers, etc., without being cluttered.

Locations for detectors and devices noted by the Contractor shall be dimensioned, and acceptable tolerances shall be indicated. Detectors shall be centered in ceiling tile.

### 3.4.4 System Design Requirements

Each independent fire detection system shall be designed to provide adequate fire detection and annunciation in each of the areas protected. Each detection control panel shall continuously monitor detection systems for fire or trouble condition and activate the appropriate fire or trouble alarm(s) as required. These detection and alarm functions shall be performed independently of any other plant equipment or facility.

Each panel shall be tagged and located appropriately through the facility to ensure distributed monitoring of systems. All local supervisory panels shall be capable of operation as a stand-alone system.

#### 3.4.4.1 Independent Fire Detection Systems

This article covers design and fabrication requirements for the independent fire detection systems.

The Contractor shall furnish complete independent fire detection systems, including but not limited to smoke/heat detectors, manual pull stations, HVAC duct detectors (when specified), local supervisory panels, instrumentation, wiring, and alarms as required for complete systems. Communication between local panels and field devices shall be via an addressable signaling line (style 6 or 7).

#### 3.4.4.2 Independent Fire Detection System Requirements

Specific requirements for components of the independent fire detection systems are listed herein.

Independent smoke/heat detection systems shall be designed to provide the protection and coverages stated in the Design Basis Document. Spacing and location of detectors shall take into account the airflow, ceiling height and slope, and ceiling constructions of the protected area.

Any fire detector in alarm shall initiate a fire alarm condition at the appropriate local supervisory panel and the existing Fire Alarm Annunciator Panel (FAAP) in the control room.

Remote annunciation of local supervisory panels to FAAP shall be provided through a signal communication line.

If required, HVAC duct detectors shall be furnished by the Contractor, installed in the duct under a separate contract, and wired by the Contractor to the Contractor's local fire protection panel. Upon detection of smoke, the panel shall initiate all required HVAC equipment shutdown functions. Contacts for shutdown functions shall be provided for each piece or group of HVAC equipment corresponding to applicable HVAC duct detectors. The fire alarm shutdown contacts shall be located in a junction box (provided by the Contractor) next to the HVAC controller. Wiring from local panel to the contacts is to be supplied and installed by the Contractor. Shutdown wiring from the fire alarm contacts to the temperature control panel will be wired under separate specifications.

The following equipment shall be furnished and installed for each fire detection system:

Ionization smoke detectors except HVAC (if not specified), or photoelectric smoke detectors or spot type heat detector.,

Fire detection circuits, wiring, raceway, and supports as required for a complete system.

Local supervisory panel with distinctive trouble and alarm signals in accordance with the article titled Local Supervisory Panel herein, except where otherwise specified.

Interface junction boxes near HVAC control panels, as shown on HVAC schematic drawings.

Manual pull stations, where required.

Trouble horn and fire alarm bell (may be common with other systems controlled from the same panel).

Visible signaling appliances, where required by ADA.

Connecting wire and raceway for all electrical devices.

3.4.4.3 Independent Fire Detection System Component Requirements

Components of the independent fire detection systems shall be furnished in accordance with the following requirements.

3.4.4.3.1 Ionization Smoke Detectors

Ionization detectors shall be dual chamber type and shall employ light emitting diodes for indicating normal, unstable, and alarm conditions. The unit shall be UL-listed and FM-approved. Detectors shall be self-resetting when the chambers are cleared of

smoke. The ionization and photoelectric detectors shall be from the same manufacturer and shall be mounted on the same bases so that they are interchangeable.

3.4.4.3.2 Photoelectric Smoke Detectors

Photoelectric detectors shall use the light scattering principle to detect fire conditions. Smoke particles in the detector cause the light source to be reflected and refracted onto a photosensitive sensor. This increase of light in the sensor causes an alarm condition. Detectors shall be self-resetting when the chamber is cleared of smoke. Ionization and photoelectric detectors shall be from the same manufacturer and use the same base.

3.4.4.3.3 UV/IR Detectors

UV/IR (ultraviolet/infrared) radiant energy detectors detect electromagnetic radiation emitted as a byproduct of the combustion process. UV/IR detectors shall be selected to react to the hazard, while minimizing false alarms.

3.4.4.3.4 Duct Smoke Detectors (HVAC)

Duct detectors shall be specifically designed for HVAC duct applications. Detectors shall be FM-approved at a minimum of 10 percent above HVAC system flow capabilities. Detectors shall be fully compatible and listed for use with the local panel. Detectors shall be ionization dual chamber type and shall employ light emitting diodes for indicating normal, unstable, and alarm conditions.

The HVAC Contractor shall indicate the quantity and location of smoke detectors in accordance with NFPA 90A and local codes. Duct mounted smoke detectors will be furnished by the fire protection contractor and shall be installed by the HVAC Contractor. Upon receiving the signal from the fire protection system, the air handling unit(s)/air conditioning unit(s) shall be de-energized by the temperature control panel (TCPL) and fire/smoke dampers shall close. An alarm shall be provided at the TCPL to indicate system shutdown due to a signal from the Fire Protection System. Startup and testing of the Fire Protection System will be provided by the fire protection contractor in accordance with NFPA 72. The HVAC Contractor shall provide startup and testing services to support the interface with the Fire Protection System and ensure that the HVAC is de-energized as designed.

3.4.4.3.5 Spot Type Heat Detectors

Spot type heat detectors shall be Fenwal Model 027121-0 or acceptable equal.

3.4.4.3.6 Manual Pull Stations

Manual pull stations shall be FM-approved double action type with dual action releasing lever to minimize accidental operation. Break glass type manual pulls shall not be used. All manual pulls shall be red, keylocked, and keyed the same as the door on the local supervisory panel.

3.4.4.3.7 Alarm Devices

Fire alarm bells, strobes, and trouble alarm horns shall meet the requirements of Article 3.1.9.7.

3.4.4.3.8 Network Interface Equipment

Network interface equipment shall be provided to connect the fire suppression and detection systems and other equipment together. Equipment shall include media converters, hubs, switches, fiber-optic patch panels, surge suppressors, and any other devices necessary for a complete network. All devices shall be mounted in system cabinets or junction boxes. Equipment shall be installed in cabinets or junction boxes with factory installed power supplies and wiring such that the customer interface within the cabinet is minimized

A complete network system drawing shall be furnished showing all major equipment, network panels, junction boxes, and interfacing devices (media converters). Drawing shall clearly note all items that are shown and not included under this contract.

3.4.4.4 Remote Annunciation Requirements

Each fire detection and alarm system shall provide a communication signal for remote annunciation of fire, trouble, and supervisory alarms to the FAAP.

The following distinctive alarms shall be as a minimum provided to the FAAP from each of the local panels:

| **Alarm Condition** | **Source** | **Type of Alarm** |
|---|---|---|
| Fire detected* | Area smoke detector, heat detector, or duct smoke detector (Style B)* | Fire |
| Detector circuit trouble (short, open, or ground fault) | Panel (Style B)* | Trouble |
| Loss of ac power (battery in use) | Local panel | Trouble |
| Low or missing batteries | Low voltage in batteries/panel | Trouble |
| Battery short, charger, or wiring trouble | Open or ground in circuits | Trouble |
| Notification circuit trouble | Open or ground in wiring to indicating appliance | Trouble |
| System normal | Panel | N/A |
| High or low pressure in piping | Pressure switch | Supervisory |

| Alarm Condition | Source | Type of Alarm |
|---|---|---|
| Isolation valve not fully open | Tamper switch | Supervisory |
| *NFPA Style D circuit, when detection is used as releasing device. | | |

## 3.5 FIRE ALARM ANNUNCIATOR PANEL (FAAP)

### 3.5.1 General

The following articles cover the design, shop fabrication, and installation requirements of the fire protection signal notification equipment to be furnished and installed in the Main Plant Control Room.

### 3.5.2 Scope of Work

The Contractor shall furnish the Fire Alarm Annunciator Panel (FAAP) and separate remote annunciation panel (alarms, troubles, and supervisory) in accordance with all codes and standards to annunciate trouble, supervisory, and fire alarm signals from all fire protection and detection systems provided for the facility.

The FAAP and associated equipment shall be furnished complete with light emitting diode (LED) indicators for all specified alarms, distinctive audible device for fire alarms, distinctive audible device for supervisory and trouble alarms, sequence-of-events detection equipment, and fuses and fuse holders for power supply and audible devices.

A separate annunciator panel, as required, shall be located beside the existing FAAP and contain incandescent lamps to annunciate distinctive alarm, trouble, and supervisory conditions. The panel shall also contain terminal blocks for all external circuits (for FAAP and remote annunciator); and push-button controls to start each fire pump (if required). Space on the panel shall be supplied for a minimum of five future suppression or detection systems.

AC power wiring to the FAAP will be furnished and installed under separate specifications.

Contractor shall provide all necessary instrument, power, and control wiring and raceways integral to any equipment furnished under these specifications. This shall include terminal blocks and internal wiring to these terminal blocks for equipment requiring external connection.

### 3.5.3 Codes and Standards

The FAAP and associated equipment shall be designed and tested in full accordance with the latest issues of all codes, recommended practices and documents specified herein. The FAAP shall be listed as a Proprietary Control Panel if communicating with other supervisory panels located in a different building within the same compound.

The FAAP and associated equipment shall be included in the Approval Guide as published by Factory Mutual Engineering. Equipment shall be considered as FM-approved only if it conforms to the characteristics and limitations of the individual component approvals, and if those components are used in the service intended by the Approval Guide.

### 3.5.4 Arrangement

The FAAP and associated equipment will be located in the main control room. The FAAP shall be installed as a wall mounted panel in the location indicated on the drawing. The printer shall be integral with the FAAP or located adjacent to the FAAP and easily accessible. The maximum space allocated for the FAAP is 30 inches (762mm) wide, 48 inches (1,219 mm) high, and 12 inches (300) deep.

### 3.5.5 Design Requirements

The FAAP shall annunciate alarm and trouble for each of the fire protection/detection systems. The panel shall be of modular construction and front accessible. In addition, the panel shall have a minimum of ten spare alarm zones requiring only field wiring for future use. Communication between FAAP and field devices shall be via an addressable signaling line (style 6 or 7).

The FAAP shall be housed in the manufacturer's supplied enclosure, shall operate on specified volts ac, and shall be FM-approved. The panel shall have an independent tag number indicated on the panel and drawings.

FAAP shall contain annunciator switches, LCD display, lamps, and switches viewable through door. Each indicator shall be clearly labeled to indicate system number and location/description. Red indicators shall be used for alarm and amber indicators for trouble. Switches shall be provided for lamp test, alarm acknowledge, and alarm reset. Reset of fire alarms shall not occur until the condition causing the alarm has been completely restored to normal. A red strobe light shall also be furnished and activated by any fire alarm condition. The strobe shall be low intensity and visible throughout the room.

Switches to start fire pumps shall be Honeywell Micro Switch Type PT with Type PTW indicating lights or acceptable equal (when required). Switches shall be located on the face of the annunciator panel.

Audible annunciation for fire alarms shall be distinctive in sound from trouble alarm signals as required by NFPA 72. The audible devices shall be mounted and wired integral to the FAAP.

The FAAP shall be capable of performing electrical supervision of each signaling line circuit that is routed from the local fire protection control panels. Alarm contacts in each local panel will be electrically isolated as specified in Article 3.1.9.3, Remote annunciation requirements, or alarm can be sent to the FAAP through a communication circuit.

The following devices shall be mounted and wired inside the enclosure:

Fuses and fuse holders for annunciator power supply system.

Annunciator power supply for alarm contacts.

Fuse and fuse holder for the audible device.

Terminal blocks for connections to all external circuits.

All necessary actuating devices and relays shall be furnished to provide annunciation. Spare annunciator capacity shall be provided and internally wired.

The equipment furnished shall include a printer that prints the date and time, name of the zone or system, zone location, and specifies either alarm or trouble. Alarm or trouble "return to normal" shall print out in the same manner. The printer shall print the alarms in the sequence of occurrence.

The printer shall be designed to serve as the second source of annunciation outlined in NFPA 72. The printer shall be furnished and installed with printer stand or other suitable means of support in an arrangement adjacent or integral to the FAAP and easily accessible.

Battery backup shall be provided for the FAAP. The backup system shall include a battery charger and shall be designed such that, upon supply power failure, backup power automatically supplies the system without interruption of service. The battery system shall be capable of powering the system as a minimum for a period of 24 hours in the "power loss" condition, plus an additional 10 minutes of powering the entire system in full alarm condition. If the FAAP is controlling any suppression systems, the battery backup requirement is a minimum of 90 hours for system normal. A "power loss" annunciator light shall indicate that the system is operating on battery power. The backup power supply proposed shall be FM-approved.

### 3.5.6 Testing

The Contractor shall perform acceptance testing of all fire protection systems in accordance with NFPA 72. Tests shall verify receipt of alarms from all systems on the FAAP. The Contractor shall notify Owner of all tests and shall be present for all tests. All tests shall be documented and provided to the Owner.

## 3.6 FIRE EQUIPMENT

### 3.6.1 Scope

If required by applicable codes and standards, the Contractor shall furnish the following items complete as specified and in accordance with the specifications and documents:

Fire hose stations complete with fire hose, hose racks, and accessories.

### 3.6.2 Code Requirements

Valves, fire hose stations, equipment, and fire hoses, shall be FM-approved. If FM approval is not available, then UL-listed equipment shall be provided.

### 3.6.3 Fire Hose Stations

The fire hose stations shall be furnished and installed as required by Section 2.0 and as specified herein. Fire hose stations shall be Class III as defined in NFPA 14 and shall consist of a fire hose cabinet, fire hose rack, and equipment. Hose stations and associated equipment shall be designated with the appropriate tag number.

#### 3.6.3.1 Class III Fire Hose Stations

Class III fire hose stations shall be furnished. Each Class III fire hose station shall consist of the following:

Potter-Roemer Model 1558 or acceptable equal surface mounted hose cabinet, or Potter-Roemer Model 1508 or acceptable equal recessed hose cabinet as indicated on the Fire Protection and Detection Systems Specification Sheets. Cabinets shall have Plexiglas panels and non-locking doors. Doors shall have provisions for attaching breakable seals. The words "FIRE HOSE" shall be painted in block letters a minimum of 3-1/2 inches (88 mm) high on the Plexiglas panels. Cabinets shall be adequately sized to contain the equipment and extinguisher as listed below.

One 2-1/2 inch (63.5 mm) standard hose valve, Potter-Roemer Model 4065, or acceptable equal with female NPT inlet, male NSHT outlet, cap, and chain.

One 1-1/2 inch (38 mm) standard hose valve, Potter-Roemer Model 4060, or acceptable equal with female NPT inlet and male NSHT outlet.

One semiautomatic hose rack, Potter-Roemer Model 2792, or acceptable equal, suitable for the specified fire hose.

One 1-1/2 inch (38 mm) adjustable pressure restricting device, Potter-Roemer Model 2765 with NSHT connection.

One 1-1/2 inch (38 mm) automatic drain valve, Potter-Roemer Model 2760 or acceptable equal with NSHT connection.

100 feet (30 meters) of 1-1/2 inch (38 mm) single polyester jacket, synthetic rubber lined fire hose, Potter-Roemer PR Superflex, or acceptable equal, with NSHT connections.

One 1-1/2 inch (38 mm) fully adjustable polycarbonate hose nozzle rated for Class A and B fires, Potter-Roemer Model 2960, or acceptable equal.

One universal spanner wrench, Potter-Roemer Model 6057, or acceptable equal.

3.6.3.2 Identification

Each fire hose station shall be provided with a 1-1/2 inch (38 mm) diameter, 15 gauge permanently stamped corrosion-resistant metal tag bearing the "Tag Number" securely attached to the assembly by bolting or riveting.

**APPENDIX G1**
**ATTACHMENT 04**
**EXHIBIT 01**

# GENERAL ELECTRICAL STUDY REQUIREMENTS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 11Dec17 | Issued for Implementation | DNV-GL | DS | CPA | Craig Armstrong |
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# 1.0 SCOPE

## 1.1 GENERAL

This specification covers the technical requirements for electrical system studies. The Contractor shall provide electrical system studies for the entire project, including arc flash hazard, load flow, short circuit, relay coordination, insulation coordination, DC/UPS sizing and grounding calculations.

The electrical system studies shall be prepared by the Contractor's qualified engineers or by an approved consultant. The coordination study and analysis shall be signed and sealed by a registered Professional Engineer. The Contractor is responsible for providing all pertinent information required by the preparers to complete the study.

## 1.2 STANDARDS AND DOCUMENTS

Calculation and documentation shall be performed in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

# 2.0 SOFTWARE AND MODELING REQUIREMENTS

Electrical system studies (3.1 – 3.3) shall be performed utilizing Easypower software (Contractor shall confirm acceptable software version with Owner). Systems or components considered as part of the Bulk Electric System (BES) shall be modeled using Aspen OneLiner. Examples of BES components are collector circuits, substation, and switchyard equipment. The Easypower/Aspen model shall include a complete system one line diagram with the following minimum requirements:

1. Utility source information including calculated short-circuit values and X/R ratio.
2. Bus nodes with ampacity and voltage ratings, and available short circuit current.
3. Transformer ratings with size, voltage, impedances, and inrush currents.
4. Cable and iso-phase bus size, type, impedance, and cable lengths within 10 feet of actual (through the 480 V level).
5. Circuit breaker or protective device make and model, frame ampacity, trip plug rating, and protective settings.
6. Motor circuit protectors make and model, ampacity, and protective settings.
7. Motor loads including horsepower, voltage, full load amps, and locked rotor amps.
8. Variable speed drives and protective settings.
9. Generators, including all nameplate information.

10. Neutral grounding resistor/transformer size and ratings.

11. 480 V panelboards including all branch circuit information.

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

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

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

15. As agreed upon by Owner, below a certain KVA, any loads fed from a single distribution panel, including aggregated power sources, can be lumped together as an individual element within the model.

## 3.0 DESIGN CALCULATIONS

### 3.1 AUXILIARY POWER STUDY

#### 3.1.1 Load Flow

Prepare a load flow study in Easypower to determine the steady state loading profile of the project electrical system.

Review the load flow study results and provide a listing of electrical equipment that shows overload, based on National Electrical Code loading requirements

Present the data conclusions of the load flow study in a table format. Include the following:

1. Bus identification
2. Bus nameplate ampacity
3. Operating voltage
4. Load Current

#### 3.1.2 Reactive Power

Prepare a reactive power study to determine the reactive power capability of the project including additional reactive power compensation equipment to meet interconnection requirements as necessary to supplement site generation equipment reactive power capability, if applicable. Study shall include determination of voltage step due to capacitor switching to confirm compliance with power quality requirements including flicker.

#### 3.1.3 Thermal Ampacity

Prepare a thermal ampacity study to determine the underground MV and LV cables are adequately sized for the worst-case load current. Study shall include modeling of all

trench and bore configurations including supporting assumptions of soil rho, native or non-native backfill, temperature, and compaction.

### 3.1.4 Electrical Losses

Prepare an electrical losses study to determine the total power losses and annual energy losses from generation unit to point of interconnection. The calculation shall include supporting assumptions and breakdown of subsystem loss contribution The energy loss calculation shall be based on site specific wind speed distribution and turbine specific power curve, if applicable. The loss study shall be based on IFC drawings, and be revised following construction to include any material changes to the EBoP in as-built drawings.

### 3.1.5 SHORT-CIRCUIT

Prepare a short-circuit study for electrical equipment provided for the project.

The Contractor shall request from the Owner the available fault ratings of the source utility connection. The Owner shall provide the fault ratings no later than 28 days upon receiving the request from the Contractor.

Calculate the fault impedance to determine the available short-circuit and ground fault currents at each bus. Incorporate the motor contribution in determining the momentary and interrupting ratings of the protective devices. Calculations shall be based on 3 phase bolted faults. Short circuit analysis shall be run at a collection system pre-fault voltage of nominal voltage of 105%. In addition, the report shall be prepared with the bus ties closed.

Analyze the short-circuit calculations, and highlight equipment determined to be underrated regarding fault duty as specified. Propose approaches to effectively protect the underrated equipment.

Present the data conclusions of the short-circuit study in a table format. Include the following:

1. Device identification
2. Operating voltage
3. Device rating
4. Calculated short-circuit current (symmetrical and asymmetrical)

### 3.1.6 MOTOR STARTING STUDY (if required)

Prepare a static motor starting study for electrical equipment provided for the project. The motor starting study shall evaluate the capability of the auxiliary power system to start the largest motor load on the MV and LV systems at normal operating voltage (100%) as well as the minimum operating voltage (95%) with transformers at nominal tap.

Cases shall also be run for startup (back fed from system no generator online) and normal (generator online).

The report should confirm that the motor terminal voltage does not dip below the minimum starting motor terminal voltage of 80%.

Present the data conclusions of the Motor Starting study in a table format. Include the following:

1. Device identification
2. Operating voltage
3. Motor terminal voltage during starting

## 3.2 COORDINATION STUDY

The Contractor shall provide a selective coordination study using either Easypower or Aspen OneLiner (Easypower to be populated with Aspen OneLiner results) with an organized time-current analysis of each protective device in the project. The coordination study scope shall include devices starting at the switchyard relays to the fixed setting low voltage circuit breakers.

The coordination study shall include a ground fault analysis.

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

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, long-time, short-time, and instantaneous settings.
4. Fuse rating and type
5. Ground fault pickup and time delay

## 3.3 ARC FLASH HAZARD STUDY

An arc flash hazard analysis shall determine the arc flash boundary, the incident energy at the working distance, and personal protective equipment that people within the arc flash boundary shall use.

The Contractor shall perform an Arch Flash Hazard Study in Easypower as identified and in accordance with IEEE 1584. The following modeling requirements shall apply:

- In addition to IEEE 1584 recommended scenarios, scenarios shall include maintenance mode selection of switchgear protective relays.

- As identified in NPFA 70E Article 130 the Arc Flash Boundary shall be the distance at which the incident energy equals 5 J/cm2 (1.2 cal/cm2).

Develop a report to summarize the arc flash hazard information at electrical equipment rated 120 volts or greater. The report shall provide the following information for each piece of electrical equipment:

1. Available incident energy and the corresponding working distance.

2. Minimum required level of PPE to meet incident energy calculations

3. Highest Hazard/Risk Category (HRC) for the equipment

4. Nominal system voltage

5. Arc flash boundary

## 3.4 INSULATION COORDINATION

The purpose of this calculation is to determine the expected transient over voltages due to lightning strikes near the generator step up transformer, substation main power transformer, and standby transformer. This calculation shall confirm the specifications of the surge arrestors required to protect the GSU, substation main power transformer, and standby transformer.

## 3.5 GSU TRANSFORMER SIZING

GSU sizing calculation shall be provided prior to procurement of main power transformer.

## 3.6 DC/UPS SIZING

A DC and UPS sizing calculation shall be provided to verify that the DC and UPS systems are adequately sized for the project. The contractor shall provide the initial calculation prior to procurement of the equipment. The supplier of the equipment shall also submit a battery sizing calculation to validate the project specific battery.

The calculation shall include:

1. A UPS Load List (indicating a load factor and diversity factor)
2. A DC Load Cycle
3. A battery sizing calculation per IEEE 485 (including 10% design margin and 125% aging factor)
4. Battery Charger sizing calculation

## 3.7 GROUNDING CALCULATION

Grounding calculations shall confirm that the grounding systems be provided to assure that a person in the vicinity of grounded facilities is not exposed to the danger of critical electric shock. The grounding calculations shall be performed in CDEGS software and provided to Owner for review. The calculations must establish:

1. Touch and step potentials are within tolerable safe limits in accordance with IEEE 80.
2. Ground grid resistance is low enough to limit the ground potential rise (GPR).

In addition to IEEE 80 recommended practices, the following requirements shall be followed:

1. Most conservative body weight shall be assumed (50 kg).
2. A minimum of 3000 Ohm-meter surface rock to be installed. Surface rock to be 4” in depth with an appropriately compacted base later of ¾” minus and no felt separating the layers.
3. As-built crushed rock depth shall be recorded and updated in the calculation.

CDEGS software shall conform to the following:

1. Software Version: Contractor shall verify acceptable version with Owner.
2. Multi-layer soil model in RESAP
3. Grounding Plan in SESCAD

4. Step and Touch Potentials in MALZ

## 3.8 HARMONICS STUDY (if required)

A harmonics study shall confirm that the generation plant harmonics output does not exceed limits required by generator interconnection requirements.

## 3.9 SUBSYNCHRONOUS RESONANCE STUDY (if required)

A subsynchronous resonance study shall confirm no subsynchronous resonance issues or mitigation is required. EMTP software shall be used (Owner to approve software version).

## 3.10 FIELD EFFECT STUDY

Provide Field Effect study for transmission line. Calculations shall be made for measurement heights of 1 meter above ground surface in areas accessible to the public, within the ROW. Electric Field Strength shall be calculated for the line voltage as well as any under build. Magnetic Field Strength shall be calculated at full rated ampacity, with balanced phase currents.

# 4.0 REPORTS AND DELIVERABLES

## 4.1 APPROVAL REPORTS AND SOFTWARE FILES

The Contractor study preparer shall analyze the electrical system studies, prepare, and submit an approval report for each study that is required. Each report shall include an analysis section that summarizes 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 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 G1 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 G1 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.

## 4.2 FINAL REPORTS AND SOFTWARE FILES

Upon receipt of the Owner’s review comments, the Contractor shall incorporate comments into a final electrical system study report.

For the coordination study, after commissioning is complete, the Contractor shall verify the study protective device settings corresponding to the device settings in the field, and resolve any conflicts.

The Contractor shall provide the Owner two hard copies and two electronic copies of the final electrical system studies in accordance with Appendix G1 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.

**APPENDIX G1**
**ATTACHMENT 04**
**EXHIBIT 02**

# GENERAL TRANSFORMER SPECIFICATION

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 11Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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# 1.0 SCOPE OF WORK

## 1.1 DESCRIPTION

This specification covers the general design, construction, and operating requirements for oil-immersed outdoor station type power transformers including solar/wind substation Generator Step Up (GSU) transformers.

## 1.2 DESIGN REQUIREMENTS

Transformer cooling shall be ONAN/ONAF/ONAF at 60 degrees C rise on a 45 degrees C ambient.

The transformer specified herein shall be designed, manufactured, and tested in accordance with all applicable regulations, codes, IEEE, and NEMA standards, except as otherwise required by this specification.

The manufacturer's proposal shall list any additional standards, and codes the manufacturer intends to invoke in the performance of the requirements of this specification.

Control wiring and alarms shall be in accordance with PGE Design Masters (see drawings that will be provided as an Addendum or upon request). Current versions of Design Masters shall be requested by the manufacturer prior to starting design of transformer.

## 1.3 INSPECTION

Manufacturer shall give Contractor/Owner two months advance notice of the following hold points so that a Contractor/Owner representative may be present.

- Design Review
- Core and coil nesting
- Pre-tanking
- Factory acceptance testing

Design review drawings shall be submitted for approval, 3 weeks prior to the design review meeting or as otherwise noted. The design review submittal shall include, but is not limited to the following:

1. General Outline Drawings
2. Component Outline Drawings (including bushing and surge arresters)
3. Transformer Nameplate Drawings
4. Current Transformer Magnetization and Correction Ratio Curves
5. Current Transformer Connection Drawings
6. Control Schematic and Wiring Diagrams
    a. Wiring diagrams shall show all external connections to be made by Contractor

   b. Wiring diagrams shall show all internal wiring connections made by the manufacturer
   c. Wiring diagrams shall be “point to point” wiring
   d. Drawing shall show operating voltage and current ratings of fuses and circuit breakers
7. Control Cabinet Arrangement and Connection Drawings
8. Detailed Test Plan listing all tests in sequence
9. List of all transformer parts to be shipped including spare parts
10. Short-circuit test data as described in the section 4.4(A) of this specification

## 1.4 SHIPPING

All bushings, surge arresters, and radiators shall be removed from the transformer prior to shipment. The openings left in the transformer tank from their removal shall be covered with metal plates for shipment. Transformer shipping should follow IEEE C57.150 (Transformer Transportation).

- If the transformer tank is to be shipped filled with oil, it shall be covered with a nitrogen gas blanket.
  - Positive pressure of nitrogen gas shall be maintained between 1 psi to 5 psi at all times during shipment.

- If the transformer tank is to be shipped without oil, the tank shall be filled with dry air.
  - Positive pressure of dry air shall be maintained between 1 psi to 5 psi at all times during shipment.
  - Manufacturer shall provide dew point at time of shipment.

Bushings shall be marked with the corresponding winding that they were used for during testing.

Rail, ship, or truck shipping methods are acceptable. Transformer Center of Gravity (COG) should be clearly indicated using appropriate symbols. At least two functional impact recorders and GPS locator shall be installed on transformer. Rail car shall be equipped with end-of-car hydraulic cushioning devices, GPS locator and impact detector. If shipped by rail, “Do Not Hump” signage shall be attached to rail car.

### 1.4.1 Storage

Storage during/after shipping, and before installation shall be in accordance with IEEE C57.150, manufacturer’s written requirements/recommendations, and with manufacturers approval of conditions and maintenance, including confirmation of no impact to warranty. Storage measures will include oil fill and dry nitrogen blanket (for long storage durations – nitrogen pressure to be between 1 psi to 5 psi), power to control panel heater, and periodic inspection and gauge readings, all in accordance with manufacturer requirements and approval. Unassembled components shall be stored in

accordance with manufacturer requirements/recommendations, in original shipping containers, and protected from weather.

## 1.5 REFERENCE STANDARDS

This equipment shall be built and tested in accordance with the applicable standards and its supplements listed in Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

# 2.0 MATERIALS

## 2.1 GENERAL

Materials and components shall be new, undamaged and shall conform to pertinent NEMA and IEEE standard specifications and the following requirements.

All components and parts shall be readily available in the United States. All components shall be readily identifiable by manufacturer's name and part number.

Metric sizes are not acceptable.

## 2.2 CORE AND WINDINGS

Contractor shall specify the winding ratings for each terminal designation, including the voltage rating, continuous current rating, BIL rating, and catalog number. BIL ratings shall be determined as per IEEE C57.12.00.

Except for pad-mount transformers, all windings shall be copper. Aluminum windings may be used pad-mount transformers only.

All windings shall be insulated with thermally upgraded paper and verified with long-duration test per IEEE C57.100.

Where applicable Netting Continuously Transposed Cable (CTC), Epoxy Bonded, is preferred.

All windings, except tertiary winding, shall have a through-circuit capacity MVA rating at a 60°C rise, of the max MVA rating of the transformer.

The average winding temperature rise shall not exceed 60°C above ambient (a maximum 30°C average 24-hour ambient, and a 45°C maximum ambient).

The maximum hottest-spot winding temperature rise shall not exceed 80°C rise over ambient (110°C continuous with 30°C ambient, 120°C short-term emergency rating with 40°C ambient).

The hottest-spot of the interior of the core should never exceed 85°C rise over ambient (125°C at 45°C ambient) to avoid gassing, and the core surface temperature must not exceed the thermal capability of the insulation or parts touching the core.

Tertiary windings (if required) shall be a delta connected stabilizing winding, and be self-protecting for short circuits at all bushing terminals. Refer to the detailed specification to determine if tertiary should be buried or brought out.

1. Tertiary windings that are brought out may be used for station service.
2. Assume no system impedance for short circuit calculations.
3. Tertiary windings that are buried shall be designed with provisions to have the tertiary be brought out only for factory testing.
4. Tertiary winds that are buried shall have one corner of the delta brought out with two leads, from adjacent legs. These leads shall be bonded and grounded externally.

The transformer shall be designed with impedances sufficient to make the transformer self-protecting. Manufacturer shall assume that the transformer will be operated from an infinite bus.

Nuts, bolts, and clamps of the core assembly shall be provided with positive locking devices to prevent loosening caused by vibration or change of shape or position during transportation or operation. The complete core and winding assembly shall be removable from the tank for repairs.

Nomex insulation shall be used between the core and clamping structure.

For GSU's only: fiber optic temperature probes shall be installed, and provisions shall be made for monitoring system as noted below.

1. Monitoring system and sensors shall be LumaSense Technologies QualiTROL 408-12 or Owner approved equivalent.
2. Location of sensors - Fiber optic probes shall be located at the hottest winding spots as determined by manufacturer's calculations.
3. Number of sensors - Install two in each winding (for example in case of three-phase three-winding (primary, secondary, and tertiary) GSU, each winding shall have six sensors)
4. All fiber optic temperature probes shall be connected through a tank penetration box with tank wall feed-through with proper identification. (Phase, winding, Probe 1 or 2, etc…).
5. The fiber optic tank penetration box shall be mounted on upper tank wall.

## 2.3 BUSHINGS

Contractor shall specify the bushing ratings for each terminal designation, including the voltage rating, continuous current rating, BIL rating, and catalog number. BIL ratings shall be determined from the insulation coordination study and as per IEEE C57.12.00.

Acceptable manufacturers for the bushings are provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

All bushings shall be bolted on.

The bushing color shall be ANSI 70 (light gray).

Bushings shall be resin impregnated synthetic (RIS) condenser capacitive graded type and shall contain no oil.

RIS bushings shall be supplied with an air-side insulator with HTV silicone rubber adhered directly to the RIS condenser body having low stress teardrop tip and no visible parting lines.

If bushings are mounted at an angle other than vertical, the angle shall not exceed 30 degrees. The bushings shall be mounted so as to provide maximum clearance to the isolated phase bus enclosure, if applicable.

All standard routine tests as prescribed by ANSI/IEEE C57.19.00 shall be performed on every bushing at levels and requirements equal to or better than specified in ANSI/IEEE C57.19.01 for oil impregnated paper bushings.

HV bushing top terminal shall conform to the requirements of IEEE Standard C57.19.01.

Bushings 35 kV and lower shall have the 200 kV BIL rating as defined in IEEE Standard C57.19.01.

Bushings shall have 20% current margin over transformer winding rating at full load with maximum cooling.

Bushings to be attached to bus duct shall be rated to 125°C hot spot temperature with no additional loss of life.

The manufacturer shall not provide bushing terminal connectors.

Bushings with bolted bottom connections shall have spade connectors with NEMA hole spacing, through bolts, and nuts. Bolted connections shall have a minimum of 4 bolts per connection.

The neutral bushing shall be identical to low voltage line bushings if voltage ratings are the same.

The neutral bushing shall be connected to a ground pad near the base of the transformer using a continuous conductor of not less than 250-kcmil flexible copper cable or equivalent flat copper bar.

Bushing monitors may be included as a line-item option.

## 2.4 SURGE ARRESTERS

Contractor shall specify the surge arrester ratings, including the duty cycle rating (station class), MCOV rating, manufacturer, type, and catalog number for each terminal designation.

A ground loop shall be furnished, of not less than 250-kcmil flexible copper cable, which is connected from one ground pad on one side of the transformer through the three low voltage arrester ground terminals to another ground pad on the opposite side of the transformer. Also, similar separate ground loops shall be provided for the high voltage and tertiary surge arresters.

Arresters shall be mounted so that the spacing between the energized end of the arrestor and the top of the in-phase bushing is no less than half the minimum recommended phase to ground clearance for the selected arrestor. Furthermore, the spacing between the grounded end of the arrester and bottom of the in-phase bushing shall be no less the minimum recommended phase to ground clearance for the selected arrester.

## 2.5 INSTRUMENT TRANSFORMERS

A list of approved instrument transformer vendors is provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

All instrument transformers shall be C800 relay accuracy per IEEE Std. C57.13.

All instrument transformers shall have a thermal rating factor (T.R.F.) of 2.0.

All current transformer leads internal to the tank shall use ETFE insulated wire with a minimum temperature rating of 150ºC. All current transformer leads shall run the full length from the current transformer to the CT tank wall penetration box without any splices.

All taps from all current transformer secondary windings shall be connected to short-circuiting type terminal blocks located in the control cabinet.

Bushing current transformer wiring shall be a minimum of stranded No. 12 AWG, copper, terminating on ring-type terminals.

## 2.6 CONTROL CABINET

The main control cabinet shall house cooling equipment controls, electronic transformer monitor, relays, meters, test switches, indicating lights, manual control equipment, and terminal blocks.

Main control cabinet and any auxiliary control cabinets shall be a non-condensing, weatherproof, metal enclosure mounted on transformer.

The middle of the cabinet(s) shall be approximately 5 feet vertically from transformer base for easy access.

Cabinet shall be no smaller than 6 feet wide and 5 feet tall.

Cabinet shall have a minimum of two doors which shall each have:

1. A handle connected to a three-point latch to provide ease of opening and closing.
2. Door stops to hold door in "open" position. Door stops shall not interfere with opening the relay and control panel.
3. Provisions for padlocking in the “closed” position.
4. A small, clear, tempered glass window with a UV-proof coating and an aluminum hinged cover that can be lifted for viewing the transformer monitor display. Alternatively, the transformer monitor may be mounted on a swing-panel inside the control cabinet.

Cabinets shall be ventilated to avoid temperature extremes that may damage any of the contents.

Conduit entrance plate shall be removable from inside the cabinet.

Cabinets & Panels shall be configured to provide easy access to all components and their wiring during installation, testing, and maintenance.

Mounting devices on the cabinet ceiling and bottom is not acceptable.

If panel mounted equipment is used, the panels shall be hinged to swing-out for convenient access to all wiring.

Provide pockets to hold drawings and instruction books inside the control cabinet doors.

## 2.7 ELECTRICAL ITEMS

Control cabinet design shall follow requirements of IEEE C57.148 and the following:

1. Interior illumination with on-off switch activated by cabinet door shall be installed on the ceiling of the control cabinet. The interior lighting shall illuminate the front of the swing panel in addition to the rest of the cabinet. A minimum of two cabinet lights with 800 lumens or more shall be installed.

2. As a minimum, a 200 watt positive temperature coefficient heater, with fan, for 120-volt AC operation shall be installed. The manufacturer shall determine if more than one 200 watt heater is required.

3. One exterior-rated 120-volt AC duplex, 20-amp, three-wire grounding-type GFI receptacle shall be installed on the exterior of the control cabinet.

4. Two interior 120-volt AC duplex, 20-amp, three-wire grounding-type GFI receptacle shall be installed inside the control cabinet.

Control cabinet instrument transformers shall follow requirements of IEEE C57.13.

Multi-breaker overload protection shall be provided for items 1, 2, 3 & 4 above.

Separate breaker overload protection shall be provided for each monitoring device: the transformer monitor, dissolved gas & moisture monitor, and bushing monitor.

Manufacturer shall supply a spare one-pole 120-volt, 20-amp breaker for use by Contractor and PGE.

All Contractor external connections for power sources, relays, alarm, and trip circuits shall be wired to terminal blocks and clearly labeled.

Manufacturer shall provide 20% spare open/unused terminal blocks for Contractor's and PGE's future use.

Any spare or unused contacts of any device used shall be connected to terminal blocks for Contractor's and PGE's future use.

Indicating lights shall have LED type displays with appropriately sized resistors in series for 125-volt DC operation. Lights shall be compatible with ET-16 lamps.

All DC circuits shall operate from an ungrounded 125V DC source. All DC equipment, including relays and alarm controls, shall be suitable for continuous operation over a range of 102-140 volt for 125V DC source.

Any device capable of producing a surge voltage in control or alarm circuits shall be furnished with surge suppressors to limit the surge voltage. Properly rated MOVs are to be applied on the AC coils. Properly rated diodes are to be applied on the DC coils.

All equipment rated 600 volts and less shall have a dielectric withstand capability of a minimum of 2500 volts, as described in IEEE Standard C37.90. Should such voltage level exceed the capability of the equipment, means shall be provided as a part of the device to protect the device against damage by voltage in excess of its withstand capability.

All lugs used for any internal compartment wiring will be of the non-insulated ring type. The indent mark from the indent tool must be clearly visible.

All control terminations made to be modular compression terminal blocks or device terminals shall be made using bare tin-plated copper ferrules. The indent mark from the compression tool shall be clearly visible.

All wiring shall be stranded, No. 14 AWG, or larger, unless otherwise specified.

All PLC and transformer monitor input (analog and discrete) wiring shall be stranded, No. 18 AWG.

Device grounds and neutrals shall be directly connected to neutral and ground buses and shall not be daisy-chained through other devices between taps.

All operating controls and indicators accessed by operating personnel in the normal operation and testing of equipment shall be located such that personnel are not unnecessarily exposed to live parts.

All circuits to the control cabinet shall be routed through flexible seal tight conduit. Conduit penetrations into control cabinet shall be conduit hubs for sealing. (Lock nuts with RTV are not acceptable.) Conduit penetrations shall only be made in the side wall of the cabinet.

## 2.8 DE-ENERGIZED TAP-CHANGING EQUIPMENT (DETC)

The DETC shall not limit the loading of the transformer and shall be capable of a loading that is 150% of the maximum current rating.

DETC shall be furnished to provide plus and minus 5 percent adjustment of the high-voltage winding voltage in 2 ½ percent steps with 2 steps above and 2 steps below rated high voltage.

DETC shall have an external operating mechanism with provisions for pad-locking in each position. The mechanism shall be easily accessible to personnel standing on the transformer foundation.

The tap position indicator shall use the letters A, B, C, D, and E, where “A” is the setting with the highest voltage magnitude, “C” is the center tap, and “E” is the setting with the lowest voltage magnitude.

## 2.9 ENERGIZED TAP CHANGER (OLTC)

When specified, a load tap changer shall be provided per the requirements of this section.

1. Design in accordance with ANSI C57.12.10
2. Load tap changing equipment shall be housed in a separate compartment mounted on the main transformer tank designed to prevent any interchange of oil between the compartment and the tank.
3. Equipment for the manual control of the tap changing equipment shall be furnished in a weatherproof compartment mounted adjacent to the tap changing equipment compartment in a location to allow access and operation from the ground.

4. The tap changer shall have full rated kVA on taps above rated voltage and a current rating corresponding to the full load current at rated voltage on taps below rated voltage.
5. When specified to be designed for parallel operation, all equipment required for control of the load tap changer using the circulating current method of control shall be provided. This equipment shall include a selector switch for selecting parallel or individual operation, all required paralleling reactors and current transformers, and an overcurrent relay with two circuit closing contacts for remote alarms.
6. The tap changer shall be completely wired and shall include the following features:
    a. Voltage testing terminals
    b. All required current transformers.
    c. "Remote-Local" control switch.
    d. "Raise-Lower" control switch for local control.
    e. Provisions to operate tap changer by hand. Interlock shall be provided to prevent operation by electrical controls when hand operation is being performed
    f. Limit switches and stops for full raise and full lower positions and for preventing over travel.
    g. Adjustable time delay to provide sufficient delay in the first step of a raise or lower tap change.
    h. Operations counter.
    i. Space heater, lamp, and GFI-protected convenience receptacle in control cabinet.
    j. Tap position indicator mounted on the tap changer compartment.
    k. Tap position transducer with 4-20 mA output proportional to tap position.
    l. Tap position transmitter shall be compatible with remote tap position indicator provided by transformer vendor.
    m. Any additional equipment required for manual operation from either the transformer or a remote location.

## 2.10 AUXILIARY POWER SOURCE

Contractor will provide the following power sources:

1. Two (2) 480 volt AC, three phase, 60 hertz, three-wire grounded sources
2. 125 volt DC, ungrounded two-wire source.
3. The manufacturer shall provide main Multi breaker disconnecting devices for the power sources described above.

Manufacturer shall supply automatic transfer equipment to transfer to an alternate source upon loss of the normal source. An alarm contact shall be provided to indicate a transfer to the alternate source.

## 2.11 OIL AND OIL PRESERVATION SYSTEM

The transformer oil shall be provided by the transformer manufacturer.

If the transformer is to be supplied with oil, the oil shall be new Type II inhibited transformer mineral oil that meets ASTM D3487.

Oil used in testing or supplied with transformer or furnished in components, such as bushings, shall contain less than 1-ppm of PCB.

All oil used or furnished with the transformer and used during factory acceptance testing shall meet ASTM Standard D1275 Modified (b), Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils.

A conservator tank oil preservation system shall be used. The transformer shall include the following:

1. Oil expansion tank (OET) of the conservator system shall be capable of withstanding full vacuum.
2. There shall be no air contact with oil in the OET. This shall be accomplished by a nitrile air cell (diaphragm not allowed) vented to the outside air through a dehydrating breather. The breather shall be installed at eye level to allow for access without a ladder. Acceptable dehydrating breather manufacturers shall be Messko MTraB. The use of other manufacturers are subject to Owner approval.
3. Air cell shall be designed for flange installation; clamps not allowed.
4. A sealed entry into the air cell shall be provided to permit calibration of the oil level gauge.
5. Each end of the OET shall have sealed entry ports to adjust the bladder.
6. OET shall be of sufficient volume to operate through an ambient temperature range of minus 29°C to plus 43°C without causing a low-oil-level alarm or exceeding recommended full-oil level upper limit.
7. Two SHUT-OFF VALVES shall be provided in the oil line between OET and main tank. One at the entry point to the OET capable of holding full head of oil in OET, one at entry to main tank that will hold under full vacuum on the main tank.
8. Piping shall be provided between the oil and air space of the OET to equalize the pressure on both sides of the air cell during vacuum oil filling. A vacuum-proof valve shall be installed at the highest practical point on the oil expansion tank (OET) to isolate the two areas after the operation is completed.

## 2.12 GASKETED JOINTS

Nitrile (BUNA-N) elastomer gaskets shall be used to make pressure tight joints on the oil filled transformer. Gaskets made of cork-only or neoprene-only are not acceptable.

Gaskets that are not continuous shall be “vulcanized joint nitrile gaskets” and not have a butt or scarf joint.

O-ring gaskets are preferred for bushing flanges and manhole covers.

Flanges shall be provided with mechanical stops or grooves to prevent over compression of gasket when tightened.

Joints shall be designed so that gasket material will not be exposed to the weather.

## 2.13 TANK

The manufacturer shall provide the following on the transformer tank:

1. At least two manhole covers for transformer inspection; they shall be 24 inches or larger in diameter and shall be bolted. Additional access manholes may be requested for larger transformers.
2. Radiator valves at inlets and outlets of tank to permit removal of radiators without draining oil from tank.
    a. Radiators shall have at least one lifting eye, a vent plug in the top header, and a drain plug in the bottom header.
    b. No gasketed joints are allowed between the valves and the tank.
    c. Valves shall provide minimum restriction of oil flow.
    d. Valves shall be lockable butterfly type valves. Flapper type valves are not allowed.
    e. Paint shall not interfere with the operation of valves.
3. Two-inch lower oil-drain globe-type valve with oil sampling device provided on discharge side of valve. Valve shall allow essentially full drainage.
4. Two-inch upper oil-fill globe-type valve connection.
5. An external 1-in, pipe shall be provided between the tap changer compartment and the main tank located not more than 3 in. below the top of each compartment. A 1-in, ball valve shall be installed for manifolding between the two tanks.
6. Core ground leads shall be brought out of the main transformer tank wall through an insulated, porcelain bushing, and connected to a separate grounding pad at an external location.
    a. Grounding pad shall be identified and located within 6 feet of the transformer base.
    b. A protective cover shall be provided for the core ground bushing.
7. Five grounding pads with tapped holes (NEMA 2-hole Standard); one on each corner of the transformer base, and one for the core-ground leads detachable connector.
8. If tank ribs are used for expansion space, permanent labels, noted in 3.3 (B.3) shall be attached to each rib that it is pressurized. Tank weld seams inside pressurized ribs shall be avoided. Drain plugs shall be provided for pressurized ribs.

9. Tank weld seams that are behind tank ribs shall have an inspection plug installed to verify weld integrity.
10. The entire interior of the transformer tank shall be primed white with a primer that will not affect the electrical characteristics of the oil.
11. Provide one-inch valve approximately one foot above oil drain valve for connection of an air supplier during maintenance. Valve shall be plugged with a removable plug.
12. Gas sampling valve to vent gasses from transformer tank or gas accumulation relay.
13. Seven dry thermometer wells shall be installed in the main tank for specified or future thermal devices, to be used as follows:
    a. Dial-type Top Oil Thermometer.
    b. Top Oil Temperature (for transformer monitor)
    c. Top Oil Spare.
    d. Top Oil by Radiator Header Pipe (spare)
    e. Bottom Oil by Radiator Header Pipe (for transformer monitor).
    f. Dial-type Winding Temperature Thermometer
14. Spare thermometer wells shall contain a removable metal plug incapable of corrosion (brass, stainless steel, etc.).
15. The high voltage bushing H2 shall be on the same centerline as the low voltage bushing X2 (not necessarily on the tank centerline).
16. Low voltage and tertiary bushings that are external to the tank shall be spaced no less than 30 inches center-to-center.

## 2.14 COOLING EQUIPMENT

### 2.14.1 Fan Motors

A list of approved fan manufacturers are provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

1. Cooling fans shall be rated 60 Hz and 115/230Vac (for single-phase) or 208-230/460Vac (for three-phase).
2. Motors shall be suitable for operation in wind-driven rain. Motor bearings shall be ball-bearing, self-lubricating, sealed-type, designed for continuous as well as intermittent duty.
3. Motors shall be fitted with flexible cable terminating on self-locking, weatherproof connectors.
4. Manufacturer shall provide disconnecting devices, control switches, control relays, starting equipment with undervoltage protection, and separate overload protection for each fan motor.
5. Manufacturer shall provide Elapsed Time Meters capable of counting 99,999 hours, non-reset, to record each fan group’s running time to the nearest hour.

### 2.14.2 Radiators

1. Heat exchangers are not to be substituted for radiators, unless otherwise specified.
2. Radiator materials shall have melting points in excess of 1000°C. Materials used for welding or brazing the radiators shall also have melting points in excess of 1000°C.

### 2.14.3 Fan Blades

1. Fan blades shall be made of corrosion-resistant metal.
2. Fans shall have OSHA-approved safety guards.

### 2.14.4 Cooling Equipment Control

1. The temperature monitoring equipment described in 2.15 (D) shall be utilized to control cooling.
2. A three-position “ON-OFF-AUTO” SWITCH shall be provided for automatic and manual control of cooling equipment.
3. A toggle switch shall be provided in the control cabinet to provide manual switching between Stage 1 and Stage 2, regardless of APT programming.

## 2.15 ACCESSORIES

Accessory devices are to be insulated from ground for use with 125 DC source. Exception: Online dissolved gas & moisture monitor shall be powered by 120 volts AC.

All devices in the control cabinet shall be provided with a nameplate indicating their function.

Alarm and trip circuits shall operate at 125 volts DC.

### 2.15.1 Transformer Monitoring

A transformer monitor shall be provided. Acceptable transformer monitoring systems manufacturer is APT Eclipse Monitor.

The transformer monitor shall be mounted on the swing panel in the main control cabinet and shall be visible through a viewing window on the door.

### Monitored Signals

1. Discrete Signals - Refer to the attached transformer control schematic for alarms/annunciation required.
2. Analog Signals – The following analog signals shall be wired to the monitor.
    a. LV Winding Currents (X1, X2, and X3)
    b. Cooling Motor Current (Stage 1 and Stage 2)

3. RTD Temperature Signals and Sensors – The following RTD sensors shall be wired to the monitor.
    a. Top Oil
    b. Bottom Oil by Radiator Header

## Cooling Control

1. Manual Control - The monitor will have the provisions to force individual banks of cooling to turn on under manual control. The transformer monitor will continue to monitor the cooling motor current against the expected current levels.
2. Automatic Control – The monitor shall have provisions to automatically control cooling.
    a. Separate set points for all stages of cooling will be provided for calculated winding temperature and measured top oil temperature.
    b. Fan stage alternating will be programmable to allow for Stages 1 and 2 to be alternated on a daily basis, equalizing fan cycling.
    c. A period of daily fan cycling will be programmable to exercise fan motors during periods of inactivity.

## Sensors

1. Resistive Temperature Detectors (RTD's)
    a. RTD's shall be installed in dry wells
    b. RTD's shall have insulation rated to at least 200°C.
    c. RTD's of length greater than 10cm shall be 3-4 wires compensating for lead resistance.
    d. Maximum allowed error shall be +/- 1°C.
    e. Each RTD cable shall be at least 3 feet (91.4 cm) longer than necessary. Excess cable shall be coiled and shall be located within one foot (30.5 cm) of the RTD to facilitate RTD testing.
    f. The signal cable shield shall be grounded at the transformer monitor case.

## AC Current Transducers/Signal Conditioners

1. Current transducers or signal conditioners shall be non-intrusive and shall not require disconnecting sensed current signal for removal or installation.
2. The signal cable shield shall be grounded at the transformer monitor case.

## Construction

1. The manufacturer shall ensure the monitor is programmed prior to and functional during factory testing.
2. The manufacturer shall program the monitor with a current PGE settings file obtained from the monitor manufacturer. Settings shall be reviewed by PGE before programming.

### 2.15.2 On-line Dissolved Gas and Moisture Monitor

An on-line dissolved gas & moisture monitor shall be provided. Acceptable on-line dissolved gas & moisture monitor manufacturer and model shall be Qualitrol Serveron TM8-F or Owner approved equivalent.

Monitors that require oil circulation shall be plumbed to main tank valves (described below) with flexible stainless steel tubing. Installation of tubing and monitor shall be performed in field by Qualitrol Serveron.

Two stainless steel ball-type valves, full-port, shall be installed for the monitor on the transformer main tank. The first shall be located near the top of the tank, 12 inches below the lowest expected oil level, in an area with oil circulation, and shall be plumbed as the monitor's oil input from the main tank. The second shall be located at least 18 inches above the level of the drain valve and at least 48 inches away from the first valve, and it shall be plumbed as the oil return line from the monitor to the transformer. Valve size shall be 1/2" with female NPT outlet.

The monitor shall be provided with a dust cover over the monitor's manual oil sampling port.

Commissioning of monitor shall be performed in field by Qualitrol Serveron.

### 2.15.3 Magnetic Liquid-level Indicators

Acceptable liquid level gauge manufacturer shall be Messko.

One Main Tank Liquid-Level Indicator shall be located on the main tank wall and consist of the following:

1. An alarm contact for low oil level.
2. A trip contact that engages at an oil level at least 1.50 inches below the alarm level but at a level that will not cause damage to the transformer.
3. No contacts are required for transformers with conservators. This gauge will be used for local oil level indication only.

One Conservator Tank Liquid-Level Indicator shall be located on the conservator tank wall and consist of the following:

1. An alarm contact for low oil level.
2. A trip contact that engages at an oil level at least 1.50 inches below the alarm level but at a level that will not cause damage to the transformer.

The alarm and trip circuits shall include adjustable time delay relay set to delay annunciation or tripping after the contacts close.

Time delay relays shall be Signaline Model No. 360, 48 or 125 VAC/DC, 1-1023 seconds.

The trip circuit shall use a Qualitrol seal-in-relay 909-300-01 to provide a seal-in, trip and alarm for the trip circuit. For transformers with a conservator tank, the trip contacts from the main tank and conservator tank liquid level gauges shall be connected in series.

Alarms and/or trips shall not occur due to cold oil (minus 5°C for alarm and minus 15°C for trip). The trip shall not occur above the low-level mark on gauge.

### 2.15.4 Pressure Relief Devices

Acceptable pressure relief manufacturer shall be Messko. A minimum of two devices shall be located on the cover of the main tank, on opposite corners.

1. For inert gas pressure systems, a pressure relief of 8 PSI is required.
2. For conservator tank pressure systems, a pressure relief of 8 PSI is required.
3. One device shall be located on the Load-Tap-Changing compartment.
4. A pressure relief of 8 PSI is required.

### 2.15.5 Rate-of-Rise Fault Pressure Relay

Rate-of-Rise fault pressure relay and seal-in reset switch with alarm and tripping contacts.

Rapid Pressure Rise Relay

1. Qualitrol relay model 900-1, with Qualitrol seal-in-relay 909-300-01.
2. Qualitrol relay shall be installed in oil space.

Buchholz Relay

1. Cedaspe model EE3-ML + RG3.3, with Qualitrol seal-in-relay 909-300-01, and the following alarm and trip contacts.
    a. One Form-C trip contact for oil surge
    b. One Form-A trip contact for low oil level
    c. One Form-C alarm contact for gas accumulation

Trip and alarm contacts shall be connected to terminal blocks.

Sudden Pressure Relay shall operate on rate-of-rise pressure change to protect transformer against damage due to internal faults.

Relay shall be insensitive to pressure pulses caused by electrical disturbances such as magnetizing inrush currents, through faults, or mechanical shocks that may be caused by the normal operation of the transformer.

### 2.15.6 Bladder Integrity Relay

For a conservator tank system, a relay shall be installed to verify the integrity of the bladder system. Acceptable bladder integrity relay manufacturer shall be TREE Tech MBR.

### 2.15.7 Dial-Type Top-Oil Thermometer

Acceptable temperature gauge manufacturer shall be Messko.

Thermometer shall have three adjustable alarm contacts which close on temperature rise.

Mount remote readout less than 7 feet from transformer base.

### 2.15.8 Dial-Type Winding Thermometer

Dial-type winding thermometer and seal-in reset switch with alarm and tripping contacts.

Acceptable temperature gauge manufacturer shall be Messko.

For single phase, three winding transformers: Each winding shall have one thermometer.

For three phase, single tank transformers: Thermometer shall be furnished for B phase LV winding

Each thermometer shall have four adjustable contacts (alarm, trip, and two spare) which close on temperature rise.

The winding temperature indicator shall incorporate a current transformer responsive to its associated winding current, calibrating resistor, temperature detector element, and heater all mounted and connected to simulate the hot spot temperature of the winding.

The trip circuit shall use a Qualitrol seal-in-relay 909-300-01 to provide a seal-in, trip and alarm for the trip circuit.

Mount remote readout less than 7 feet from transformer base.

### 2.15.9 Transformer Nameplate

In addition to the requirements of IEEE C57.12.00, the transformer nameplate shall include the following:

1. Contractor transformer equipment number in upper left hand corner with extra-large lettering.
2. The current rating of the OLTC
3. The turns ratio of internal series or auto-transformers.
4. The minimum number of gallons of oil required to cover the core and coils.
5. The main tank & OLTC pressure & vacuum information (pressures shall be shown in PSI).
6. An adjacent nameplate shall show the various slings and lift positions required for proper lifting for the completely assembled transformer. It shall indicate whether the transformer may be lifted when filled with oil.
7. If tap voltages are not equally spaced, actual calculated tap voltages shall be indicated.
8. Transformer capacity ratings shall be stated in MVA, not kVA.
9. A simple plan view outline of the transformer showing bushings, control cabinet, OLTC tank and DETC handle locations.
10. Current transformers tap ratio tables.

### 2.15.10 Fiber Optic Connector Panel

Provide one Corning model CCH-CP12-25T fiber optic connector panel, installed in housing Corning model SPH-01P.

### 2.15.11 Ethernet Switch

Ethernet switch to convert Ethernet connections from transformer monitor and dissolved gas monitor to Ethernet fiber shall be provided. Acceptable manufacturer shall be Ruggedcom.

Switch shall be mounted inside control cabinet.

Minimum six RJ-45 ports shall be provided.

Minimum three ST multimode fiber connections shall be provided.

## 2.16 ALARMS/ANNUNCIATOR

All alarm/annunciation points shall be wired to the transformer monitoring device.

## 3.0 EXECUTION

### 3.1 TANK

#### 3.1.1 Design

Tanks shall be of oil and gas-tight steel plate construction.

1. All seams shall be welded.
2. All butt welds shall be full penetration.
3. Weld slag and spatters shall be removed.
4. Field installation shall not require welding.
5. Corner welds on the tank are not allowed.

Tank and compartment walls shall be reinforced to permit drawing full vacuum on each compartment, with oil in adjacent tanks or compartments.

Tank and all other oil-filled compartments shall be designed to withstand, without permanent deformation, an internal pressure of 10 PSI.

Transformer designs using an oil expansion conservator tank shall be designed to channel all generated gases to a Gas Accumulation Relay. Gas-channeling piping shall not cause a tripping hazard for personnel walking on the transformer cover.

The CENTER OF GRAVITY shall be visibly and permanently marked on two adjacent sides of the tank and shall be appropriately identified as follows:

1. “CENTER OF GRAVITY - COMPLETE” for the completely assembled transformer filled with oil.
2. “CENTER OF GRAVITY - SHIP” for the transformer filled with oil, but without the radiators, bushings, and lightning arresters.

Lifting lugs shall be provided for lifting the completely assembled transformer.

Jacking bosses shall be provided at all four corners of base for jacking the completely assembled transformer with oil.

1. Boss pads shall be located a minimum of 13 inches above the transformer foundation
2. The area above the pads shall be clear of obstructions.

Transformer tank shall withstand skidding or rolling the transformer with oil, bushings, and radiators in a direction parallel to either center line of the tank.

Provision for anchors or tie downs to the foundation shall be provided.

Provide weatherproof penetration box for current transformer leads on upper tank wall.

### 3.1.2 Cover

Cover shall be welded to tank.

Opening(s) shall be provided to facilitate installation and removal of bushing current-transformers without removal of the tank cover.

The transformer cover shall have external lifting eyes, which shall be welded on.

All manholes, hand holes, and inspection openings shall have a gasketed, bolted cover with external lifting provisions.

All openings in the tank cover employing gaskets shall be raised above the cover surface to prevent the accumulation of water around the gasket joints.

Covers shall not trap any gas generated in transformer.

Lifting eyes shall be welded inside the tank cover at all 4 corners and approximately 1 foot from each wall to be used for emergency man lifting.

Install Pelsue FB-SW1 (same as former UNI-Hoist NUH-4000-2) weld on adapter plates for confined space entry/retrieval system.

1. One retrieval system adapter plate shall be located near each man-hole.
2. One retrieval system adapter plate shall be located on the edge of the transformer, near the clean side of the transformer as recommended by retrieval system manufacturer.
3. Quantity and spacing between plates to be determined based on transformer capacity and manufacturer requirements.

Manufacturer shall apply non-skid paint on the entire transformer tank cover.

## 3.2 SOUND

The transformer shall designed to comply with a decibel rating of -10 dB relative to NEMA TR1

## 3.3 SAFETY FEATURES

### 3.3.1 Clearance

There shall be sufficient clearance from ground to live parts, in accordance with the NESC, to permit access to parts, which require adjustments or examination by operators while the transformer is energized.

### 3.3.2 Caution Labels

For nitrogen gas pressure systems a caution label shall be provided on the top of each manhole cover. The nameplate shall read as follows:

"DANGER, Pressurized with Nitrogen Gas –

1. Reduce gas pressure to zero before opening.

2. Ventilate with dry air and follow confined entry procedure to enter the transformer."

For conservator-type transformers a caution label shall be provided on the top of each manhole cover. The nameplate shall read as follows:

"WARNING, Oil must be removed from the conservator tank before opening."

For tank ribs that are pressurized a caution label shall be provided on each pressurized rib. The label shall read as follows

"DANGER, Rib is pressurized, do not drill, puncture or weld."

For manholes mounted on the tank wall a caution label shall be provided on each manhole cover. The label shall read as follows

"WARNING, Oil must be removed from the main tank before opening."

For transformers with a de-energized tap changer a caution label shall be provided next to the de-energized tap changer handle. The label shall read as follows:

"DANGER, Do not operate the de-energized tap changer with the transformer energized."

## 3.4 SEISMIC

The transformer and all of its components shall be qualified in accordance with IEEE Standard 693. Transformer shall meet the requirements of the High Seismic Qualification Level.

At a minimum the follow upgrades shall be included to ensure qualification:

1. Additional radiator supports
2. Additional conservator supports
3. Additional control cabinet supports
4. Increased bracing of the active part

A note shall be added to the nameplate that indicates that the transformer was designed to meet the IEEE 693 High Seismic Qualification Level.

A finite element analysis shall be done and report, verified by a registered professional engineer, shall be submitted to verify the High Seismic Qualification Level.

## 4.0 FACTORY TESTS

### 4.1 GENERAL

The manufacturer shall notify Contractor at least 30 days prior to commencement of testing so that a Contractor/Owner representative may witness the tests. The manufacturer shall notify Contractor immediately of any delays.

The tests specified in IEEE Standard C57.12.00 and manufacturer's quality control tests, shall be performed, except as stated in this specification.

Tests, which have been run on other transformers of essentially duplicate designs, are not acceptable in lieu of the tests specified, except as stated in this specification.

All tests shall be performed in accordance with IEEE Standard C57.12.90, unless otherwise specified by the Contractor/Owner. The manufacturer shall notify Contractor immediately of any test results not in compliance prior to any modifications and retesting.

Contractor/Owner will accept the transformer only if it has passed all tests to Contractor/Owner's satisfaction.

All dielectric tests shall be performed after the heat run.

All tests shall be performed on all units (including duplicates).

### 4.2 SPECIFIC TESTS

#### 4.2.1 Bushing Tests

Immediately after receiving the bushings into the factory, the bushings shall be thoroughly inspected, cleaned and shall receive power factor and capacitance tests.

### 4.2.2 Winding Resistance Tests

Resistance measurements and impedance voltage tests of all windings on rated voltage connection and at tap extremes.

1. The same method shall be used to determine both cold-resistance and hot-resistance values (same winding resistance meter, same test leads, same connections, same current, etc.).
2. The same method shall be used to determine both the temperature associated with the cold-resistance test and the temperature associated with the hot thermal tests (same measuring device, same RTDs/probes, same calculation to determine mean oil temperature, etc.).
3. Cold resistance measurements shall be made in the following tap positions:
4. Windings with a DETC: neutral and extreme tap positions
5. Resistances for windings in a delta configuration shall be measured phase-to-phase.
6. Resistances for windings in a wye configuration shall be measured phase-to-neutral.

### 4.2.3 Ratio Tests

Ratio tests on rated voltage connection and on all tap connections.

### 4.2.4 Polarity Tests

Polarity and phase-relation tests on rated voltage connection.

### 4.2.5 No-Load Losses

The no-load losses test shall be repeated after dielectric tests (repeated with 100% voltage, with tap changers in the nominal positions). The test shall be sustained for at least 10 minutes to help ensure the core is well demagnetized for subsequent tests.

Values from the repeat test shall be used to evaluate actual losses compared to the guarantee losses stated in the Proposal.

No-load losses and excitation current shall be reported at 60 Hz, and 90%, 100%, 105%, 110% rated voltages (before and after dielectric tests).

### 4.2.6 Excitation Tests

Excitation current test at 100 percent, 105 percent, and 110 percent of rated voltage on the rated voltage tap.

1. Excitation tests shall be performed before the impulse tests.
2. The 100 percent test shall be repeated after the impulse test.

### 4.2.7 Load Loss and Impedance Tests

Impedance and load loss at rated current and rated frequency on the rated self-cooled ONAN connection and on the tap extremes.

### 4.2.8 Zero Sequence Test

Measured zero sequence impedances (high-voltage to low-voltage) shall be reported in the certified test report, at the ONAN rating and the following voltage taps:

- Units with only a DETC: neutral and extreme tap positions

### 4.2.9 Temperature Rise Tests

Temperature rise tests shall be per IEEE Standard C57.12.90.

1. ONAN temperature rise test.
    a. Winding resistance measurement taken on one phase.
2. ONAF temperature rise test.
    a. Winding resistance measurements taken on all three phases.
    b. The tank wall surfaces shall be checked for hot spots with thermal imaging camera when the top oil temperature has stabilized.
    c. Thermal images shall be provided to Contractor/Owner electronically with the test report.
3. Overload Test shall immediately follow the ONAF temperature rise test.
    a. With all cooling equipment in operation, and after the top oil rise is re-established and with the total losses of the ONAF rating being applied, the loading shall be increased to 125% of maximum ONAF rating and held until stabilized.
    b. Winding resistance measurement shall be taken on the hottest phase recorded from the ONAF temperature rise test.
    c. The top oil rise shall be limited to 70°C rise over 40°C ambient (110°C absolute).
    d. The hot spot rise shall be limited to 90°C rise over 40°C ambient (130°C absolute).
4. Any test shall be terminated if the winding, lead, bushing, and metal hot-spot temperature exceeds 90°C rise over 40°C ambient.
5. Top & bottom oil temperature, simulated hottest-spot winding temperature, and fiber optic temperatures shall be operational and recorded at intervals of 30 minutes or less. Any test shall be terminated if any fiber optic hot spot winding temperature exceeds 140°C.
6. Transformer monitor and fiber monitor (defined in Section 2.15.1) shall be configured to record all temperatures from RTD and fiber optic temperature

probes at 1 minute intervals prior to heat run tests. Transformer monitors shall be energized and shall log all temperature inputs for the duration of all heat run tests.

7. The online DGA monitor specified in 2.15 (E) shall be fully plumbed, commissioned, and operating during the heat run tests.

### 4.2.10 Dissolved Gas Analysis (DGA)

DGA samples shall be taken from the main tank as follows and shall be analyzed using test method ASTM D3612:

1. Prior to any testing.
2. After ONAN temperature rise test.
3. After ONAF temperature rise test shutdowns.
4. After overload test or before dielectric tests if not performed on the same day.
5. After dielectric tests.
6. Prior to shipping if the transformer is being shipped filled with oil.

Cumulative dissolved gases in oil resulting from any test shall not exceed:

| Gas | After ONAN or ONAF Test | After Dielectric Tests |
|---|---|---|
| Acetylene | 0 ppm | 0 ppm |
| Hydrogen | 10 ppm | 15 ppm |
| Carbon Monoxide | 20 ppm | 40 ppm |
| Carbon Dioxide | 200 ppm | 200 ppm |
| Methane | 2 ppm | 4 ppm |
| Ethylene | 1 ppm | 2 ppm |
| Ethane | 2 ppm | 4 ppm |

### 4.2.11 Impulse Test

Switching and lightning impulse tests shall be performed in accordance with the requirements of IEEE C57.12.90 and IEEE C57.12.00. Measurement of test voltages shall be performed based on IEEE Std. 4.

The dielectrics tests shall be performed in the following sequence:

1. Lightning impulse tests (on all terminals)

2. Switching impulse tests

3. Applied potential test

4. Induced potential test

### 4.2.12 Applied Potential Test

Applied potential tests shall be performed in accordance with the requirements of IEEE C57.12.90 and IEEE C57.12.00 at low frequency (below 500 Hz) and duration of 1 minute. Measurement of test voltages shall be performed based on IEEE Std. 4.

### 4.2.13 Induced Potential Test

RIV measurements (in microvolts) and partial discharge measurements (in picocoulombs) shall be performed at the end of all dielectric tests Values shall be recorded for each phase in both microvolts and picocoulombs.

1. The test shall be recorded on at least 6 channels (3 RIV and 3 PD).
2. Limiting criteria for the test is as follows:
    a. Maximum RIV < 100 microvolts
    b. Maximum PD < 300 picocoulombs
    c. Increase of RIV during 60 minutes does not exceed 30 microvolts
    d. Increase of PD during 60 minutes does not exceed 50 picocoulombs
    e. No steadily rising trend in RIV or PD during the last 20 minutes
    f. The RIV and PD of any one phase shall not be higher than 200% of another phase (desire somewhat symmetrical values across phases)
3. If the limiting criteria is near the failure limit and/or is steadily increasing near the conclusion of the test, the test length shall be extended indefinitely until a confident judgment can be made as to whether the transformer has passed or failed.

### 4.2.14 Audible Sound Level Tests

Sound level tests shall be performed per IEEE C57.12.00 and IEEE C57.12.90.

1. Performed at the tap position that produces the highest audible sound level.
2. The test shall be performed a second time with both the first and second stages of auxiliary cooling energized.
3. The test report shall include all test data taken with corresponding locations of microphones at all tap settings in accordance with the referenced standards.

### 4.2.15 Insulation Power Factor and Excitation Tests

Power factor and excitation tests of the transformer, with bushings and oil installed, shall be performed at 10 KV before and after dielectric and load tests are complete.

1. The individual tested power factors of the winding-to ground insulation and of the inter-winding insulation (CH, CL, and CHL by Doble Method II) shall not exceed 0.50 percent at 20°C top oil temperature.
2. Power factors for bushings C1 and C2 shall be tested.

### 4.2.16 Current Transformer Tests

The insulation resistance and polarity of all current transformers shall be tested.

### 4.2.17 Sweep Frequency Response Analysis (SFRA)

Provide Sweep Frequency Response Analysis test (at nominal test positions) on all windings using Doble SFRA test equipment. To ensure the core is free of any residual magnetization due to impulse tests, the SFRA test shall follow the repeated no-load test (after impulse test). The test shall be performed with the DETC in the maximum voltage position (all winding in the circuit).

### 4.2.18 Furanic Compound Analysis

Analysis shall be performed after all tests, prior to removing test oil from transformer, on the main tank, DGA-syringe sample using test method ASTM D5837.

### 4.2.19 Oil Quality Tests

If the transformer is to be shipped with oil, oil quality tests shall be performed on the oil shipped in the transformer prior to shipping. The sample for the oil quality tests shall be taken from the main tank. The oil quality tests shall include the following:

1. Interfacial Tension @ 25°C, min, dynes/cm – ASTM D971
2. Dielectric Breakdown, min, KV – ASTM D1816
3. Power factor, max 25°C, % – ASTM D924
4. Power factor, max 100°C % – ASTM D924
5. Water, max, ppm – ASTM D1533
6. PCB content, ppm – EPA 8082
7. Acid Number, mg KOH/g – ASTM D974
8. Any oil that will be provided with the transformer shall be tested for corrosive sulfur in accordance with ASTM D1275 Modified (b) and shall be classified as non-corrosive. A copy of this report shall be provided upon delivery of the transformer.
9. Oxidation Inhibitor content, % by weight – ASTM D2668
10. Relative density – ASTM D1298

## 4.3 TEST REPORT

All test data shall be recorded in the Test Report. The Test Report shall be accompanied by copies of the raw hand-written data sheets used to record test results, including, but not limited to:

1. Tests completed for setup and calibration.
2. Tests repeated due to incomplete test records.
3. Test failures.
4. Test records incorporated into the final report.

The manufacturer shall e-mail a copy of the certified test report to Contractor/Owner for approval prior to shipment. Final copies of the test report shall be included in each instruction book and provided in electric form to Contractor/Owner. The report shall include a short summary noting any abnormal results and stating if the unit has passed or failed. The following test data shall be provided for review.

1. Winding Resistance (All tests)
2. No-load losses, Load losses & Impedance tests (All tests)
3. Excitation Current (All tests, 100%, 105%, 110% and 100% after dielectric tests)
4. TTR Results (All taps with deviation from equally spaced taps)
5. Impulse tests (including waveform comparisons, i.e. reduced wave vs. full wave, chopped wave 1 vs. chopped wave 2, etc.)
6. Induced voltage test results (all micro-volt and pico-coulomb readings)
7. Sound Level (All data points)
8. 10kV Power Factor and Excitation data (in test report and separately in Doble .XML file)
9. Doble SFRA test results (in test report and separately in Doble .SFRA files)
10. Oil sample results (All tests, including DGA, oil quality, furanic compounds, and corrosive sulfur)
11. Bushing Power Factor and Capacitance Tests (in test report and to be included in Doble .XML file specified in item 8 above)
12. Provide continuous log, in the test report and EXCEL file, of all temperatures (fiber, bottom and top oil, top and bottom header, ambient, and customer temperature gauges) and transformer loading, with date and time stamps for the temperature rise and overload tests. Provide shutdown plots of resistance.

The Test Report shall show the stray loss ratio, i.e.:

- SFL = Stray losses / Full Load Losses
- Full Load Losses = Total load losses - $I^2R$ Losses X 100 % / Total load losses

The Test Report shall show no-load losses at 90 percent, 100 percent, 105 percent, and 110 percent of rated voltage.

The Test Report shall show the manufacturer's quality control sound level test, including noise data by location.

The Test Report shall include ratio test results with deviation from equally spaced taps.

The Test Report shall show induced voltage test results in time vs. measurement table format. (Both RIV and picoCoulombs.)

The Test Report shall indicate PCB level of oil used for tests.

The Test Report shall include winding temperature indicator calibration value and the winding hot spot temperature rise above top oil for every heat run test shutdown.

Test Report shall include all oil test reports, including the manufacturer's ASTM D3487. The D3487 test should be from one of the tankers that deliver oil to the transformer manufacturer during the time our transformer is being filled or tested.

## 4.4 SHORT CIRCUIT REQUIREMENTS

The manufacturer shall furnish information and type test data to document that a transformer of similar design that is being furnished is capable of withstanding, without damage, the mechanical stresses caused by short circuits imposed at the bushing terminals of the secondary windings under the conditions specified in the American National Standard for Distribution and Power Transformer Short-Circuit Test Code (C57.12.90, Part II).

## 5.0 ASSEMBLY AND OIL FILLING:

The Contractor shall furnish all labor, supervision, material, and equipment required to attach all auxiliary equipment that is shipped separate from the transformer tank(s) and completely fill the transformer(s) with oil.

Prior to oil filling, the following tests shall be performed on the oil:

1. Moisture content
2. Dielectric strength
3. Power factor
4. Interfacial tension
5. Neutralization number
6. After filling with oil, check transformer(s) for oil and pressure leaks.

## 6.0 FIELD INSPECTIONS AND TESTS

The transformer supplier shall perform and record the following field inspections and tests upon delivery of the transformer(s) to the site:

1. Check impact recorder
2. Check blocking
3. Check transformer tank and fittings for the following:
    a. External damage
    b. Paint finish
    c. Attached fittings
    d. Oil leakage, if shipped oil-filled
    e. Positive pressure or vacuum in tank
4. Inspect bushings
5. Perform the following internal inspections:
    a. Check for moisture
    b. Check coil supports
    c. Disconnect core ground and measure insulation to ground to verify no unintentional grounds
    d. Check for any visible insulation damage
    e. Check for any loose parts
6. Check that all parts have been delivered and report and expedite shipment of any missing or damaged parts
7. Provide and record the following field tests:
    a. Insulation resistance
    b. Each winding-to-ground and to other windings
    c. Core-to-ground
    d. Winding ratio tests on all tap positions

e. CT ratio and polarity tests

f. Dissolved gas analysis sampled at least one day after energized

8. Compare results with factory test report and inform Contractor/Owner of any discrepancies.

9. Check and report on all accessories for proper operation, including the following:

a. Cooling fans

b. Oil pumps, if applicable

c. Cooling controls

d. Pressure relief device

e. Sudden pressure relay

f. Magnetic liquid level indicator

g. Winding temperature indicators

h. Liquid temperature indicator

i. Pressure-vacuum indicator

j. Tap changer

k. Winding temperature detectors

10. Provide all additional field inspections, adjustments, and tests recommended by the transformer manufacturer.

**APPENDIX G1**
**ATTACHMENT 05**
**EXHIBIT 01**

# TRANSMISSION LINE DESIGN SPECIFICATION

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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**Design Criteria Memorandum (DCM)**

# PGE Transmission Line Design

Rev. 0

**December 14, 2017**

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# 1. General Overview and Summary

This Project Design Memorandum has been prepared to use in connection with the Transmission Line Project for Portland General Electric (PGE). Its purpose is to define the scope of work and compile the mechanical, electrical and safety criteria that will govern design on the Transmission Line Project.

## 1.1. Codes and Standards

Applicable codes and standards, laws and regulations shall be in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

Where a reference to the above is made in this document the latest edition shall apply. Furthermore, in the event of any discrepancy in the Applicable Codes & Standards, the most stringent standards and requirements shall apply.

Contractor shall be responsible for ensuring that the Work comply with all Applicable Codes & Standards and as these may be amended and revised from time to time.

The Applicable Codes & Standards are in addition to the requirements set forth in the Agreement, this document, including any additional standards, Applicable Permits, and the Specifications.

In the event of any departure from Applicable Codes & Standards the referenced codes and standards must be fully explained in writing and submitted for Owner's review and approval prior to implementation.

## 1.2. FAA Requirements

Contractor shall be responsible for ensuring site location is checked with the FAA Notice Criteria Tool and filed in accordance with CFR Title 14 Part 77.9, as required.

The FAA Notice Criteria Tool can be found on the Federal Aviation Administration's website.
https://oeaaa.faa.gov

## 1.3. State, Federal, or Local Regulations

Contractor shall be responsible for obtaining all Applicable Permits and authorizations required to undertake the Work. This includes, but not limited to: wire-crossing permits in connection with the Work for the crossing of railroads, roads, highways, and rivers; any permits from local and state authorities for work activities such as setting guard poles, the setup of construction equipment in road right of way or curb and sidewalk crossings, including traffic control. The Contractor is also responsible for obtaining any road permits necessary for moving any equipment or material due to weight or length. The fees associated with these permits are to be paid by the Contractor. The cost of any railroad flagging and coordination will be paid and coordinated by the Contractor. Contractor shall comply with provisions of the permit(s) to minimize interference with the operation or maintenance of traffic or service of any railroad, highway, power, telegraph, or telephone line.

## 1.4. Grade of Construction

The project shall utilize Grade B construction. Lower grade of construction shall not be used.

# 2. Conductor

### *Standard conductors*

- Conductor selection shall be limited to those listed in LD23000. In addition to those conductors listed, the following may also be used:
- 795 ACSS Drake
- 1272 ACSS
- 2156 ACSS Bluebird

### *Communication Wire*

- PGE communication conductor selection shall conform to the (reference the communication specification here) Analysis of sag and loading shall be completed using an appropriately developed WIR file for the ADSS or OPGW fiber selected.

- All other communication attachments shall be modeled in PLS-CADD to appropriately apply loading on structures.

### *Maximum Operating Temperatures*

Maximum operating temperatures are specified by wire type in PGE standard LD23000 and are summarized in the Table 2-11.

**Table 2-1 Maximum Operating Temperature by Conductor Type**

| *Wire Type* | *Max. Operating Temp. (°F)* |
|---|---|
| AAC | 200 |
| ACSR | 212 |
| ACSS | 355 |
| Copper | 212 |
| Neutral | 120 |
| Communications Wires | 120 |

### *Conductor Sag & Tension*

### *New Conductor*

All newly sagged wires will not exceed the PGE standard tension criteria outlined in standard LD23000.

## 2.1. Structures

### *Structure Types*

Transmission structure types can include wood, light duty steel, tubular or lattice steel poles as necessary for the voltage class. Structures will be guyed according to PGE standards.

Distribution structures will use standard crossarm assemblies spaced according to drill patterns shown in LC10220.

# 3. Climate

## 3.1. NESC Loading

The project is located in NESC Medium loading zone, however, PGE T&D Standard LD20020 requires all 230kV and higher voltage transmission lines to withstand NESC Heavy loading conditions.

## 3.2. Wind Experience

Refer to NESC Figure 250-2(a) and PGE T&D Standard LD20020 for wind load.

PGE T&D Standard LD20020 requires loads supported on steel structures over 60’ to be designed for a 20.7 psf. wind (90 mph).

## 3.3. Ice Experience

PGE T&D Standard LD20020 requires lines designed to NESC Heavy zone loading to be also designed for a 1” thick ice loading.

## 3.4. Combined Ice and Wind Loading

All structures over 60’ tall are subjected to NESC Concurrent Ice and Wind loading.

# 4. Electrical Design Criteria

## 4.1. Code Clearances

Conductor and ADSS clearances are designed to PGE T&D Standards LD29000, LD29001, LD29002, LD29003, LD29004 and LD29005.

The Project will be designed to satisfy NESC minimum clearances and PGE minimum clearances specified in standards LD29000 through LD29006. In the case of overlapping standards, the more stringent requirement will govern for this project.

### *Conductor Clearances*

#### *Vertical Clearance to Ground*

Vertical clearances shall be evaluated at 120°F for neutral, communication, and guy wires. Conductors will have clearances evaluated at maximum operating temperature with no wind, or 32°F, no wind, [TBD]" ice; whichever scenario results in maximum sag. See LD29002

#### *Crossing Conductor Vertical Clearances*

Unsupported wire crossings will be checked under two conditions:

- Upper conductor at maximum operating temperature, no wind, and final sag. Lower conductor at 60°F, no wind, and final sag.
- Upper conductor at 32°F, 0.25" ice, no wind, and final sag. Lower conductor at 0°F, no ice, no wind, and final sag.

#### *Vertical Conductor Clearances for Wires Supported on the Same Structure*

Wires supported on the same structure will be wire crossings will be checked under two conditions:

- Upper conductor at maximum operating temperature, no wind, and final sag. Lower conductor at 60°F, no wind, and final sag.
- Upper conductor at 32°F, 0.25" ice, no wind, and final sag. Lower conductor at 0°F, no ice, no wind, and final sag.

#### *Horizontal Conductor Clearances*

Horizontal clearances will be evaluated with wires at 60°F, final sag condition and 6psf wind applied in perpendicular to the alignment in either direction.

#### *Structure Clearances*

Structures clearances refer to the minimum distances adjacent to structures that must be free of any obstacles. Structures, in this case, refer to any element of the supporting structure, including poles, arms, equipment, guys and anchors.

#### 4.1.1. Galloping Wires

Clearances between cables will be analyzed using double loop gallop analysis and blowout to prevent the possibility of wires clashing in mid span where possible, PGE T&D Standard 29005 clearances will be maintained.

## 4.2. Structure Spotting

If required, transmission poles will be spotted at Contractor's discretion to allow for necessary clearances and strength requirements with approval of owner.

## 4.3. Corona and Field Effects

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

### 4.4. Electric Field Effects

Electrical field studies shall be performed for this project as needed when using new structure types or with the addition of fiber within or near the supply space.

# 5. Structural Design Criteria

## 5.1. Wire and Wire Support Hardware

### 5.1.1. Wire Tension Limits

All newly sagged wires will not exceed the PGE standard tension criteria outlined in standard LD23000.

### 5.1.2. Support Hardware and ADSS accessories

Support hardware and cable accessories will be selected according to PGE standards and/or manufacturer's specifications and checked to withstand all applicable load cases and load factors without strength reduction factors.

## 5.2. Guys and Hardware

Structures will be guyed according to PGE standards.

## 5.3. Structures

### 5.3.1. Supporting Structures

Transmission structure types can include wood, light duty steel, tubular or lattice steel poles as necessary for the voltage class. Distribution structures will use standard crossarm assemblies spaced according to drill patterns shown in LC10220. Additional structures beyond what is included in PGE's initial design will be spotted at Contractor's discretion with Owner approval. All structures will be designed to loading conditions as described in LD20010, LD20020, LD20030 and LD20055.

### 5.3.2. Strength Reduction Factors

Pole and guy capacities will be reduced by strength reduction factors according to PGE standard LD20055.

## 5.4. Loads and Load Factors

### 5.4.1. Weather cases

Weather cases shall be used for structure loading per PGE T&D and NESC standards.

### 5.4.2. Loading Factors

Loading Factors shall be used for structure loading per PGE T&D and NESC standards.

### 5.4.3. Intact Loading Cases

All tangent, running angle and deadend structures shall be analyzed using the following intact applicable loading conditions:

- NESC 250B

- NESC 250C
- NESC 250D
- PGE Extreme Wind
- Extreme Ice
- Cold

### 5.4.4. Unbalanced Longitudinal Loading Case

All deadend structures shall be analyzed for unbalanced longitudinal loads due to broken wire conditions. These longitudinal loads shall be applied in conjunction with the transverse and vertical loads calculated for the intact loading conditions.

### 5.4.5. Deadend Structures

All deadend structures shall be analyzed using the intact loading cases in addition to the following loading cases:

- Camber

This load case stipulates that pole tip deflection from vertical shall be limited to 12 inches under the camber load case.

- Deflection

This load case stipulates that pole tip deflection from vertical shall be limited to 36 inches under NESC 6 PSF blowout (6 psf wind) conditions. In addition, the pole tip deflection shall be limited to pole height/20 under any loading condition. The pole shall be pre-cambered if deflection under the cambered load case exceeds 6 inches at the pole top.

The following weather cases shall be applied as Broken Conductor loading cases. All of the wires shall be broken on one face at a time.

- NESC 250B
- NESC 250C
- NESC 250D
- PGE Extreme Wind
- Extreme Ice

### 5.4.6. Tangent

All tangent structures shall be analyzed using the intact loading cases in addition to the following loading cases:

- Camber

This load case stipulates that pole tip deflection from vertical shall be limited to 12 inches under the camber load case.

- Deflection

This load case stipulates that pole tip deflection from vertical shall be limited to 36 inches under NESC 6 PSF blowout (6 psf wind) conditions. The pole shall be pre-cambered if deflection under the cambered load case exceeds 6 inches at the pole top.

### 5.4.7. Construction and Maintenance Cases

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

## 5.5. Foundations

All wood distribution poles and all tangent and guyed wood transmission poles will be directly embedded at least 10% of the structure height plus 2 feet. All light-duty steel poles will be directly embedded at least 10% of the structure height plus 5 feet as a minimum, but each foundation embedment shall be analyzed for the given load cases and soil parameters . Adjustments may be made if rock is encountered at a shallower depth, on steep slopes, or when poor soils are encountered. Refer to PGE standard LC10270 Depth of Setting Poles for these adjustments.

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

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

Drilled pier foundation design will be in accordance with PGE standard S-123-10 Foundation Design or engineering best practice, whichever is more conservative.

Foundations shall be designed using L-Pile and MFAD software, and soil conditions shall be based on geotech study. Foundations will be designed with anchor cages and rebar (not full length anchor cages). The reinforcement steel shall be Grade 60 conforming to ASTM A-615. The concrete strength shall have a compressive strength of 3500 PSI in accordance with ASTM C150. Foundation serviceability requirements are as follows:

- Deflection: 1.5” at top of pile head with un-factored loads (OLF = 1.0)
- Rotation: 1° Rotation under factored loads (From PLS-CADD/PLS-POLE)
- Soil Capacity: Deflection less than 10" with un-factored loads multiplied by an OLF of 2.0

**APPENDIX G1**
**ATTACHMENT 05**
**EXHIBIT 02**

# TRANSMISSION LINE CONSTRUCTION SPECIFICATION

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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# 1. GENERAL

## 1.1. COORDINATION OF OUTAGES

1. The scheduling of work requiring outages of an existing line shall be included in the Contractor's overall work schedule, which is to be prepared by the Contractor and approved by Owner prior to the start of work. The specific outage dates for each line segment to be rebuilt will be furnished as part of the bid specification.

2. The Contractor shall notify Owner at least five (5) working days in advance of the specific date the Contractor intends to work on an existing line segment. Owner will work in conjunction with Contractor to schedule outages and one shots with existing utility. If necessary, the Contractor shall adjust the date for taking the line out-of-service to accommodate system operations considerations.

3. Immediately prior to starting work on the existing line, the Contractor will contact Owner to receive final verification that the line is de-energized. It shall then be the Contractor's responsibility to test the line as necessary to ensure that the conductors are not energized and install grounding as required prior to allowing work to proceed.

## 1.2. PERMITS

1. Contractor is responsible for obtaining all permits incident to the work. This includes, but not limited to: wire-crossing permits in connection with the work for the crossing of railroads, roads, highways, and rivers, any permits from local and state authorities for work activities such as setting guard poles, the setup of construction equipment in road right of way or curb and sidewalk crossings, including traffic control. The Contractor is also responsible for obtaining any road permits necessary for moving any equipment or material due to weight or length. The fees associated with these permits are to be paid by the Contractor.

2. The cost of any railroad flagging and coordination will be paid and coordinated by the Contractor.

3. Contractor shall comply with provisions of the permit(s) to minimize interference with the operation or maintenance of traffic or service of any railroad, highway, power, telegraph, or telephone line.

1.3. UNDERGROUND OBSTRUCTIONS

1. Contractor shall call the facility locating service, and local utilities not subscribing to such services, before doing any excavation work.

2. Protect underground facilities encountered during work until it is determined whether they are active or inactive.

3. Repair, without compensation, damage to known active facilities. Repairs shall be made by facility owner or by their direction.

1.4. TEMPORARY GROUNDS

1. Contractor shall keep a record of all temporary grounds and their final removal. A copy of this list shall be supplied to Owner. A “grounding log” form to be used is attached with this specification.

1.5. MATERIAL

1. Contractor shall provide all materials.
2. Materials required, as a permanent part of the completed electric transmission line shall not be substituted without the approval of Owner.

3. Materials, furnished by Contractor and not specifically described, required to complete the electric transmission line, shall be approved by Owner and not damage nor cause the electric transmission line not to conform to these Specifications.

1.6. STORAGE AND HANDLING OF MATERIALS

1. Contractor will provide secure storage facilities.

2. Contractor to:

a. Furnish all labor and equipment to load, haul, unload, handle and store materials furnished by Owner from storage facilities to the job site.

b. Be responsible for materials upon receipt at storage facilities until

acceptance of electric transmission line work, unless indicated otherwise.

c. Replace damaged material for which the Contractor is responsible for at no cost to Owner.

d. Handle and store materials in accordance with manufacturer's recommendations and in a manner that will preserve their quality and fitness.

e. Separate and package all unused materials to prepare for pickup by others.

f. Keep storage facilities neat and orderly at all times. Upon completion of the project, the storage facilities shall be left free of all material and debris.

g. Dispose of all unused materials as directed by Owner.

1.7. POST CONSTRUCTION INSPECTION

1. Owner performs routine inspections of all transmission lines. Similarly, Owner desires to inspect any newly constructed line before energizing to insure its fitness for service.
2. As far in advance as possible, prior to energizing and prior to demobilization, the Contractor shall request Owner for an inspection of new transmission line facilities.
3. A list of any defects found during the line inspection will be given to the Contractor by the Project Manager.
4. The Contractor will be expected to correct such deficiencies, within the scope of the contract, prior to energizing the newly constructed line or line segment.
5. The Contractor shall complete a line inspection form, grounding test results, anchor pull test, sag reports, and OTDR testing and review prior to scheduling energization of new transmission line.

1.8. DAMAGE AND RESTORATION

1. Contractor shall take all necessary precautions to avoid or minimize damages

to property of landowner within and outside the easement. Unless otherwise agreed upon, construction vehicle movement shall be limited to the easement area and to as narrow a strip as practicable. All construction activities shall be conducted in such a manner as to minimize rutting. If rutting does occur, Contractor shall promptly level the area by filling, grading or by using other methods to remove any ruts to the satisfaction of landowner. In urban location, this includes protecting (ramping) curbs.

2. Contractor shall be responsible for all physical damages to property of landowner within the easement and any approved access routes outside the easement that Contractor has identified in the Landowner Contact. Contractor must secure written permission for use of lands outside the easement and is responsible to restore all property to the satisfaction of the landowner. Landowner's signature shall appear on the Landowner Contact/Access Report form.

3. Contractor shall be responsible for all damages (physical damages and crop damages) to other lands of landowner utilized for the sole use and convenience of Contractor. Contractor shall obtain written permission from landowner to use such lands. Landowner's signature and date shall appear on the Landowner Contact/Access Report form.

4. Contractor shall be responsible for restoration including, but not limited to, restoring to its original condition any roadways, driveways, lawns, slopes, terraces or waterways disturbed by any construction or maintenance activities; clearing all litter, debris and removing all stones and rocks resulting from such activities; removing and properly disposing of spilled oil, hydraulic fluids or other petroleum products; repairing or replacing any drain tile lines, culverts, structures and any other improvements of landowner damaged by such construction or maintenance activities; satisfactorily repairing or replacing any fences damaged as a result of construction or maintenance operations. If it is necessary to cut or remove any fences, a temporary gate shall be installed and such gate shall be left in place if the landowner so requests.

5. All restoration work shall be completed to landowner's satisfaction and in compliance with current government statues and regulations.

6. Construction activities shall be conducted to minimize the creation of dust.

Petroleum products shall not be used for dust control.

7. If soil compaction has occurred due to construction or maintenance activities, Contractor shall undertake the appropriate measures including, but not limited to, sub-soiling, chisel plowing or deep tilling to restore the soil and sub-soil as nearly as is reasonably possible to the condition existing prior to any construction or maintenance activities.

8. Upon completion of construction or maintenance activities, Owner's designated Real Estate Representative shall be responsible to negotiate and settle any claims for crop damages within the easement and any approved access routes outside the easement and will secure a release from the landowner for all damages resulting from such activities.

1.9. CLEANUP

1. As the work progresses Contractor shall remove and dispose of all paper, cardboard, wood containers, packing materials and other debris resulting from work.

2. Burning of debris is not permitted unless authorized under local ordinance or by permit obtained by the Contractor and with the permission of Owner.

3. Final cleanup must be completed within 15 days, or a mutually agreed upon timeframe, following completion of construction.

4. Owner shall determine when construction has been completed on a property for the purpose of clean up. Contractor shall notify Owner when final cleanup has been completed on a property.

1.10. CONTROVERSIES

1. Controversies arising between property owners and the Contractor regarding the performance of the work shall be immediately referred to Owner, and such controversial work shall not be performed on that property until the discrepancies are resolved between the property owner, the Contractor, and Owner.

## 2. DRAWING AND REFERENCE INFORMATION

2.1. SUBMITTALS

1. Contractor shall submit timely and descriptive information which relates to the technical aspects of the Work set forth in the Contract. Such submittals shall be adequate to convey the arrangement, operating modes, output performance, selection of construction materials, maintainability of equipment, and all other information as required by Owner to determine Contractor's adherence to the drawings and specifications. As a minimum, the information pertaining to transmission lines in Appendix G1 Attachment 01 Exhibit 02 Engineering Documents, Drawings and Other Deliverables.
2. The Contractor is to provide the following submittals as applicable to the project. They are to be submitted to Owner by the end of the project.
    a. Ground Resistance Report
    b. Sag Report
    c. Anchor Pull Test Report
    d. Changes from IFC design shall be red-lined on IFC drawings and submitted to Owner

## 3. SITE WORK

3.1. SUMMARY

1. This section contains general site work requirements for control of dust and mud, locating and protecting underground facilities and excavation dewatering.

3.2. EXECUTION

A. DUST CONTROL

1. Use all reasonable means necessary to control dust on and near the work that is caused by the Contractor's operations during performance of the work or if resulting from the condition in which Contractor leaves the work areas.
2. Thoroughly moisten all surfaces as required to prevent dust from being a

nuisance to the public, neighbors, and concurrent performance of other work on the site. If the site is paved, sweeping or scraping may be used to control fugitive dust. Moisture used for dust control shall consist of water with no chemicals or additives unless approved by Owner's Environmental staff.

B. MUD CONTROL

1. Use all reasonable means necessary to control mud and tracking of mud both on and off the construction site. Provide stone, tracking pads or other means, and grade and fill areas as required to minimize tracking.
2. Clean up areas of tracked mud both on and off-site, i.e. driveways, streets, sidewalk, etc., by any means necessary.

C. UNDERGROUND OBSTRUCTIONS

1. Contractor shall contact the underground facility locating service and local utilities not subscribing to such services, before doing any excavation work.
2. Contractor shall protect underground facilities encountered during work until it is determined whether they are active or inactive. Repair of active facilities damaged by the Contractor shall be without compensation.

D. DEWATERING

1. Provide and maintain at all times during construction ample means and services with which to promptly remove and dispose of all water from every source entering the excavations or other parts of the work.
2. Dewater by means that will ensure dry excavations and the preservation of the final lines and grades of bottoms of excavations.
3. Dewatering activities include both active means (i.e. active pumping methods), and passive means (i.e. displacing water from an excavation by placement of concrete, soil, etc.) and shall be done in accordance with legal restrictions, permits and regulations.
4. No discharge of water from dewatering operations to waterways or wetlands will be performed without a permit. The Contractor will be required to meet all the terms and conditions of that permit. If there are any

questions or uncertainty, the Contractor shall consult with the Owner's Environmental Staff.

5. The Contractor shall dewater by means that will protect adjacent properties from flooding or property damage due to dewatering releases.

6. The Contractor will dewater by means that will protect adjacent wetlands and waterways from sedimentation.

7. It is generally preferable to discharge water to an upland location (within the right of way) and release into an area which will allow water infiltration (within a reasonable time or distance under the soil and weather conditions present at the time of the dewatering release). If existing soil contours or soil types are not conducive to support infiltration, the use of containment or settling basins constructed (within the right of way) with bales of straw and/or filtration fabrics (among other means) may be used to control the discharge of sediment laden waters.

## 4. CONDUCTORS, SHIELD WIRES, AND ACCESSORIES INSTALLATION

### 4.1. SCOPE

1. The Contractor shall be responsible for installing all conductor, shield wires and accessories shown on the drawings and specified herein, subject to other applicable Specifications and requirements of the Contract. The work to be performed and the materials and equipment to be used are defined in the Contract Documents.

2. Guard poles will be furnished by the Contractor. All other material needed for temporary protection of existing facilities shall be provided by the Contractor. Contractor shall install and remove guard poles and structures as specified herein or as the Contractor deems necessary for safe completion of the work or as may be indicated in the Contract Documents or as required to maintain safety of the public, employees and facilities as determined by the Contractor.

3. A brief description of the major work items included in this Specification is as follows:

a. Storing, hauling, sorting, etc. at the storage yards of all materials received there.

b. Installing all conductors, shield wires, including stringing and sagging, and installing all required accessories for a complete installation.

c. Installing and removing guard poles as required.

d. Protection of work until completed, including leaving all incomplete work in a safe and secure manner.

e. Installing and removing temporary anchors or deadends as may be required for temporary line terminations.

## 4.2. GENERAL STRINGING REQUIREMENTS

1. The Contractor shall plan his stringing operations to keep waste to a minimum. Lengths of wire less than 200 feet are considered to be scrap lengths and shall not be spliced into the line without Owner's approval. All scrap lengths not used in the line shall be returned with the reels to the storage yard. The Contractor shall remove all conductor from the reels and coil it or combine it on reels as directed by Owner or Owner's Representative. The Contractor shall be responsible for the loading of returnable reels for return shipment to the conductor supplier. Non-returnable reels shall be disposed of by the Contractor.

2. The wire shall be sagged in accordance with the stringing data for each wire. Stringing sag and tension data for expected conditions will be furnished by the Engineer. No minus tolerances from the sag data will be allowed and the plus tolerance shall be 5% of the stringing sag, but not to exceed 6". Tension tolerances shall be within those values for tension calculated and shown on the data sheets supplied that correspond to the respective sag tolerances for the condition of concern.

3. The Contractor shall submit to Owner for review, prior to the starting of stringing operations, the procedure to be followed in stringing, sagging, and clipping-in of the conductors. This procedure will be such that the conductors shall hang in the stringing blocks a maximum of 24 hours before being brought up to sag. Once brought to sag, it is recommended but not required to allow the conductors to hang in the stringing sheaves a minimum of 2 hours before being clipped in. From

the start of stringing, conductors should not remain in the stringing sheaves more than 72 hours before being clipped in. Cables remaining in the blocks for more than 72 hours before being clipped in shall be subject to inspection. If inspection reveals distortion of the conductor has occurred, damaged cables shall be replaced at the Owners discretion and at the Contractor's expense.

4. When stringing and sagging from angle structures, the Contractor shall develop procedures that will compensate for structure deflections. All angle poles and dead- end structures shall be plumbed straight or properly raked, as specified in the applicable structure erection specification, after all shield wires have been brought up to their proper sag-tension position and before clipping in or dead-ending the shield wires. Swing out type angle structures shall be clipped-in before at least the adjacent structures are clipped-in.

5. The Contractor shall provide a suitable means of communication, such as an adequate telephone system or radio transmitter and receivers for use by crews during stringing and sagging operations. The communication system used shall be subject to Owner’s approval.

6. The Contractor shall install sufficient guard structures, as required to maintain adequate clearance of shield wires over buildings, roads, railroads, communication and power lines, etc., and to prevent damage to the conductors being strung. At certain specific locations, special guard pole type structures must be installed as shown. At all other locations where guard structures are required, they shall be installed in a manner acceptable to Owner. The guard structures shall be in place during the entire stringing operation in the area of concern.

## 4.3. PHASE CONDUCTOR - STRINGING AND SPLICING

1. The phase conductors shall be kept clean and shall not be allowed to contact the ground, guard structures or any object which in the opinion of Owner, may cause abrasion or damage to the conductors. The Contractor shall continuously inspect the conductor as it leaves the reel. If nicks or scratches are detected, the stringing operation shall be stopped until the blemish is smoothed with fine sandpaper or emery paper. If any broken aluminum strands are found, splice rods shall be installed in accordance with the manufacturer's recommendation. If more than three broken aluminum strands are found within any 1000 feet section of cable, the cable section containing the broken strands will be cut out and a full tension

splice installed. Any damaged wire, resulting from the Contractor's negligence, shall be repaired or replaced at his expense.

2. Stringing of normal line tension conductors shall be done at a tension at least 15% less than the final design tension by the controlled tension method using neoprene- lined, double-bullwheel type tension stringing equipment. The bullwheels should be threaded with the conductor in such a manner that the stringing operation will not have a tendency to loosen the outside strands of the conductor. In order to minimize the danger of failure, the design must be such that when desired tension is obtained, the same constant tension will be held so long as the brakes are left at this setting, whether the brakes are actuated manually, pneumatically, hydraulically, or electrically. The equipment shall be so designed that there can be no conduction of heat generated by the braking action of the bullwheels. There shall be slight mechanical braking on the reels to prevent loose conductor between reels and the bullwheels. The neoprene lining shall be not less than 1/4 inch thick on bullwheels having a minimum outside diameter of 42 inches. A minimum of 4 and 1/2 turns of conductor shall be replaced around the bullwheels. The equipment shall be capable of maintaining continuous tension of not less than 7,000 pounds per conductor. Stringing under tension by braking the factory conductor reels is specifically prohibited. All stringing equipment and conductors shall be adequately grounded during the stringing operation. During stringing operations, if the conductor is unattended, it shall be freely suspended between stringing sheaves so as to provide a safe clear distance over ground or obstructions. The reel setup and tensioning equipment shall be located so as to maintain a minimum slope of 1:4 between the structure and the pulling line during the conductor stringing operation. That is, the distance from the reel setup or the tensioning equipment to the structure shall be at least four times the height of the stringing sheaves on the structure, adjusted as necessary for uneven ground conditions.

3. The method and procedures used to string low tension spans or slack spans to substation structures shall be such that the conductor is not permitted to contact the ground or any object which may cause damage or otherwise adversely affect the conductor. The method selected by the Contractor is subject to the review and approval of Owner prior to beginning installation.

4. The stringing operation shall be carried on with due regard to the safety of

personnel and shall be by use of methods that will prevent damage to the conductors and structures in any way. Overload strains, boring or drilling of temporary holes and the abrasion of any permanent structures shall be prohibited. Conductor pulls shall not be longer than two full reel lengths of conductor, without written procedure provided by the Contractor to Owner. This procedure shall include, but not be limited to, length of pull, proposed maximum pulling tension, angles included in pull length and method of sag measurement.

5. The Contractor is cautioned that most of the existing circuits being crossed by these lines will be normally energized and his stringing operations shall be performed in such a manner as to prevent damage to or cause inadvertent outages of these circuits. Wire rope of adequate strength shall be used to catch off and/or temporarily guy the
    a. conductors. Stringing blocks on each side of an energized circuit being crossed shall be grounded or proper grounding shall be provided at both ends of the stringing operation.
6. Stringing sheaves shall be made of aluminum alloy, with grooves lined with neoprene or an approved rubber compound. The lining material shall be electrically conducting, rather than insulating, to facilitate grounding the conductor being strung. The stringing sheaves shall be provided by the Contractor and approved by Owner.
7. The stringing sheaves shall have a minimum "bottom of groove" diameter of 15 times the conductor diameter being strung. The depth of the groove shall be at least 25 percent greater than the conductor diameter, the radius at the base of the groove shall be a minimum of 10 percent and a maximum of 25 percent greater than the radius of the conductor, and the sides of the groove shall flare at least 15 degrees from the vertical. The bearings of the stringing blocks shall preferably be ball or roller bearing type with adequate provision for lubrication. These must be well lubricated at all times to assure that they will be free-running. If the total conductor angle at the stringing sheave is greater than 40 degrees, in the horizontal or vertical planes, two sheaves in tandem shall be used.
8. The hangers used with the stringing sheaves and/or sagging blocks shall be of such length that the conductor in the sheaves is held at a uniform distance, not exceeding two feet, above or below the position it will have when finally placed in

the suspension clamp or compression deadend fittings.

9. No splices will be permitted in spans over main lines of railroads, highways, or over major power or communication lines. In other spans, only one splice per span will be permitted on each wire, and this splice shall not be located closer than 50 feet to any structure. Splices shall not be pulled through stringing sheaves or sagging blocks.

10. Conductor splices and deadends shall be made with the conductor laid out in a straight line for approximately 25 feet on each side of the joint. The ends of the conductor shall be cut back as required and thoroughly cleaned with wire brushes to obtain clean and bright surfaces.

11. Joints and splices shall be made with an acceptable jointing compressor using manufacturer's recommended dies for steel and aluminum joints. The procedure to be followed in making conductor compression joints shall be per vendor recommendations and procedures. All splices shall be made in the presence of, and witnessed by, the Owner or Owner’s Representative. No splices will be permitted in conductor jumpers. Compression splices shall not be pulled through stringing blocks, other than Implodes, if approved by Owner. Compression splices when completed, shall be straight and without any “banana shaped" curvature. Non-straight splices shall be straightened by a procedure and in a manner acceptable to Owner.

## 4.4. SHIELD WIRE STRINGING AND SPLICING

1. The overhead shield wires shall be strung in a manner that will not cause damage to the phase conductors. Stringing at a normal line tensions or less, the shield wires shall be installed by the controlled tension method.

2. Requirements and restrictions of the section above, that are applicable to the stringing of low voltage conductors, including limitations on the number and location of splices, shall be followed by the Contractor.

3. The shield wires shall be continuously inspected during the stringing operation and any cuts, kinks, or other damage shall be called to the attention of Owner. Splice rods shall be installed over damaged wires or the damaged section cut out and a full tension splice installed at the direction of Owner. Any damaged wire resulting from the Contractor's negligence shall be repaired or replaced at

his expense.

4. Shield wire splices shall be made with compression joints and the manufacturer's recommendations shall be followed throughout. Bolted strain clamps shall be used for terminating the shield wires. Jumper splices shall be made with jumper sleeves or other compression connectors as shown on the drawings and at the locations indicated.

## 4.5. PHASE CONDUCTOR AND SHIELD WIRE SAGGING

1. Sags shall be measured using a transit furnished by the Contractor and modified as necessary to be suitable for being supported on a pole and/or tower structure. The Contractor shall also provide clearly legible targets. Sag may be measured using a transit and calculated angles from the ground at the center of a structure location, or from a downhill location on long spans, without the use of targets, providing the point of tangency of the line of sight from the transit falls in the middle third of the span.
2. All such transit sags shall be submitted to Owner for review of the span chosen and the calculations performed. For sagging up to and including five spans, the transit shall be set up in a span equal to or longer than ruling span, near the end away from where the conductor was pulled. For longer pulls, the sagging shall be done in at least three spans, with the first transit set up in a span equal to or longer than the ruling span, about one-third of distance from the pulling end, and the next two set up in comparable spans especially divided to the pulling point. Sagging operations shall not be carried on when, in the opinion of Owner, wind conditions would prevent obtaining satisfactory results. Sags and/or tensions are subject to verification by Owner.
3. To ascertain the proper temperature to be used during sagging, the Contractor shall provide suitable thermometers. The thermometers shall be inserted in a basket made from the conductor with a sufficient number of center strands removed to allow insertion of the thermometer. The basket and thermometer shall be hung from the structure in a horizontal position near the sagger for at least one hour before sagging is started, so that accurate readings may be made during the sagging operation and any temperature changes or correction for creep that are required that would affect the sag shall be compensated for.

## 4.6. DAMPERS AND SPACERS

1. Vibration dampers and spacers for bundled conductors shall be installed at the locations shown on the drawings and/or as specified elsewhere. Types and catalog numbers of the dampers and spacers to be used in the various locations are also to be as shown on the drawings. The dampers and spacer shall be installed in strict accordance with the manufacturer's recommendation. Dampers and spacers shall be installed within five working days after completion of sagging.

## 4.7. JUMPERS

1. Conductor jumpers shall be installed in a neat and workmanlike manner. They shall be of the proper length so that a smooth loop, clearing the structure by the required minimum, shall be formed. Due consideration must be taken into account of the jumpers being "blown-in" sideways, if not restrained, to the angles shown on the structure drawings, and the above clearances must be maintained under such conditions.

2. Where insulator strings or post insulators are used to support the line conductor jumpers, the jumpers shall be carefully formed so that the conductor lies slightly below the horizontal adjacent to the weighted suspension clamp.

3. When completed, jumpers shall present a smooth, uniformly curved appearance without sharp bends, kinks, or "cork screws".

4. The shield wires shall be cut at deadends with sufficient wire provided to connect ends together with jumper sleeves and to form jumpers to adequately clear the structure as shown on the drawings.

## 4.8. SUBSTATION TERMINATIONS

1. The deadend terminations of conductor and shield wire shall be performed by the Contractor. Adequate length jumpers as shown on the drawings shall be measured and cut by the Contractor as indicated. The ends of the jumpers so cut shall be adequately bonded to the substation take-off structure.

## 4.9. HARDWARE AND ACCESSORIES SPECIFICATION COMPLIANCE

1. For strain clamp, conductor terminal pads or other conductor and shield wire

accessories not specified in the preceding articles of this Specification, the Contractor must comply with the appropriate articles.

## 5. GROUNDING

### 5.1. SCOPE

1. The Contractor shall be responsible for installing the grounding system(s) as shown on the drawings and specified herein, subject to other applicable Specifications and requirements of the Contractor.
2. A brief description of the major work items included in this Specification are as follows:
    a. Sorting and hauling all material required to the point of installation.
    b. Complete installation of the required grounding facilities of the types shown on the drawings and for the various structures of the line.
    c. Protection of the work until completion, including leaving all incomplete work in a safe and secure manner.
    d. Completing all grounding work to the satisfaction of Owner.

### 5.2. STEEL STRUCTURE GROUNDING

1. Summary:
    a. This section includes the furnishing and installation of permanent grounding for structures, fences, gates and buildings. Contractor shall furnish all material for work specified in this Section.
2. Submittals:
    a. Submit completed Grounding Report.
    b. Compliance Submittals:
        i. Including, but not limited to, the manufacturer's catalog entries and information for the following:
            1. Ground wires.
            2. Ground rods.

3. Ground rod clamps.
4. Parallel compression connectors.
5. Ground wire splices.
6. OPGW jumper wire.
7. OPGW jumper clamp.
8. OPGW clamp.
9. Steel structure ground clamp.
10. Guy strand clamp round rod couplings.

c. Test Reports:

i. Grounding tests.
ii. Megger calibration reports.

3. Products:

a. Contractor shall furnish all material for work specified in this Section.

b. Grounding assemblies shall be as indicated or approved equal.

4. Steel Structures:

a. All steel structures shall be grounded as indicated in drawings. Owner shall be notified if rock is encountered which prevents driving ground rods to full required depth. Alternative grounding methods are to be used if standard grounding does not accomplish less than or equal to 5 Ohms resistance.

5. Resistance Tests and Additional Ground Rods:

a. Contractor, in the presence of Owner, shall measure the resistance of all structure grounds by the three-point fall of potential method with a minimum of three measurements being taken at different distances from the current probe. All meggers shall be calibrated within the last three months.

b. The ground resistance test shall be completed prior to the installation of the shield wire.

c. Grounds shall be measured when ground is dry and no less than 24 hours after measurable precipitation has occurred at the measuring site.

d. Maximum resistance shall be no greater than 5 Ohms when all grounds have been installed and connected by temporary jumpers so that the grounds may be tested as a system.

e. Additional ground rods shall be installed at each structure as indicated until either a structure ground resistance not greater than 5 Ohms is achieved or a total of four

i. ground rods per steel structure have been installed or an alternate grounding system has been installed as directed by the Engineer and Owner.

f. If resistance of ground system does not fall below 5 Ohms, even after the maximum of four grounds installed, Engineer may require alternate grounding assemblies.

6. Antennas:

a. Antennas shall be relocated or modified as directed by the Owner.

7. Work Outside Of Transmission Line Right-Of-Way:

a. The Contractor shall not install any grounds on fences, gates, buildings, windmills, and other objects outside of the transmission line right-of-way without specific written permission from the Owner.

## 6. INSULATORS

### 6.1. SCOPE

1. The Contractor shall be responsible for installing all insulators, hardware, and accessories as shown on the drawings and specified herein, subject to other applicable Specifications and requirements of the Contract.

2. A brief description of the major items of work included in this Specification is as follows:

a. Storing, sorting, hauling, etc. at the storage yards and to the point of installation of all materials received and utilized for the work.

b. Installing the insulators, hardware, and accessories as indicated on the

Drawings and by this Specification to produce a complete installation acceptable to Owner.

c. Protection of the work until completed, including leaving all incomplete work in a safe and secure manner.

d. Insulators shall be plumbed on the raised/moved towers/structures and on adjacent towers.

## 6.2. INSULATORS, GENERAL

1. The number of insulators to be used in each assembly and the details of the various assemblies are to be as shown in the drawings.

2. The Contractor shall take every precaution to ensure that insulators of different M&E strengths are not mixed in any assembly and that each insulator assembly is composed of the proper strength units.

3. Cracked or chipped insulators or insulators with defective ball or socket or with loose cement shall not be used. Insulators found in this condition shall be collected in a separate group in the storage yard and are to be disposed of as specified by Owner.

4. The Contractor shall exercise care at all times in the handling of individual insulators and insulator assemblies to prevent damage and breakage. Insulators that were found defective when received will be replaced by Owner. Insulators that are stolen or are damaged through the neglect or by the carelessness of the Contractor, as determined by Owner shall be provided by Owner but at the expense of the Contractor for both the insulators and any costs associated with their replacement. Any insulators provided by Owner that are in excess of those required for the line installation are to be returned to the storage yard and stacked as directed by Owner.

## 6.3. HARDWARE AND ACCESSORIES, GENERAL

1. Details of the hardware assemblies and items to be used are to be as shown on the drawings. The Contractor shall use every precaution to ensure that all components of the assemblies are of the proper strength and are in accordance with the drawings.

2. Any hardware items found in a defective condition shall not be used but shall be returned to the storage yard as soon as discovered. Items that were defective when received will be replaced by Owner. Items that are stolen or are damaged through the neglect or by the carelessness of the Contractor, as determined by Owner, shall be provided by Owner but at the expense of the Contractor for both the items and any
3. costs associated with their replacement. Any items provided by Owner that are in excess of those required for the line installation are to be returned to the storage yard and stacked as directed by Owner.

6.4. INSTALLING INSULATORS, HARDWARE AND ACCESSORIES

1. Suspension insulators shall be wiped clean before installation. When raising insulator strings, slings shall be installed in a manner that will not bend the insulator cotter pins.
2. Polymer post insulators shall be wiped clean before installation. The insulator shall be free of defects and the metal portions free of dirt.
3. Hardware shall be handled in such a manner as to prevent contact with the ground. All hardware items shall be clean when installed.
4. Horizontal bolts or pins shall have the nut and/or cotter on the tower or pole side of the connection. In the case of horizontal conductor configurations for single circuit lines, horizontal bolts or pins of center phase connections shall have the nut and/or cotter consistently on one side or the other of the connections. Vertical bolts or pins shall have the nut and/or cotter on the underside of the connections.
5. Ball and socket hardware connections in a horizontal or semi-horizontal plane, as in deadend or Vee-string configurations, shall have the cotter pins installed with the eyes on top so that the spread portions may be viewed from the ground. Ball and socket hardware connections in a vertical plan shall have the eyes of the cotter pins on the tower side with the long axis of the pins perpendicular to the conductor.
6. Hump-back cotter keys when used in bolt, nut, and cotter key arrangements must not be spread. Straight cotters shall have the ends spread and turned back to an opening of 180°. Hump-back cotter pins in the suspension insulators must not be spread. All cotter keys must be fully inserted before the installation is considered

complete.

7. Heat treated “U” bolts of suspension and deadend clamps shall be properly seated and nuts uniformly tightened, as indicated on an approved calibrated torque wrench, to the following torque limits in accordance with the manufacturer's recommendations:

| “U” Bolt Size (In.) | Min. (Ft.-Lbs.) | Max. (Ft.-Lbs.) |
|---|---|---|
| 1/2 | 45 | 50 |
| 9/16 | 65 | 70 |
| 5/8 | 80 | 85 |
| 3/4 | 95 | 100 |

   - After the initial tightening of dead-end clamps, the “U” bolts shall be further seated by firmly driving them down with a hammer. The nuts shall then be fully re-tightened to the proper torque.

8. All other bolted fittings shall be installed with bolts properly seated, and nuts securely and uniformly tightened.

9. Bolted electrical contact surfaces of jumper terminals, parallel groove clamps, terminal lugs, tee connectors, etc., shall be cleaned, coated with Alcoa No.2 Electrical Joint Compound or equivalent, abraded through the grease with emery cloth or wire brush, and then bolted together with the grease in place. The Alcoa No.2 Electrical Joint Compound or equivalent will be furnished by the Contractor. All bolted electrical connections shall be torqued in accordance with the manufacturer's recommendations.

10. Line guards and dampers shall be installed on conductors and shield wires where shown on the Drawings or called for in the Contract Documents. Each type, where used, shall be installed in accordance with the recommendations of the Manufacturer. Structures shall be plumb or properly raked before clipping-in conductors. Armor rods and line guards shall be centered in the suspension clamp or grip unit within a two (2) inches maximum tolerance. The ends of the individual

rods shall not vary by more than three quarters (3/4) inch after installation. Care shall be taken to prevent damage to protective units by pliers, channel locks, or other tools.

## 7. RIGHT OF WAY USE, MAINTENANCE, AND RESTORATION

### 7.1. SCOPE

1. All anchor and guys shall be within the right of way. Use of the right of way to perform work on the transmission line is generally available to the Contractor(s) as assigned by the Owner within the provisions of this Specification and the Contract Documents.
2. A brief description of the major items included in this Specification is as follows:
    a. The proper use and maintenance of the right of way by the Contractor during the construction period.
    b. The restoration of the right or way following construction activities.

### 7.2. GENERAL RIGHT OF WAY USE AND RESTRICTIONS

1. The Contractor shall not enter upon any tract of land until it is released for construction by Owner in writing. The property owner(s) or land occupants and the Owner's project manager or Owner's Representative shall be notified by the Contractor before entry for construction is made.
2. The Contractor shall confine the construction activities to be within the limits of the right of way and on those access roads outside the right of way designated for Contractor's use by the Owner. Should the Contractor desire to make other access or use of any property outside the right of way, Contractor shall make such arrangements with the private property owners. Any damages caused by the Contractor outside the areas designated for Contractor's use by the Owner in the Contract Documents shall be fully Contractor's responsibility.
3. Use of the right of way by the Contractor shall be restricted on the basis of the following:
    a. General Right of Way Use

i. The Contractor will be permitted to perform normal construction activities within the limits of the right of way for completion of line construction. The Contractor shall follow a policy of keeping land disturbing activities to a minimum, consistent with good construction practice and long term environmental considerations. The Contractor shall perform all construction activities in the General Right of Way areas within the requirements of this Specification and the Contract Documents. Within the General Right of Way use areas, the Contractor shall restrict travel and equipment to the designated path in the Owner's right of way, and work shall be performed within the designated locations and not to exceed the right of way limits. Additional areas that may be required for specific construction activities, such as wire stringing setups, will be permitted with the approval of the Owner or Owner's Representative. The Contractor shall refrain from entering any restricted areas such as forest buffers or wetlands.

b. The Contractor shall take care to preserve all survey stakes and other markings of the Owner. If any stakes or marks are destroyed or disturbed by the Contractor as determined by the Owner, such stakes or marks will be replaced by the Owner, if they are still required as determined by the Owner, and at the expense of the Contractor.

c. There shall be no sporting activities such as hunting or fishing by the Contractor or Contractor's personnel on the right of way or any other lands leased or owned by the Owner.

d. The Contractor shall take necessary precautions to prevent pollution of or damage to the right of way by spilling, leaking or the discarding of fuel, oils, lubricating fluids and other such substances. The Contractor shall, when changing oil and other lubricants in the equipment, catch all such substances in containers and dispose of properly.

e. The Contractor shall maintain all fences and gates in good condition. Gates and gaps shall be kept closed except when a vehicle or person is passing through. The Contractor shall make provision for locking gates when requested by the property owner or Owner.

f. Any unsafe conditions created by the Contractor, including holes from excavating, shall be safeguarded by the Contractor. Any damage or injury resulting from the Contractor leaving any unsafe condition shall be Contractor's responsibility.

g. The Contractor shall take necessary precautions to prevent damage to any existing utility facilities, field drain tile, buildings, or other structures, whether public or private and whether on the right of way or access roads. The Contractor shall work with the Owner and the individual property owners as required to determine the location of field drainage tiles, and where they are so indicated, the Contractor shall do all that is reasonable to prevent damage to such tiles and drainage systems. The Contractor shall be responsible for replacing, repairing, or otherwise restoring any such facilities damaged by the Contractor.

h. All tree clearing and trimming that is to be done on the right of way will be as directed by the Owner. The Contractor shall not cut or trim any additional vegetation on the right of way or access roads unless approved in writing by the Owner. All timber, logs, wood, and brush piles that have been left on the right of way are not to be disturbed or moved from their present location by the Contractor unless such items cause a hindrance to construction and the Contractor obtains the permission of the Owner for their relocation. Additionally, in certain areas, vegetation has been left or established in the right of way to provide visual screens, erosion protection or ground cover. The Contractor shall take precautions to preserve and protect such areas from damage during construction.

## 7.3. ROADS

1. The Owner assumes no responsibility for the condition or maintenance of any road or structure that may be used by the Contractor in performing the work under these Specifications, or in transferring materials, men, and equipment to and from the Site of the work. Unless noted elsewhere in the Contract Documents, roads subject to interference by the work shall be kept open. The Contractor shall provide, erect, and maintain, effective barricades on which shall be placed acceptable warning and/or detour signs at each side of any road obstructions caused by the operation of the Contractor.

2. Entrances from all public roads (state and federal highways, township roads, etc.)

used by the Contractor to the right of way or to the private ranch access roads to the transmission line right of way shall be installed, maintained, and subsequently removed by the Contractor to the acceptance of the representative of the governing body or landowner controlling such roads.

3. Recognizing the fact that private roads and trails are not designed or built for use by heavy construction equipment, construction activities are expected to result in the deterioration of such roads. The Contractor shall be required to maintain at all times all such roads that are affected by his construction activities in the same or better condition as existed prior to use for construction by the Contractor. These roads shall be back-dragged, have ditches opened, banks re-sloped, or have any other maintenance performed that is required for these roads to be useable by others.

4. The Contractor shall be responsible for installation and removal/restoration of construction access roads. These roads shall lie entirely within the right of way boundary. Generally this right of way will not exceed 150 feet in width. Removal and restoration shall be in accordance with Right of Way and Road Restoration Section.

## 7.4. GRADING, EROSION AND WATER CONTROL

1. Where grading is required on side hills or slopes for the purposes of leveling ground for work equipment, such grading shall be held to a minimum and blocking of equipment shall be employed whenever possible. Upon completion of work by the Contractor, sites cut or filled for placing work equipment or constructing foundations will be restored to the approximate original grade and compacted to prevent erosion. At some locations, and at the discretion of the Owner, it may be desirable to restore the right of way to a different and improved grading arrangement from the original grades.

2. The Contractor shall not cause by his or her construction activities any impoundments of standing water and shall maintain existing water flow in all drainage ditches within the right of way and access roads. Damage caused by impoundment of water shall be solely the responsibility of the Contractor.

3. It is the desire of the Owner that erosion of slopes and siltation of water courses both on and off the right of way be kept to a minimum. Slopes of fill areas shall

conform to a 4:1 slope ratio. Drainage channels maintaining flow from fill, Cut or other disturbed areas shall have sedimentation controls consisting of fabric or straw bale dikes. Care shall be taken by the Contractor that his construction activities do not cause unnecessary erosion of stream banks, steep slopes and hillsides, and deterioration of water courses.

4. During construction activities, the Contractor shall not grade top soil from the right of way for use as a backfill or for other reasons. Where a significant amount of grading is required, and it is determined necessary by the Owner, the Contractor shall grade and store topsoil for future replacement on the right of way. Upon completion of the construction activities in the areas of concern, this topsoil shall be spread out over the area as directed by the Owner's Representative.

7.5. CLEANUP OF RIGHT OF WAY

1. The Contractor shall not bury, discard, or leave upon completion of construction any materials, equipment, packaging containers, rubbish, dunnage, or other items within the limits of the right of way or other property controlled, owned, or operated by the Owner without the written approval of the Owner.

2. Burning of construction debris is not permitted.

3. The Contractor shall clean up daily all rubbish and debris made by Contractor’s personnel, and keep the construction Site and right of way clean. All trash shall be disposed of by the Contractor. The Owner reserves the right to order this cleaning done by outside personnel, should the Contractor not comply with this requirement, the cost thereof being charged to the Contractor.

7.6. RIGHT OF WAY AND ROAD RESTORATION

1. Within 30 days following Contractor’s construction activities, and as conditions permit, the Contractor shall have completed all the restoration of all right of way, roads and public and private property to the satisfaction of the Owner and in accordance with the requirements of this Article. Any extensions in time or alternations in restoration different from this Article will be permitted only with the written approval of the Owner. Once an access road and/or area of right of way has been restored to the satisfaction of the Owner and has been

accepted by the Owner as complete, the Contractor shall not again take any construction equipment on such a road or area without the permission of the Owner. Any such areas further damaged by the Contractor shall again be restored by the Contractor.

2. Restoration of any roads used by the Contractor shall be carried out as follows:

    a. Private roads, lanes, driveways, and trails shall be restored to a condition as good as, or better than, they were found by the Contractor at the beginning of construction. Any ruts, holes, broken blacktop or concrete, or other locations where gravel or dirt has been altered that results in an unsatisfactory condition, as determined by the Landowner, shall be reworked and repaired by the Contractor.

        i. Any ditches or other facilities along such roads damaged by the Contractor shall be repaired.

    b. Temporary access roads used by the Contractor shall be left by the Contractor without ruts or other land defacement. Such roads shall be back-dragged and have any banks or ditches that were created along them appropriately dressed up.

    c. Construction roads within the right of way shall be left by the Contractor without ruts or other land defacement and restored to the same as original landscape. Particular care shall be taken by the Contractor to dress up and smooth out areas around streams and drainage ditches to minimize future erosion problems.

3. The right of way and other lands used by the Contractor shall be restored by the Contractor, dependent upon the type of terrain or concern, in accordance with the provisions of this Article. Seeding shall be carried out on all restored roads within the right of way. The land is to be generally returned to its original use prior to construction unless designated to be restored in some other fashion by the Owner.

4. At the completion of these construction activities and as part of the right of way restoration, the Contractor shall permanently close all gates and gaps made during the construction and/or original right of way clearing operations. Fence gates, shall be replaced, unless the Contractor is directed to leave a gate in

place by the Owner, with a permanent fence section of equal or better quality of construction than the existing fence where the section is to be installed. Such replacements shall include installing new posts as necessary, stringing and tensioning fence materials of the same or better types than originally existed, and splicing or otherwise permanently securing all fence wires. Where the original fence material at a gap is of adequate quality to be re-used, as determined by the Owner, it may be tension spliced together to form the completed permanent fence. Electrical fences shall be permanently spliced or may have insulating openings left in place as directed by the Owner. Any fence that is relocated from its original position for facilitating construction activities, by the Contractor, shall be replaced by the Contractor in the original fence location.

### 7.7. DAMAGES TO PROPERTY AND CROPS

1. All crop or other damages resulting from the Contractor's operation outside the designated path, areas near structures or those additional areas approved by Owner, all as described in General Right of Way Use shall be the responsibility of the Contractor. Additionally, crop or other damages resulting from the Contractor's operations outside the designated path for access roads, shall be the responsibility of the Contractor. Restoration, as necessary, of such areas, unless agreed to otherwise by the Owner, shall be performed without additional cost to the Owner.

### 7.8. SPECIAL RIGHT OF WAY/CONSTRUCTION RESTRICTIONS

1. During the securing of the right of way for the transmission line in particular, and at all times in general, it is the policy of Owner to maintain as friendly a relationship as possible with the property owners whose lands the transmission facilities cross. The Contractor shall perform his or her work and carry out any dealings the Contractor may have with the individual property owners so as to likewise maintain a good and friendly relationship with the property owners.

## 8. STEEL STRUCTURE INSTALLATION

### 8.1. STEEL STRUCTURES

A. Summary:

1. This section includes all work necessary to receive, assemble and erect tubular steel structures for the Owner as indicated and specified.

B. Delivery, Storage and Handling:

1. Bundling by Piece:
   a. All like pieces for the same structure types shall be bundled and shipped together.
   b. Members for two separate structure types shall not be packaged into the same bundles.
   c. Small parts, for example, clip angles and U-bolts shall be packed in containers, according to part, size, and structure type. Several individual containers for more than one structure type may be packed into a larger one.
   d. Bolts shall be shipped in bulk sorted by diameter and length.
   e. Nuts and washers shall be shipped in bulk sorted by diameter.
2. Bundling by Structure:
   a. As an alternative and in conjunction with bundling by piece, some structures may be bundled by structure.
   b. All the pieces necessary to erect one complete structure shall be bundled and shipped together.
   c. Members for two separate structures shall not be packaged into the same bundles.
   d. Small parts, for example, clip angles and U-bolts shall be packed in containers, according to part, size, and structure. Several individual containers for one structure may be packed into a larger one.
   e. Bolts shall be shipped in bulk sorted by diameter and length.
   f. Nuts and washers shall be shipped in bulk sorted by diameter.
3. Bundling straps or bands, or their equivalent, and related items as well as containers and crating shall be of sufficient strength to contain and protect the contents under normal export shipping, handling, and storage yard conditions. The banding material shall be galvanized or aluminized steel or other equivalent material which will not rust or otherwise deteriorate during shipping

and storage. The containers shall be constructed in a manner which will prevent pilferage of contents from the unopened container.

4. Vehicles in which steel is shipped or stored shall be clean and free from foreign materials which could in any way injure the steel or the structure coating.

5. Contractor will be responsible for off loading poles and steel members before mobilizing for construction. Poles and tower steel members will be delivered up to 1 month before construction is scheduled to start. This should be included in the structure installation bid units. Exact schedule for pole and tower steel members deliveries will be provided once Contractor is awarded.

C. Products:

1. Owner will furnish all structure components for assembly and erection of the tubular steel structures.

2. Spare Materials:

   a. The structures will be supplied with 5% more fastening hardware than required to assemble and erect the structures.

3. Upon completion of the work, Contractor shall replace any damaged, lost and spare materials used. Replacement material shall be equal to the material supplied by Owner.

D. Receiving and Storage of Materials:

1. Care shall be taken not to damage the steel structures or members during unloading and handling.

2. Structures and members shall be sorted and supported on wooden blocks or other method approved by Owner, prior to erection. At no time shall the structures or members be laid directly on the ground.

3. Parts bent, twisted or damaged by the Contractor during his or her operations shall not be installed, but shall be reported immediately to Owner. Such damaged members shall be replaced with identical members, or repaired, at the direction of Owner at the Contractor's expense.

E. Methods of Erection:

1. The proposed structure design will permit the use of the following erection methods:
   a. Bucket Truck
   b. Crane Erection

F. Assembly and Erection:

1. Structures shall be erected at the locations indicated by center line hub in the field.

2. Contractor will be responsible for staking all structures leg locations and slope angles. A centerline hub staked by survey contractor with offsets will be provided. Engineer will provide centerline hub coordinates in either Latitude/Longitude or State Plane Coordinates. Surveying for leg locations and slope angles should be included in the steel pole and lattice tower installation units.

3. Structures shall be assembled and erected in compliance with the manufacturer's instructions.

4. Slip joints shall be assembled as follows:
   a. Thoroughly clean members at the joint.
   b. Align match marks.
   c. Jack sections together maintaining proper alignment.
   d. Sections shall not be forced into place.
   e. Tie the slip-jointed sections together so that the sections will not separate during erection. Remove ties after erection.
   f. No welding shall be allowed in the assembly without approval by Owner.

5. The structure shall be erected using only the lifting points specified by the structure manufacturer.

6. Structures shall be assembled such that when erected the arms will be perpendicular to the centerline of the transmission line on tangent structures, and on the bisector on angle structures. Tolerances on arms shall be within **+/- 6”** referenced to the centerline.

7. The installed and unloaded structures shall be plumb to within 6” of vertical for

non-cambered and non-raked poles measured when there is no temperature gradient in the pole. Cambered or raked poles shall be plumb to within 6” of the amount of camber or rake indicated by the manufacturer's drawings.

8. All bolts and nuts shall be torqued and paint marked to manufacturer's recommendations.

9. Arms shall be secured after erection until stringing in accordance with the manufacturer's recommendations.

10. The top anchor-bolt nuts on the tubular steel poles shall be tack welded to the base plates after the pole is erected, plumbed, and all wire strung and clipped in and the anchor-bolt nuts torqued.

11. The structures will be furnished with climbing devices where specified.

G. Coating Repair:

1. Embedded Structures:

a. Repair damage to the embedded section with CorroCote “S” or approved equal, per manufacturer's recommendations.

8.2. SURVEYING AND STAKING

1. An Owner approved surveyor, will only stake a centerline hub of the new pole and tower locations.

2. Contractor shall be responsible for survey and staking the footing layout and stub angle locations of poles.

3. Refer to Table 3 for staking coordinates.

## 9. CONCRETE

9.1. CONCRETE AND REINFORCEMENT

A. Summary:

1. This Section covers furnishing of materials and installation of concrete and reinforcing steel for structure foundations.
2. Related Work Specified Elsewhere:
   a. Concrete Formwork: Paragraph 9.2.

b. Drilled Shaft Foundations: Paragraph 9.3.
c. Direct Embedded Foundations: Paragraph 9.5.

B. Submittals:

1. Compliance Submittals:
   a. Including, but not limited to, the following:
      1) Reinforcing steel bar schedule, details and erection drawings.
      2) Grouts and curing agents.
2. Miscellaneous Submittals:
   a. Including, but not limited to, the following:
      1) Concrete mix design data for concrete batches from which test specimens have been obtained with a minimum of the following information:
         (i) Slump.
         (ii) Maximum aggregate size.
         (iii) Aggregate analysis.
            (a) Fine aggregate - sieve analysis, fineness modulus, deleterious substances, reactivity, and soundness.
            (b) Coarse aggregate - sieve analysis, deleterious substances, reactivity, and soundness.
         (iv) Air content.
         (v) Admixture content.
         (vi) Water-cement ratio.
         (vii) Cement content.
         (viii) Aggregate moisture - free and absorbed moisture contents.
      2) Certification on materials:
         (i) Cement tests.
         (ii) Aggregate tests.
         (iii) Reinforcing steel mill tests.
      3) Concrete cylinder test reports with a minimum of the following information:
         (i) Project name.
         (ii) Owner's project number.
         (iii) Engineer's project number.
         (iv) Structure number
         (v) Portion of foundation.
         (vi) Dimensions of test cylinder.
         (vii) Cylinder identification.
         (viii) Date cast.
         (ix) Date to be tested.
         (x) Slump.
         (xi) Entrained air content.
         (xii) Supplier.
         (xiii) Truck number.
         (xiv) Ticket number.
         (xv) Dispensing time.
         (xvi) Sampling time.

(xvii) Ambient temperature at time of placement.
(xviii) Concrete temperature at time of placement.
(xix) Amount of water added at site.

4) Laboratory test reports of material for use in concrete.

C. Reinforcing Steel:

1. All main bars shall be deformed bars and conform to ASTM A615, ASTM A616, ASTM A617, or ASTM A706, Grade 60.
2. All ties shall be deformed bars and conform to ASTM A615, ASTM A616, ASTM A617, or ASTM A706, Grade 60. Spiral lateral reinforcement providing the equivalent steel area of the specified size and spacing of the ties to comply with the design may be substituted in drilled piers.
3. Bolsters, chairs and accessories shall conform to ACI 315.

D. Concrete:

1. Materials:
   a. Portland Cement Type (I) and shall conform to ASTM C150.
   b. Fine Aggregate:
      1) Conform to ASTM C33.
      2) Maintain fine aggregate free of ice and frozen lumps.
      3) Grading Requirements:
         (i) From No. 10 to No. 4 for all concrete unless otherwise specified.
   c. Coarse Aggregate:
      1) Conform to ASTM C33.
      2) Blast furnace slag will not be permitted.
      3) Maintain coarse aggregate free of ice and frozen lumps.
      4) Grading Requirements:
         (i) From No. 4 to 3/4” for all concrete unless otherwise specified.
   d. Mixing Water:
      1) Only potable water will be acceptable without testing.
      2) Non-potable water may be used if it produces concrete with at least 95% of the strength of similar specimens of the same mix design made with potable water, subject to Engineer's approval of qualitative analysis. Expense of testing water shall be paid by Contractor.
   e. Admixtures:
      1) Water Reducing Type:
         (i) Conform to ASTM C494, Type A.
         (ii) Conform to manufacturer's recommendations for use.
         (iii) Technical assistance of the manufacturer's field representative shall be furnished upon request.
      2) Air-Entraining Type:
         (i) Conform to ASTM C260.
         (ii) Conform to manufacturer's recommendations for use.
         (iii) Technical assistance of the manufacturer's field representative shall be furnished upon request.

(iv) Testing of air-entraining admixtures shall conform to ASTM C233.

3) Other Admixtures: Used only with Engineer's written concurrence.

(i) Water Reducing, High Range Type: Conform to ASTM C494, Type F or Type G and shall not contain any chloride ions.

2. Laboratory Testing of Materials for Use in Concrete:

a. An approved independent testing laboratory shall be selected and paid by Contractor to perform all required laboratory tests of materials proposed for use in the production of concrete and to determine mix proportions when laboratory trial batches are required.

b. The laboratory shall report the results of the testing and mix designs.

c. Contractor shall deliver representative samples of all proposed concrete materials to the laboratory for the following testing:

1) Fine Aggregate:

(i) ASTM C33.

2) Coarse Aggregate:

(i) ASTM C33.

3) Mixing water, if other than potable water is proposed for use and in the opinion of Engineer there is reason to suspect its acceptability:

(i) With the design mix the laboratory shall make two concrete test cylinders using proposed water and two concrete test cylinders using potable water conforming to ASTM C192.

(ii) All cylinders shall be tested conforming to ASTM C39. Age of cylinders at test shall be twenty-eight (28) days unless an earlier age is authorized by the Engineer.

4) Air-entraining admixture shall be tested conforming to ASTM C233.

3. Concrete Qualities Required:

a. Compressive Strength:

1) Minimum twenty-eight (28) day strength = 4000 psi for all construction unless otherwise indicated.

b. Slump:

1) 5” ± 1” for drilled shafts constructed dry, without casing.
2) 7” ± 1” for drilled shafts constructed with casing.
3) 8” ± 1” for drilled shafts constructed with slurry or under water.
4) 4” ± 1” for all other concrete.

c. Air Content: 5 to 7%.

4. Mix Proportions:

a. Concrete shall be homogeneous, readily placeable and uniformly workable; proportioned to conform to ACI 211.1.

b. Mix proportions for all concrete unless otherwise specified shall be selected preferably on the basis of field experience; but in the case where sufficient or suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design or water-cement ratio.

1) Field experience using test results within the last ninty (90) days with the materials and plant to be employed may be the basis of mix proportioning

provided that not less than 30 consecutive satisfactory compressive strength tests on concrete using the proposed materials with a similar mix are available. A compressive strength test is defined as the average twenty-eight (28) day compressive strength of two companion cylinders made conforming to ASTM C172 and ASTM C31 and tested conforming to ASTM C39. The standard deviation of such tests shall be computed

as a basis for design of the mix. The design average strength shall exceed the specified strength in accordance with the following formulae:

(i) When standard deviation is less than 500 psi, Design Average Strength = Specified Minimum Strength + 1.343 x Standard Deviation.

(ii) When standard deviation is greater than 500 psi, Design Average Strength = Specified Minimum Strength -500 + 2.326 x Standard Deviation.

(iii) Submit previous test data, calculated standard deviation, and the proposed mix proportions to Engineer for approval prior to placing concrete.

2) When laboratory trial batches are used as a basis for determining mix proportions, all such work shall be performed by the laboratory as specified in 10.1.E.2 “Laboratory Testing of Materials for Use in Concrete.”

(i) Laboratory trial batches shall be used to establish a water-cement ratio compression strength curve with at least three points, each representing the strength of a separate trial batch. At least one point shall be above and one below the strength required. Each point on the curve shall represent the average of at least three specimens tested at twenty-eight (28) days or an earlier age when approved by Engineer. The slump and air content shall be at the maximum limits specified in 10.1.E.3 “Concrete Qualities Required.”

(ii) A point on the water-cement ratio compressive strength curve shall be selected that will provide an average strength at least 1200 psi greater than the specified minimum strength.

(iii) Laboratory reports establishing mix proportions shall be sent to Engineer, and his approval obtained prior to placing all concrete.

3) When water-cement ratio is used as a basis for determining mix proportions, the maximum permissible water-cement ratio by weight is 0.35.

c. Mix Proportions for Concrete for Underwater Placing (Special Requirements) (and for Placing in Drilled Shafts Requiring Casing or Bentonite Slurry):

1) Fine aggregate - not less than 40% natural sand.
2) Coarse aggregate - 3/4” maximum size natural gravel.
3) Cement - seven (7) sacks minimum per cubic yard.
4) Water - Minimum required for slump between 6” and 8” with water reducing agent.
5) High range water reducer - Conform to ASTM C494 Type F or G and use in accordance with manufacturer's recommendations.
6) Air entrainment - Conform to ASTM C260 and use in sufficient amount to entrain 4% air plus or minus 1%.
7) Twenty-eight (28) day compressive strength:

(i) Not less than 4000 psi when tested conforming to ASTM C31 and ASTM

C39.

(ii) Not less than 3,400 psi when tested conforming to ASTM C42.

5. Measurement of Materials:
   a. General Requirements:
      1) Conform to ACI 304.
      2) Measure materials within 1% by weight for aggregates and cement, and within 1- 1/2% by volume or weight for water.
   b. Apparatus:
      1) Beam or springless dial-type scale conforming with NBS - “Specifications for Scales.”
      2) Volumetric measurement of water shall be performed with an approved automatic valve.
6. Mixing and Delivery:
   a. Conform to ACI 304.
   b. Cement temperature when added to mix shall not exceed 170 degrees F.
   c. Batch Plant Mixer:
      1) Adequate to handle one or more full-sack batches.
      2) Charge with 5% to 10% of the mixing water both in advance and after the addition of aggregates and cement.
      3) Charge with remaining water uniformly with the other materials.
      4) Avoid charging in excess of manufacturer's rating.
      5) Discharge mixed concrete completely prior to recharging.
      6) Mixing Time:
         (i) Start immediately when all ingredients except the last of the water are in the mixer.
         (ii) Minimum mixing time shall conform with mixer manufacturer's instructions, but not be less than the following:

| Capacity of Mixer Cubic Yards | Minimum Time of Mixing. Minutes |
|---|---|
| 1 or less | 1 minute |
| 2 | 1 minute, 15 seconds |
| 3 | 1 minute, 30 seconds |
| 4 | 1 minute, 45 seconds |
| 5 | 2 minutes |
| 6 | 2 minutes, 15 seconds |

         (iii) Add 15 seconds' mixing time for each additional cubic yard of concrete.
   d. Mixing of Concrete at Plant Off Jobsite:
      1) Mix concrete in central mixer or truck mixer. Transport in truck mixer turning at agitation speeds only.

2) Water added to concrete having a slump below the specified minimum shall be at Contractor's risk. If the water added produces a slump greater than the specified maximum, the concrete will be rejected. If water is added the concrete shall be remixed for a minimum of 25 revolutions.
3) Truck mixer shall conform to “Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau,” of the National Ready-Mix Concrete Association.
4) Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.
5) Contractor shall furnish Owner with a concrete delivery ticket for each load of concrete. The ticket shall have the following information recorded:
   (i) Ticket number.
   (ii) Time batched.
   (iii) Time arrived on jobsite.
   (iv) Amount of concrete (by volume).
   (v) Mix number.
   (vi) Amount of all water added at jobsite by Contractor.
   (vii) Number of revolutions on the truck's revolution counter before batching and after placement is completed.
   (viii) Truck number.
   (ix) Truck driver's name.
   (x) Types and quantities of admixtures added to the batch.
   (xi) Slump of concrete.

E. Curing Agent:

1. Liquid membrane forming compound conforming to ASTM C309, Type 1. ASTM C309 Type 2 shall be used as specified in “Hot Weather Concreting”, this section.

F. Non Shrinking Grout:

1. Required for setting all structures utilizing base plates.
2. Conform to manufacturer's recommendation for use.
3. Technical assistance of the manufacturer's field representative shall be furnished upon request.
4. Non-shrink grout shall be one of the following:
   a. Supreme Grout, Gifford-Hill & Company, Dallas, Texas.
   b. Crystex, L and M Construction Chemicals, Inc., Omaha, Nebraska.
   c. Masterflow 713 Grout, Master Builders Company, Cleveland, Ohio.
   d. Sauerelsan F100, Sauerelsen Cement Company, Pittsburgh, Pennsylvania.
   e. Five Star Grout, US. Grout Corporation, Old Greenwich, Connecticut.
5. Exposed edges of grout shall be chamfered at 45 degrees along the exterior of the base plate.

G. Reinforcing Steel:

1. Reinforcing steel detailing shall conform to ACI 315.

2. Reinforcing steel shall be tied securely with 16-gauge or larger annealed iron wire at a minimum of 50% of the reinforcing steel intersections, or to maintain indicated spacing, maintaining the clearances to the earth indicated.
3. No welding shall be performed on reinforcing steel (except that the top and bottom rows of ties for drilled shafts may be tack welded provided ties conform to ASTM A706).
4. Bars shall be spliced only as indicated or as approved by the Engineer.
5. Reinforcing steel shall be clean of dirt, rust, mill scale, form oil or bond reducing chemicals.
6. Contractor shall supply bracing required to insure constructability of the reinforcing steel cage. Braces shall be located so they do not interfere with the placement or pumping of the concrete.

H. Form Work:

1. Adequately brace and stiffen forms to restrain the concrete without deformation or settlement. Contractor shall be responsible for structural adequacy of formwork.
2. Forms shall have a smooth interior surface and be treated with an approved oil or form- releasing agent prior to placement of reinforcing steel. Material shall not stain, cause injury to exposed concrete surfaces, or affect bonding of specified surface coatings.
3. All form work shall conform to ACI 347.

I. Placing Concrete:

1. Forms shall be wet with clear, potable water prior to concreting.
2. Excavation, where practicable, shall be dewatered before placing concrete.
3. Concrete shall remain in the forms for a minimum of 12 hours.
4. Do not place concrete that has partially hardened or has been contaminated by foreign materials.
5. Prevent mud or foreign materials from entering the concrete or forms during placement operations. Should soil, rock or other foreign material enter the excavation and contaminate the concrete, the contaminated concrete shall be removed before completing pour.
6. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.
7. Aluminum conveying equipment shall not be used.
8. Place concrete at a sufficient rate to assure that lifts below have not taken initial set before fresh concrete is deposited.
9. Place concrete within 45 minutes after mixing or before the drum has revolved 300 revolutions. This period may be extended to one (1) hour and thirty (30) minutes

provided that the combined air temperature, relative humidity and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation and that the specified mixing water is not exceeded as indicated in Figure 2.1.5 by ACI 305, in Appendix. Concrete which has partially set shall not be re-tempered but shall be discarded.

10. Concrete shall be placed with an approved drop pipe in dry excavations deeper than 25'.
11. Concrete shall be placed with an approved funneling device in dry excavations less than 25' deep.
12. Concrete shall not be allowed to freefall more than ten (10) feet.
13. Concrete placed through a slurry or under water shall be pumped with an approved concrete pump as follows:
    a. Concrete shall be placed using a rigid pipe or flexible hose. Placement shall be started with the lower end of the pipe or hose sealed with a rubber gasketed wood plug with a line attached, or similar device, lowered to the bottom with the pipes or hose dry, plug shall be displaced by the concrete and retrieved from the work. The water shall be displaced as the concrete is placed and the end of the pipe or hose shall be kept embedded 2 to 5' in the concrete as the concrete is placed.
    b. Should the end of the pipe or hose be accidentally pulled out of the concrete during the placement, the pour shall be immediately discontinued, and the pipe or hose withdrawn from the hole. The pipe or hose shall be resealed at the bottom and returned to the hole with the sealed end inserted into the concrete. Pouring may then be resumed.
    c. The cutoff point shown on the drawings shall be over poured. The excess concrete shall then be dipped out, and visual inspection made of the concrete at the top of the pour. If any contamination of the concrete is observed, it will be necessary to reinsert the pipe or hose a sufficient distance into the concrete and to continue pouring fresh concrete until the contaminated concrete has been replaced by uncontaminated concrete.
    d. Draw off slurry displaced during concrete placement and remove from the Site.
    e. Use of a tremie pipe, as defined in Paragraph 9.3, is not permitted.
14. Consolidation of Concrete:
    a. Consolidate concrete in conformance with ACI 309.
    b. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
    c. Concrete in dry excavations shall be vibrated only until the concrete is thoroughly consolidated and voids filled as evidenced by a level appearance.
    d. Do not drag vibrators through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole will be left in the concrete. Do not flow concrete from one location to another by use of a vibrator.
15. Concrete shall be placed in accordance with ACI 304, ACI 305, and ACI 306, as applicable.

16. Concrete shall not be placed against frozen or partially frozen soil.

J. Construction Joints:

1. Shall be prepared and installed as follows:
2. Clean and break laitance and/or other foreign material from bonding surface.
3. Tighten forms remaining in place (where applicable) to prevent seepage between forms and hardened concrete.
4. Bed horizontal joints with 1" of grout for bonding.
5. Provide shear keys as indicated or required by Engineer in any new approved construction joint.

K. Finishing:

1. Troweled Finish:
   a. Immediately after screening, use a wood float, to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces.
   b. Trowel with magnesium trowel, by hand, to obtain a dense, but not slick, finish. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
   c. Do not trowel before surface water has evaporated or been removed with a squeegee.
2. Repair of Defective Surfaces:
   a. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area.
   b. Repairing:
      1) Repair as soon as forms have been removed and before liquid membrane forming compound is applied.
      2) Chip surface back to minimum depth of 1/2", chip edges perpendicular to surface, pre-wet depression and brush with neat cement immediately before patching.
      3) Patch surfaces using stiff mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
      4) Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and ramming rod for compacting the holes.
      5) Moist-cure for three days or use curing compound.
      6) Engineer shall be notified of areas containing major defects or where reinforcing steel is exposed prior to determination of repair method.

L. Curing:

1. Cure all concrete by one of the following methods:
   a. Leaving in forms for a minimum of seven (7) days. Keep formwork wet to prevent

drying of concrete surfaces.

b. Use of saturated bats, soaker hoses, or sprinkler for a minimum of seven (7) days. Keep concrete continuously wet.
c. Using one coat of a liquid membrane forming compound conforming to ASTM C309, Type 1. Apply immediately after removal of forms (which have been continuously wet); or in case of a slab or other exposed surface, after the concrete has been finished and is hardened sufficiently to walk on.
d. Using polyethylene sheets applied in full contact with surfaces.
e. Curing of concrete during hot or cold weather shall conform to “Hot Weather Concreting” and “Cold Weather Concreting”, this section.

M. Hot Weather Concreting:

1. When the temperature is 90 degrees F or above, or is likely to rise above 90 degrees F within the 24-hour period after concrete placement; or when there is any combination of high air temperature, low relative humidity and wind velocity which would impair concrete strength or quality, follow the recommendations of ACI 305.
2. Concrete shall have a maximum temperature of 85 degrees F during placement.
3. Dampen sub grade and forms with cool water immediately prior to placement of concrete.
4. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305 (Figure 2.14, in Appendix, does not exceed 0.2- pound per square foot per hour.
5. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.
6. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.
7. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water saturated material to all exposed surfaces; horizontal, vertical and otherwise. After the 24-hour interval, continue curing, using one of the following methods:
   a. Moist curing for six days.
   b. Application of one coat of curing compound conforming to ASTM C309, Type 2.
   c. Application and maintenance of curing paper or heat reflecting plastic sheets for six more days.
8. Begin curing formed concrete immediately after placing. Curing shall consist of keeping forms continuously wet for 24 hours. Thereafter, continue curing using one of the following methods:
   a. Loosen forms and position soaker hose so that water runs down along concrete surfaces. Continue for six days.
   b. Strip forms and apply curing compound conforming to ASTM C309, Type 2. Do not allow concrete surfaces to dry prior to application of curing compound.

N. Cold Weather Concreting:

1. When the temperature is 40 degrees F or is likely to fall below 40 degrees F during the 24-hour period after concrete placement, follow the recommendations of ACI 306 to prevent loss of concrete strength or quality.
2. Minimum temperature for concrete as mixed shall be as indicated on lines 2,3 and 4 of Table 1.4.1 of ACI 306, in Appendix. Maximum temperature for concrete as mixed shall be 10°F greater than the corresponding minimum temperature.
3. Place and maintain concrete so that its temperature is never less than the temperature indicated on line one (1) of Table 1.4.1 of ACI 306, in Appendix. Maintain the required temperature for the time duration indicated on Table 1.4.2 of ACI 306, in Appendix.
4. Monitor temperature of concrete in place at corners or edges of formwork as applicable.
5. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines. Oil or coke burning salamanders will not be permitted. Personnel shall be present at all times to maintain safe, continuous operation of heating system.
6. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.
7. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen sub grade prior to concrete placement.
8. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on line 5 of Table 1.4.1 of ACI 306, in Appendix.

O. Low-Strength Concrete:

1. Low-Strength Concrete:
   a. Defined as concrete whose twenty-eight (28) day test (average of two cylinder breaks) is less than the minimum twenty-eight (28) day strength required.
   b. Remove and replace with acceptable concrete when the quality and location of the low- strength concrete is such that the Engineer considers the strength or durability of the structure is impaired and so orders.
2. Potentially Low-Strength Concrete: Defined as concrete whose seven (7) day test (average of two cylinders) is less than 70% of the specified minimum twenty-eight (28) day compressive strength.
3. Construction delays caused by low-strength or potentially low-strength concrete shall not relieve Contractor from responsibility for substantial completion on schedule.

P. Low Air Concrete:

1. Low Air Concrete:
   a. Defined as concrete whose entrained air content is less than 4.0%.

b. A transit mixer batch shall be determined to be below 4.0% when three out of five air tests are below 4.0%.

2. Placement and Protection of Low Air Concrete: Low air concrete shall not be placed in any horizontal or substantially horizontal slab whose top surface is directly exposed to the weather. If such a placement is unavoidable or is made inadvertently, then the surface of the concrete shall be coated with a boiled linseed oil base sealer or acceptable equal.

Q. Testing.

1. Field Testing of Concrete and Making of Concrete Test Cylinders:
   a. The Contractor shall furnish test equipment, test cylinder molds, and trained personnel to perform all required field tests, make the required concrete test cylinders and deliver test cylinders to the testing laboratory selected by the Owner. The prescribed tests shall be made in the presence of or with the concurrence of the Owner.
   b. Concrete sampling for tests and cylinder making shall be done conforming to ASTM C172.
   c. Perform the following tests:
      1) Prepare test cylinders conforming to ASTM C31, with not less than one set of four (4) cylinders from each concrete foundation or each 100 cubic yards or fraction thereof. Each set shall be taken from only one (1) batch of concrete.
      2) Slump Test conforming to ASTM C143.
      3) Air Content Test conforming to ASTM C231.
      4) Discard concrete used for slump and air tests.
      5) Slump and Air Test results shall be furnished to the Testing Laboratory for inclusion in the Cylinder Test Reports.
2. Laboratory Testing of Concrete During Construction:
   a. An independent testing laboratory will be selected and paid by the Owner to perform the required laboratory tests and statistical evaluations of concrete being used in the work.
   b. Laboratory will cure and test concrete cylinders conforming to ASTM C192 and C39, testing two cylinders at seven (7) days of age and two at twenty-eight (28) days of age.
   c. Contractor shall have the right to observe all phases of concrete cylinder curing and testing. Should Contractor observe any deviations from the prescribed testing procedures that be considers detrimental to concrete strength test results, be shall immediately notify Engineer and Owner in writing.
   d. The Contractor shall make arrangements with the testing laboratory to receive copies of test reports. The cost of providing a maximum of two copies of each report will be paid by the Owner.
   e. Should the statistical data indicate an unacceptable combination of average strength and standard deviation, Contractor shall take immediate corrective action.
   f. Should the statistical data indicate an excessive margin of safety, the concrete mix may be modified subject to Engineer's approval.

## 9.2. CONCRETE FORMWORK

A. Description:

1. This Section includes formwork for concrete.
2. Related Work Specified Elsewhere:
   a. Concrete and Reinforcement: Paragraph 9.1.
   b. Drilled Shaft Foundations: Paragraph 9.3.
   c. Direct Embedded Foundations: Paragraph 9.5.

B. Quality Assurance:

1. Applicable Standards:
   a. American Concrete Institute (ACI):
      1) 318 -Building Code Requirements for Reinforced Concrete.
      2) 347 - Guide to Formwork for Concrete.

C. Materials For Facing:

1. Where concrete will be exposed to view after construction:
   a. Smooth finish exterior grade plywood at least 5/8" thick.
   b. Steel.
2. Where concrete will not be exposed to view after construction:
   a. Exterior grade plywood at least 5/8" thick.
   b. Steel.
   c. Wood fiberboard.
   d. Dressed lumber free of loose knots.
3. Treat forms with lacquer, form oil or other acceptable material to prevent bonding to concrete. Material shall not stain, cause injury to exposed concrete surfaces or affect bonding of specified surface finishes.
4. Clean forms of sawdust, dust, dirt, and other foreign materials.

D. Form Ties:

1. Break-back, coil, or screw-type, except where otherwise specified.
2. Water seal coil type in walls below grade and walls of water-bearing structures.
3. Coil-type shall leave conical depression in concrete.
4. Space as required against pressure of fresh concrete.

E. Chamfer Strips:

1. 3/4" chamfer except where otherwise indicated.
2. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

F. Form Construction:

1. Conform to ACI 318 and ACI 347.
2. Adequately brace, stiffen and support forms to prevent perceptible deflection or settlement, and to hold plumb or level and true to line.
3. Construct sufficiently tight to prevent mortar leakage.
4. Avoid offsets between adjacent forms and construct so that shores, braces and stiffening members are in line with those below.
5. Space studs and stringers as required to support facing against concrete pressure but not more than 12" for 5/8" plywood or 16" for 3/4" plywood.
6. Use wales, strongbacks, shores and bracing as required.
7. Form all necessary openings or chases for piping, ductwork and similar items where indicated or as required for the Work.
8. Construct forms to be removable in sections without marring concrete surface.
9. Surface of forms shall provide smooth, dense, plane surface to finished concrete where exposed to view.
10. Contractor shall be responsible for structural adequacy of formwork.

G. Time In Place For Forms:

1. No shores, bracing, supports or other formwork shall be loosened or removed until the concrete members supported thereby have acquired sufficient strength to support safely their own weight and any other possible loads.
2. The minimum time between concrete placement and form removal shall be determined either by field-cured test specimens or in accordance with the time specified for the member involved.
3. If Contractor elects to determine the required time by means of test specimens, all costs in connection therewith shall be his responsibility.
4. Test specimens shall be made, field-cured and tested as specified in Paragraph 9.3 - Drilled Shaft Foundations. No forms or supports shall be loosened or removed until tests indicate strength of members as follows:

| Structural Member | Percent of design compressive or flexural |
|---|---|
| Unshored slab and beam forms or forms which can be removed without disturbing shores | 70 |
| Slab or beam shoring | 85 |
| Wall, column and beam side forms | 40 |

5. If field-cured test cylinders are not used as the basis for determination of time in

place for formwork, the following criteria shall apply:

| Structural Member | Time in Place for Forms* |
|---|---|
| Slab or beam shoring | 12 days |
| Slab forms or beam soffits | 7 days |
| Wall, column and beam side forms | 18 hours |

*These periods are a cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the concrete surface is above 50°F.

H. Removal Of Forms:

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

9.3. DRILLED SHAFT FOUNDATIONS

A. Summary:

1. This Section covers drilled shaft foundations.
2. Perform all drilling and excavation and supply all labor, equipment and materials to construct drilled shaft foundations as indicated.
   a. Concrete and Reinforcement: Paragraph 9.1.
   b. Anchor Bolts: Paragraph 9.4.
   c. Direct Embedded Foundations: Paragraph 9.5.

B. Compliance Submittals:

1. Miscellaneous Submittals:
   a. Proposed drilled shaft rig name, model number, maximum continuous torque rating (ft- lb), maximum downward force (“crowd”), proposed earth and rock auger attachments and proposed special techniques and equipment.
   b. Proposed procedures for each anticipated method of construction - dry and uncased, temporary casing, bentonite slurry or other procedure including:
      1) Sequence of excavation, concrete placement, rebar cage placement, and placement of embedded items such as stub angles or anchor bolts.
      2) Methods to prevent caving if necessary.
      3) Procedures for supporting rebar cage during concrete placement.
      4) Procedures for supporting stub angles, anchor bolts or other embedded items.

C. Reports:

1. Drilled shafts: The Contractor shall submit at the completion of each day, drilled shaft record reports, containing the following information:
   a. Structure location.
   b. Identification number, structure type and leg number
   c. Shaft dimensions.
   d. Ground surface elevation.

e. Bottom of concrete elevation.
f. Top of concrete elevation.
g. Description of soils encountered during drilling.
h. Bearing strata description.
i. Nature and location of obstructions.
j. Water conditions during drilling and concrete placement.
k. Amount of unclassified excavation.
l. Amount of rock excavation, if encountered.
m. Log of test probe holes.
n. Method of construction - temporary casing, slurry, slurry and temporary casing, or other procedure.

D. Qualifications Of Contractor:

1. A minimum of three-years' experience in drilled shaft construction, including experience with similar subsurface material, water conditions, shaft sizes, and special techniques as required.

2. The name of proposed Subcontractor, if other than Contractor, along with a written description of equipment and techniques proposed for use, and the name of three similar projects completed in the last three years, shall be submitted at time of Bid and will be considered in evaluation of Bids.

E. Definitions:

1. Allowable Service Load Bearing Pressure - The vertical pressure per unit area that may be applied to the bearing stratum at the level of the shaft bottom. Allowable service load bearing pressure has been selected on the basis of samples, tests, and applied soil mechanics, with due regard for the character of the loads to be applied and the settlements that can be tolerated.

2. Bearing Stratum or Bearing Elevation - The formation(s) or layer(s) of soil or rock that support the shaft and loads imposed on it. Bearing elevation is the proposed depth of the base of each shaft, as noted on drawings, accounting for minimum embedment and rock socket into competent rock.

3. Slurry - Method of advancing drilled shaft hole where bentonite, sodium montmorillonite in accordance with API 13A, or anionic polymer is mixed with clean water or water within shaft to produce a slurry mixture capable of maintaining the stability of shaft walls and bottom in potentially caving and/or water-bearing soils. Slurry is also used to increase density of fluid within shaft to offset exterior hydrostatic pressure and to facilitate removal of coarser grained soils by mixing and incorporation into slurry mixture.

4. Casing - Protective steel casing usually of cylindrical shape, lowered into the excavated hole to protect workmen and inspectors entering the shaft from collapse or cave-in of the sidewalls and for the purpose of excluding soil and water from the excavation during drilling and concrete placement.

5. Competent Rock - Solid rock, sound, un-weathered siltstone or sandstone without visible voids, known to have or exhibited a minimum thickness of at least 5’ and

generally commencing from the elevation at which rock is first encountered, and as defined by refusal criteria. Rock generally exhibiting hard, massive, solid appearance and lacking the presence of clay seams, voids, solution cavities, broken, rubbly, or weathered rock conditions are indicative of competent rock. Boulders or portions of irregular rock contact along the shaft side wall shall not be considered competent rock for purposes of developing a minimum embedment for rock socket. Rock socket may or may not be considered cumulative along the side wall shaft, depending upon the size, extent, location and frequency of cracks, crevices and clay seams that can be cleaned and filled by dental work. Owner's geotechnical engineer shall evaluate extent of irregularities and their effect upon detrimental settlement in defining adequate rock socket into competent rock.

6. End Bearing Drilled Shaft - Cast-in-place foundation element with or without enlarged bearing area extending downward through weaker soils or water to a rock or soil stratum capable of supporting the loads imposed on or within it. A shaft diameter of 2-1/2’ is the lower limit for shafts covered by these specifications.
7. Pumping of Concrete - “Underwater-Type Concrete” is conveyed by pressures through rigid pipe or flexible hose and discharged directly to bottom of shaft through slurry or under water. Pressure is applied by piston pumps, pneumatic compressed air, or squeeze pressure pumps in accordance with ACI 304.2.
8. Rock - Rock excavation is defined as all material encountered in excavating drilled shafts which cannot be removed with a conventional earth auger and/or underreaming tool, and requires rock auger, core barrel, boulder rooter, or hand labor using air-powered tools and/or other special excavation procedures. Refusal of the earth auger shall be defined as a penetration rate equal to, or less than, one (1) foot per ten (10) minute period using an aforementioned drill rig providing its maximum continuous torque and its maximum downward force (“crowd”). There shall be no proportioning of torque or downward pressure and advancement time to evaluate smaller equipment. All earth, clay, coal seams, rock fragments, soft fractured materials or voids encountered between rock units will not be considered rock for pay purposes. Note: Rock is not anticipated to be encountered during drilling.
9. Shaft - Drilled shaft above bearing surface, exclusive of bell, if any.
10. Tremie - Method of placing concrete, if permitted by Engineer, for “Underwater - Type Concrete” through a rigid pipe with minimum dimensions of 10” to 12”. Concrete is placed by means of gravity flow or drop through the interior of the pipe, the lower end of which is kept immersed in fresh concrete. Use of a bottom sealing metal plate or a top of pipe sealing floatable plug shall be inserted prior to charging with concrete to prevent contamination of concrete by slurry or water.
11. Unclassified Excavation - All materials encountered from the top of concrete or drilled shaft cutoff elevation to the tip-hearing elevation which can be removed with a conventional earth auger, including weathered, decomposed, broken, or highly fractured rock consisting of either detached rock pieces or loose rock fragments, or thinly bedded soft fractured rock particles; exclusive of rock excavation as described above.

F. Concrete And Reinforcement:

1. As specified in Paragraph 9.1 - Concrete and Reinforcement.

G. Slurry:

1. Slurry shall consist of a mixture of bentonite (sodium montmorillonite conforming to API 13A) or anionic polymer and water to produce a slurry of sufficient density to maintain stability of the shaft walls and bottom and to facilitate removal of coarser grained soils from the excavation.

H. Steel Casing:

1. Steel casing shall be of sufficient diameter and wall thickness to prevent collapse or cave- in of the excavation and to prevent soil and water from entering the excavation during drilling, field observation, and concrete placement.

I. Equipment:

1. Drill rig and associated drilling equipment capable of drilling as a minimum the diameter and depth of foundations as indicated in subsurface conditions present.
   a. Rock excavation is not anticipated during drilling.

J. Excavation:

1. Drilled shaft shall be located as indicated within the following tolerances:
   a. Centerline: Within 3” or 1/24 of shaft diameter, whichever is less, of location indicated.
   b. Diameter: Plus 3”, minus 1”.
   c. Plumb: 1.5% of the length, 12.5% of shaft diameter, or 15” total, whichever is less.
2. Deviations in excess of the preceding tolerances will be corrected at Contractor's expense, including additional costs for engineering, redesign and inspection.
3. Install drilled shafts in accordance with recommendations in ACI 336.1 and ACI 336.3 unless otherwise specified.
4. Install a temporary casing with a minimum outside diameter equal to the nominal diameter of the drilled shaft and a sufficient wall thickness to withstand the soil pressure:
   a. Prior to a man entering the excavation.
   b. To control seepage.
   c. To prevent collapse of the walls.
5. Remove all material regardless of classification within the shaft to the indicated depth. Take all precautions necessary to prevent blowouts and disturbance of the sides or bottom of the excavation. If required, maintain water or slurry in the shaft at all times at a height sufficient to produce a positive head in the shaft.
6. When loose soil, a high-water table, or other condition which causes the sides or bottom of the excavation to be unstable is encountered, the excavation shall be advanced through use of slurry, a temporary casing, or other approved method.

7. When slurry is used, maintain a positive head in the excavation at all times. Circulate the slurry with sufficient consistency and velocity to remove the dislodged materials from the hole. Should materials be encountered which are too heavy to be removed by the slurry, they may be removed by other approved means.
8. Excavation shall be carried to the indicated depth at which time the Owner will inspect the excavation and determine whether the excavation has reached the required depth. If required by the Owner's Geotechnical Engineer the excavation will then be continued.
9. Remove from sides and bottom of drilled shafts, loose material and free water to the degree determined by Owner prior to placing concrete. In no case should the volume of such material exceed that which would be required to cover 5% of the area of the shaft to a depth of 2".
10. Drilled shafts which are over excavated without Owner's approval shall have the over excavation filled with unreinforced concrete at the Contractor's expense.
11. Keep the ground surface for a minimum of 2' from the edge of the excavation clean and level.
12. Dispose of materials removed from the excavation off site or as directed by the Owner.
13. All soil spoils will be disposed offsite if not contaminated. Contaminated soils will be determined by Owner. This should be included in the excavation bid units.

K. Reinforcing Steel:

1. Install as specified in Paragraph 9.1 - Concrete and Reinforcement.
2. In addition, shall be prefabricated as indicated prior to completion of excavation.
3. Support or tie off the rebar cage to prevent downward movement.
4. Provide spacers to maintain appropriate clearance from the side walls or casing and shaft bottom.

L. Formwork:

1. Install as specified in Paragraph 9.1 - Concrete and Reinforcement.
2. In addition, form the drilled shaft above grade with round forms with an inside diameter equal to the drilled shaft's nominal diameter and of sufficient strength to restrain the concrete without deformation or settlement.

M. Placing Concrete:

1. As specified in Paragraph 9.1 - Concrete and Reinforcement.
2. Prior to placement of concrete, center reinforcing cage in the drilled shaft excavation and suspend or tie it off in an approved manner to cutoff elevation and to provide the specified clearance to bottom and side walls.
3. Fill entire volume of drilled shaft with concrete to the cutoff elevation in one

continuous operation. Cold joints and construction joints are not permitted unless otherwise indicated or specified. Complete concreting within the same day in which the drilled shaft is excavated.

4. Dewater excavation, where practicable, before placing concrete. Hold the water level in the bottom of the excavation prior to concreting at a nominal depth not to exceed 2".
5. Place concrete in a manner that will not cause segregation of the particles or permit infiltration of water or any other occurrence which would tend to decrease the strength of the concrete or the capacity of the finished drilled shaft.
6. Do not disturb the temporary casing, if applicable, until a sufficient depth of concrete has been placed in the shaft excavation to ensure, in the Owner's opinion, that voids will not occur in the shaft due to intrusion of soil or water, as the temporary casing is being removed. Pull casing with a smooth, vertical motion without jerks.
7. Coordinate the withdrawal of temporary casing, if applicable, with concrete placement operations to maintain a load of concrete approximately 5' above the casing bottom.
8. At Contractor's option, casing may be permanently left in place. Casings manufactured with fiber-based products shall not be permanently left in place. Pressure grout with lean grout as directed by Owner's Geotechnical Engineer to fill voids between permanent casing and the hole wall due to:
   a. Use of corrugated thin-wall casing.
   b. Use of casing with an outside diameter less than the actual diameter of the drilled shaft
   c. Caving or collapsed-wall conditions during construction which result in voids between the permanent casing and hole wall.
9. Consolidation of Concrete
   a. As specified in Paragraph 9.1 - Concrete and Reinforcement.
   b. Vibrate concrete within the top *5'* only after temporary casing has been pulled or when casing is permanent.
   c. Do not over vibrate to avoid segregation of concrete aggregate from the cement paste.
10. No construction joints shall be allowed in the anchor bolt section plus 2' of the shaft.

N. Concrete Finish And Curing:

1. As specified in Paragraph 9.1 - Concrete and Reinforcement.

O. Anchor Bolts:

1. Shall be installed as specified in Paragraph 9.4 - Anchor Bolts.

P. Directly Embedded Tubular Steel Structure Foundation Components:

1. Directly embedded tubular steel structures components shall be located to within ±2" from the drilled shaft centerline and shall not deviate from plumb by more than

¼" in 10'. Embedded structure foundation components shall be open at both ends to allow concrete to migrate to the inside of the structure.

2. Embedded structure foundation components shall be installed to depth indicated without vibrating, with concrete within the interior of the embedded structure component at the same or higher than the elevation of the finished concrete exterior to the structure component.
3. Variations in excess of the preceding tolerances shall be corrected at Contractor's expense.

Q. Backfilling:

1. Backfilling is not anticipated for drilled shaft foundations.
2. Refill any over excavation in the lateral direction around the drilled shaft resulting from sides of drilled shaft hole collapsing or sloughing in 6" lifts and compact as specified below.
3. Sufficiently compact all material replaced, with the exception of topsoil, as follows:
   a. Cohesive Soils: Compaction shall achieve a minimum of 90% of maximum density with a moisture content plus or minus 3% at optimum moisture per ASTM D698.
   b. Cohesionless Soils: Compaction shall achieve a minimum of 90% relative density as per:
      1) D4253 - Maximum Index Density of Soils Using a Vibratory Table.
      2) D4254 - Minimum Index Density of Soils and Calculation of Relative Density.
   c. Cohesionless materials include gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of clayey and silty materials -- materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
   d. Cohesive materials include silts and clays generally exclusive of sands and gravel -- materials for which impact compaction will produce a well-defined moisture-density relationship curve.

9.4. ANCHOR BOLTS

A. Summary:

1. This Section covers the installation of anchor bolts.

B. Steel Pole Anchor Bolts:

1. Stub and foundation leg angle and anchor bolts shall be accurately located in accordance with the manufacturer's drawings to maintain the structure's indicated grade and alignment.
2. Setting dimensions shall not differ from those given by the manufacturer by more than the following:
   a. Anchor Bolt Clusters:
      1) Center-to-center distance between clusters of multi-legged structures - ±l/4".

2) Tangential displacement of cage - ±l/8".

3. Center of anchor bolt pattern shall be located within 2" of the indicated location in drilled shaft and spread footing foundations.

C. Circuit Breaker Anchor Bolts:

1. Anchor bolts for circuit breaker must maintain a tolerance of - ±l/l6".

D. Measurement And Payment:

1. Payment for all work involved in installing one set of anchor bolts will be at the unit price set forth in the proposal.

## 9.5. DIRECT EMBEDDED FOUNDATIONS

A. Summary:

1. Provide all labor, equipment and materials to perform drilling, excavation and backfilling for construction of direct embedded tubular steel pole foundations.
2. Related Work Specified Elsewhere:
   a. Concrete and Reinforcement: Paragraph 9.1.
   b. Drilled Shaft Foundations: Submittals, Contractor qualifications, reports, definitions and excavation requirements for direct embedded steel poles shall be as specified for drilled shafts: 10.3.

B. Backfill Material:

1. For direct embedded foundations requiring concrete backfill, applicable products shall be as specified in Paragraph 9.1 and Paragraph 9.3.
2. Material used as compacted crushed rock backfill for direct embedded steel poles shall be crushed rock conforming to Class B with the following gradation:

| Sieve Designation | Percent Passing (By Weight) |
|---|---|
| 1" | 90-100 |
| 1/2" | 60-90 |
| No. 4 | 30-56 |
| No. 16 | 10-40 |
| No. 200 | 4-12 |

3. In shafts where slurry or under water construction methods are required, material used to backfill over excavated foundations shall be Type III high early strength concrete which is otherwise as specified in Paragraph 9.1 and Paragraph 9.3. Alternately, precast concrete base plugs may be used to re-establish the required base pole elevation.
4. Material used to backfill the upper 1 foot of direct embedded poles and surrounding area as indicated shall be as follows:

a. Cohesionless Materials: Includes gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of clayey and silty materials -- materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
b. Cohesive Materials: Includes silts and clays generally exclusive of sands and gravel -- materials for which impact compaction will produce a well-defined moisture-density relationship curve.

C. Excavation:

1. As specified in Paragraph 9.3 - Drilled Shaft Foundations.

D. Over-Excavation Backfill:

1. Shafts which are over excavated without Owner's approval shall have the over excavation filled using one of the following methods.
   a. In dry shafts, place crushed rock backfill in 1 foot lifts. Compact each lift using pneumatic tampers or immersion type concrete vibrators. No manual tamping equipment will be allowed. This procedure is to be continued until the crushed rock over-excavation backfill reaches the base of the steel pole as shown on the drawings.
   b. In shafts where slurry or under water construction methods are required, material used to backfill over excavated foundations shall be Type III high early strength concrete which is otherwise as specified in Paragraph 9.1 and Paragraph 9.3. Alternately, precast concrete base plugs may be used to re-establish the required base pole elevation.

E. Steel Pole Embedment:

1. Poles shall be located as indicated within the following tolerances:
   a. Deviation from Centerline: ±6”.
   b. Deviation from Vertical Plumb: 1/2” in 10’.
2. Deviations in excess of the preceding tolerances shall be corrected at Contractor's expense.
3. Embedded structure foundation components shall be installed to depths indicated.

F. Crushed Rock Backfill:

1. Place crushed rock backfill for direct embedded steel poles in 1 foot lifts or continuously, but very slowly, bring the material up uniformly on all sides of the pole. Compact each lift or compact continuously using pneumatic tampers or immersion type concrete vibrators. A maximum of one shoveller per three tampers or vibrators shall be used at each hole. No manual tamping equipment will be allowed. This procedure is to be continued until the crushed rock backfill is within 1 foot of the top of the hole.
2. Snow, ice or frozen earth shall not be placed in fills and fill shall not be placed on frozen earth.

3. Topsoil shall be removed and stockpiled, excess material scattered and the topsoil replaced.

G. Compacted Backfill:

1. Backfill the upper 1 foot as indicated and any over-excavation in the lateral direction around the direct embedded wood pole resulting from sides of hole collapsing or sloughing in 6” lifts and compact as specified below. Sufficiently compact all material replaced, with the exception of topsoil, as follows:
   a. Cohesive Soils: Compaction shall achieve a minimum of 95% of maximum density with a moisture content plus or minus 3% at optimum moisture per ASTM D698.
   b. Cohesionless Soils: Compaction shall achieve a minimum of 90% relative density as per:
      1) D4253 - Maximum Index Density of Soils Using a Vibratory Table.
      2) D4254 - Minimum Index Density of Soils and Calculation of Relative Density.

H. Concrete Placement:

1. A. Where concrete backfill is indicated, and when crushed rock backfill is not suitable, concrete backfill placement shall be as specified in Paragraph 9.1 and Paragraph 9.3.

## 11. ANCHORS

### 11.1. POWER-INSTALLED SCREW ANCHORS

A. Summary:

1. This Section includes requirements for installation of power-installed screw anchors for a transmission line.

B. Packaging:

1. Materials will be packaged in weather-resistant cartons, crates, or bundles suitable for outdoor storage.
2. Only individual identical parts will be packaged together. Each package will be clearly marked or tagged with the part number of the parts enclosed and the quantity of parts in the package.

C. Installation:

1. Equipment: Digger machine having a torque capacity greater than the maximum torque capacity of the screw anchors. Digger machine shall be equipped with a torque indicator approved by Owner, for measuring the torque. Torque indicator shall be calibrated, and recalibrated periodically as directed by Owner, to be accurate within ±1/2% of the required torque. Calibration shall be performed by a testing lab, approved by Owner, at the Contractor's expense.
2. Contractor shall follow the procedures specified by the manufacturer's written

instructions, manufacturer's field representative, and the following in installing these units:

a. Screw anchors shall be installed with continuous linear advancement, with sufficient rotational speed and down pressure to prevent “churning” or lateral movement from the intended line of the screw anchor.
b. Anchors shall be located as indicated within the following tolerances:
   1) Anchor eye shall be a minimum of 6” and a maximum of 3 foot above ground.
   2) The point where the anchor rod emerges from the ground shall differ from the correct location by no more than 1 foot in any direction.
   3) The axis of the anchor rod shall make an angle of less than 5 degrees with the axis of the guy.
c. After reaching the minimum torque specified by the manufacturer, the screw anchors shall be installed an additional foot, but not to exceed the maximum torque specified.

D. Testing:

1. Proof testing of screw anchors shall be as specified in Paragraph 11.2 - ANCHOR PROOF TESTING.

## 11.2. ANCHOR PROOF TESTING

A. Summary:

1. This Section covers the furnishing of equipment and labor to perform anchor proof tests during construction.

B. Submittals:

1. Compliance Submittals:
   a. Including, but not limited to, the following:
      1) List of test equipment with dimensions and arrangement.
      2) Test reports:
         (i) Calibration test reports on the dynamometer, pressure gauge, or load cell used on the pullout loads.
         (ii) Test reports for each anchor tested with the following information:
            (a) Proof load.
            (b) Maximum movement.

C. Test Equipment

1. The proof loads shall be hydraulically applied along the axis of the guy and read directly with a dynamometer, pressure gauge or electronic load cell. Reaction plates shall be sized and located to minimize the downward pressure and shall be approved by the Owner. Contractor shall supply transits and scales to measure movement.
2. Dynamometer, pressure gauge, or load cell shall be calibrated prior to start of anchor testing, and shall be recalibrated periodically as directed by Owner.

Calibration shall be performed by an independent testing laboratory, approved by Owner, at Contractor's expense.

D. Testing:

1. After installation, each guy anchor shall be tested to the actual proof load indicated.
2. 100% of the actual proof load shall be applied along the axis of the guy, in 25% increments, and each load increment held for two minutes.
3. All tests shall be witnessed by Owner. Contractor shall give Owner 24 hours' notice as to the time and location prior to any testing.
4. To successfully complete the proof load test, the anchor shall maintain the proof load without exceeding the allowable proof load movement as follows:
   a. Grouted rock anchor: 1/4”.
   b. Grouted rock anchor with extension: 1/2”.
   c. All other anchors: 4”
5. Movement shall be measured with a transit sighting perpendicular to a scale mounted on the anchor rod or tester's ram. The transit's crosshairs shall align with the scale.

## LANDOWNER CONTACT/ACCESS REPORT

Line Name:_____ DATE:_____, 201_

**LANDOWNER INFORMATION:**

Name: _____

Address: _____

City/State:_____ Phone #: _____

1 **Brushing/Clearing:** _____

_____

_____

_____

2 **Restoration:** _____

_____

_____

_____

3 **Route of Entry:** _____

_____

_____

_____

4 **Misc. Comments** (septic system, wells, bridges, etc) _____

_____

_____

_____

Attempts to Contact: (Date & Time) _____

_____

_____

_____

Contractor/Representative:_____ Company:_____

**Landowner:** _____

**APPENDIX G1**
**ATTACHMENT 05**
**EXHIBIT 03**

# SUBSTATION DESIGN AND CONSTRUCTION SPECIFICATIONS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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## END OF SECTION

# SECTION 1000 SUMMARY OF WORK

## 1.1 General

## 1.2 Description of Project

The XXXX Project consists of constructing XXXX

## 1.3 Work Performed by Contractor

The contractor's scope will include all below grade and above work required to complete construction including but not limited to the following tasks. Incidental work and materials required to provide a complete and functional substation shall be the responsibility of the Contractor.

All work shall be in accordance with this specification and the drawings.

## 1.4 Work Performed by PGE

## 1.5 PGE Provided Materials

| MATERIAL | PLANNED DELIVERY |
|---|---|

The contractor will be responsible for receiving and storing the equipment if the location is not ready. If the contractor is unable to receive the materials when they are delivered, the contractor is responsible for any additional storage or shipping.

## 1.6 Contractor Provided Materials

Contractor is responsible for providing material quantities required for construction, except for those identified in section 1.4. Quantities will not be adjusted for actual quantities installed.

## 1.7 Work Sequence

Contractor shall propose a detailed work schedule for PGE's approval.

## 1.8 Attachments

- Engineering and Construction Standards
  - MP-6C-ALL-002 – Generic Baseline for New Gas Breakers
  - MP-6C-VAC-001 – Generic Baseline for Vacuum Breakers
  - MP-6G-ALL-004 – Circuit Breaker Checkout Procedure
  - MP-11G-ALL-004 – Transformer Testing
  - MP-12G-ALL-003 REV 1 – Doble 3100 Timer Operating Instructions
  - MP-15G-INST-TESTS-REV 3 – Testing Instrument Transformers
  - S-116-25 – Potential Fuse Box
  - S-130-50 – Animal Deterrents
  - S-131-40 – Bolted Pad Connections
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  - S-140-30 – Underground 15kV Power Cable
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  - STND-1400 Substation Lighting
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- West Union Geotech report
- Testing Checklist for Contractor (TCC)

- Switchgear 1&2 Vendor Drawings
- C&P IFC 4-3-15
- Physical IFC 4-2-15
- Civil IFC 4-9-2015

## END OF SECTION

# SECTION 1020 QUALITY CONTROL

## 1.0 General

A. The Contractor shall ensure that subcontractors are approved by the Owner and satisfy the Owner required qualification/approval process prior to work being performed by the proposed Subcontractor.

## 1.2 Quality Assurance

A. Contractor shall monitor quality control over suppliers, manufacturers, products, services, site conditions and workmanship to produce work of specified quality.

Locations of existing structures, utilities and other site conditions indicated on the drawings are approximate, and shall be the contractor's responsibility to verify the true and correct locations so as to avoid interferences, damages or disturbances. Deviations from information indicated on the drawings shall be brought to the immediate attention of the Owner. New construction shall accommodate existing conditions.

Prior to any excavation the contractor shall call for primary power cable locates by a PGE Special Tester. To schedule a PGE Special Tester call **PGE's Power Quality Hotline at 503-572-0395.**

B. Contractor shall comply with manufacturer's instructions including performing each step in sequence. Should instructions conflict with contract documents, request clarification from Owner before proceeding.

All fabrication and installation shall comply with the drawings and specifications. Should information provided on the drawings conflict with that in the specifications, request clarification from the Owner before proceeding.

C. Contractor shall comply with specified standards as minimum quality for the work. The exception is where standards, by code or by requirements of construction permits, indicate higher standards or workmanship that is more precise is required.

## 1.3 Tolerances

A. Contractor shall comply with manufacturer's tolerances. Should manufacturer's tolerances conflict with contract documents, request clarification from Owner before proceeding.

## 1.4 Inspecting, Testing and Laboratory Services

A. Contractor will employ the services of an independent firm to perform testing and inspection services. The independent firm will perform inspections, tests and other services specified in individual specification sections or as required by the Owner.

B. Reports will be submitted by the independent firm to the Owner indicating observations and results of tests and indicating compliance or non-compliance with the specifications.

C. Contractor shall cooperate with the independent firm and furnish samples of material, design mix, and provide equipment, tools, storage, safe access and assistance by incidental labor as requested.

D. Testing or inspecting does not relieve Contractor of responsibility to perform work in compliance with contract requirements.

E. The same independent firm, on instruction by the Owner, shall perform retesting required because of non-conformance to specified requirements by the Owner. Payment for retesting will be charged to the Contractor by deducting inspecting or testing charges from the Contract price.

## 1.5 Manufacturer's Field Services and Reports

A. If the Owner, scope of work, or material specification requires the manufacturer to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, or startup of equipment, the Contractor shall arrange and coordinate such activities.

B. The Contractor will supply the Owner with certified originals or copies of all equipment or material test completed by manufacturers and/or specified by Owner specifications and/or scope of work.

## 1.6 Contractor Hold Points

Contact PGE at the following times during construction for a PGE site review of work to the drawings and specifications:

- After compaction and backfill.
- After completion of grading.
- After completion of drilling holes for pier foundations and prior to placement of rebar cage.

- For all other foundations, after rebar is installed and before pouring concrete.
- Special inspections for rebar and concrete placement.
- Prior to installing any major equipment on concrete slab foundations to check for flatness.
- Before covering conduits & grounding connections.
- After completion of all sub-grade conduit & grounding installations and before placement of geo-textile fabric and final aggregate surfacing.
- After completion of all steel structure erection and disconnect switch and switch operator placement. Verify disconnect switch operation before punching set screws.
- After completion of the placement of all 115kV & 15kV equipment and bus work and bus jumpers to equipment
- After bolted electrical connections and enclosure assembles are made. PGE to verify torqueing requirements.
- During the pulling of control cables to and from major equipment into control enclosures.
- During control cable terminations.
- After major equipment testing.

## END OF SECTION

# SECTION 1030 TEMPORARY CONSTRUCTION FACILITIES

## 1.1 General

## 1.2 Temporary Utilities

Owner will provide the following utilities to the Contractor at no cost. Contractor is responsible for connection, maintenance and removal of all temporary utilities. Owner does not guarantee continuity of service. Contractor shall minimize disruption to Owner during connection and removal activities. All utilities not listed that are required shall be provided by Contractor

- Owner will only provide electrical utility for Contractor. Contractor shall coordinate and provide a month notice to Owner for electrical utility requirements.
- Contractor shall provide a three phase, 400VAC, 50kW generator for GIS gas cart.

## 1.3 Temporary Controls

A. Barriers: Contractor shall provide barriers or barricades as required to prevent unauthorized entry to construction areas and protect existing facilities and adjacent properties from damage from construction operations.

B. Fence:

- Contractor shall provide temporary fencing as shown on the drawings or as required to maintain security.
- Any temporary fence installed that functions as the substation perimeter fence shall be installed in accordance with PGE's fence and fence grounding standards. With approval from PGE the temporary perimeter fence posts may be directly embedded into the soil without concrete.

C. Traffic Control: Contractor shall provide traffic control measures including signing, flagging and other traffic control measures as required to maintain safe access into and through the construction area and any other traffic control measures that may be required by local agencies.

## 1.4 Temporary Facilities

A. Field Office: Contractor shall provide a weather tight construction office complete with lighting, heating and cooling equipment. Office shall include space for Owner's Inspector or other personnel.

B. Temporary restrooms shall be available and shall be outfitted for conditions (i.e. space heated in the winter, if necessary).

**END OF SECTION**

# SECTION 1040 CONTRACT CLOSEOUT

## 1.0 General

1.1 Summary

A. This Section includes administrative and procedural requirements for contract closeout including, but not limited to, the following:

1. Inspection procedures
2. Project record document submittal
3. Submittal of warranties
4. Final cleaning

1.2 Substantial Completion

A. Preliminary Procedures: Before requesting inspection for certification of Substantial Completion, complete the following. List exceptions in the request.

1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the Work claimed as substantially complete.

a) Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Sum.
b) If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.

2. Advise the Owner of pending insurance changeover requirements.
3. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
4. Obtain and submit releases enabling the Owner unrestricted use of the work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
5. Submit final record information.
6. Make final changeover of permanent locks and transmit keys to the Owner. Advise the Owner's personnel of changeover in security provisions.

7. Discontinue and remove temporary facilities, construction tools, and similar elements from the site.
8. Complete final cleanup requirements.
9. Touch up and otherwise repair and restore marred and exposed finishes.
10. The contractor will submit their internal QA process which will indicate any outstanding construction issues.

B. Inspection Procedures: On receipt of a request for inspection, the Owner will either proceed with inspection or advise the Contractor of unfilled requirements. The Owner will prepare the Certificate of Substantial Completion following inspection or advise the Contractor of construction work that must be completed or corrected before the certificate will be issued.

1. The Owner will repeat inspection when requested and when assured that the work is substantially complete.
2. Results of the completed inspection will form the basis of requirements for final acceptance.

1.4 Final Acceptance

A. Preliminary Procedures: Before requesting final inspection for certification of final acceptance and final payment, complete the following. Create a list of exceptions in the request.

1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
2. Submit an updated final statement, accounting for final additional changes to the Contract Sum.
3. Submit a certified copy of the Owner's final inspection list of items to be completed or corrected, endorsed and dated by the Owner. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by the Owner.
4. Submit consent of surety to final payment.
5. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

B. Re-inspection Procedure: The Owner will re-inspect the Work upon receipt of notice that the work, including inspection list items from earlier inspections, has been completed, except for items whose completion is delayed under circumstances acceptable to the Owner.

1. Upon completion of re-inspection, the Owner will prepare a certificate of final acceptance. If the work is incomplete, the Owner will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
2. If necessary, re-inspection will be repeated.

1.5 Record Document Submittals

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for the Owner's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of black line prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record later.

1. Mark three record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the work.
2. Mark new information that is important to the Owner but was not shown on the Contract or Shop Drawings.
3. Note related change-order numbers where applicable.
4. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.

C. Record Specifications: Maintain one complete copy of the Project Specifications, including addenda. Include with the Project Specifications one copy of other written construction documents, such as Change Orders and modifications issued in printed form during construction.

1. Mark these documents to show substantial variations in actual work performed in comparison with the text of the Specifications and modifications.
2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.

3. Note related record drawing information and Product Data.
4. Upon completion of the work, submit record Specifications to the Owner for the Owner's records.

D. Record Product Data: Maintain one copy of each Product Data submittal. Note related Change Orders and markup of record drawings and Specifications.

1. Mark these documents to show significant variations in actual work performed in comparison with information submitted. Include variations in products delivered to the site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markups, submit a complete set of record Product Data to the Owner for the Owner's records.

E. Miscellaneous Record Submittals: Refer to other Specification Sections for requirements of miscellaneous record keeping and submittals concerning actual performance of the work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order. Identify miscellaneous records properly and bind or file, ready for continued use and reference. Submit to the Owner for the Owner's records.

## END OF SECTION

# SECTION 1050 CONTRACT ADMINISTRATION PROCESS

## 1.0 General

## 2.0 Plans and Specifications

The Contract Documents govern the Work to be done, set forth the relative responsibilities of the Owner and Contractor, and establishes the method by which changes in the Contract are made.

Some details of the Work may be found in only one location in the Contract Documents. Therefore, the Contractor must review all portions of the Contract Documents in order to know the full scope of Work. Including, but not limited to PGE Standard Construction and Design Documents.

## 3.1 Precedence of Contract Documents/Conflicts

Obvious conflicts in the Contract Documents, or obvious omissions, are ones that should have been discovered before submission of a Bid to the Owner by a reasonable person in the Contractor's position if all the Documents had been reviewed. In such a situation, the Contractor has a duty to inquire of the Owner before submitting its Bid about the correct interpretation of the Contract. This permits the Owner to clarify by Addendum what is intended by the Contract. That is particularly true for errors in figures, drawings or Specifications.

If the Contractor fails to bring an obvious conflict or error to the Owner's attention before it submits a Bid, it has waived its right to additional compensation when the Owner resolves it.

Anything shown on the Plans and not mentioned in the Specifications or Standards, or mentioned in the Specifications and Standards and not shown on the Plans, shall be of like effect as if shown or mentioned in both. This does not constitute a conflict, discrepancy or error between the two.

In cases of apparent discrepancies or conflicts between the Plans, the Specifications and the Standards, the Contractor shall first determine if the matter can be resolved pursuant to the rule stated above. If not, the apparent conflict shall be resolved by designating the portion of the Contract Documents that takes precedence over the others. Therefore, when preparing its Bid, or when beginning any portion of the Work, the Contractor shall use the following order of precedence to resolve any apparent conflict:

- Permits from Outside Agencies required by law
- Change Orders
- Addenda

- Technical Specifications
- Plans
- Information furnished by written notes and/or schedules on drawings
- Large Scale Drawings over small scale drawings
- Information provided by lines on drawings
- General Conditions of the Contract

Contractor shall bring any real or perceived discrepancy concerning dimensions, quantities or location between the Drawings, details, Specifications or Standards to the attention of the Owner's Representative before beginning that portion of the Work.

In the event of any inconsistency in the Drawings, Specifications and Standards unless otherwise ordered in writing by the Owner's Representative, the Contractor shall provide the better quality of, or the greater quantity of Work or materials. This provision shall apply only to inconsistencies in express requirements of the Drawings, Specifications and Standards and not the interpretations by the Owner or Architect.

## 4.1 Shop Drawings and Submittals

For purposes of this subsection the following definitions apply:

- "Shop Drawings" are drawings, diagrams, schedules and other data specifically prepared for the Work by the Contractor, a Subcontractor at any tier, manufacturer, supplier or distributor to illustrate some portion of the Work.

- "Product Data" are illustrations, standard schedules, performance charts, instructions, brochures, diagrams and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

- "Samples" are physical examples that illustrate materials, equipment or workmanship and establish standards by which the Work will be judged.

- "Submittals" are documents required by the Contract to be submitted to the Owner for review. However, they are not part of the terms and conditions of the Contract. They may include shop drawings, product data, samples, or a schedule of construction events.

Shop Drawings, Product Data, Samples and other Submittals are not part of the Contract. Their purpose is to demonstrate, for those portions of the Work for which Submittals are required, the way the Contractor proposes to conform to the requirements of the Contract and the design concept expressed in the Contract.

The Contractor shall review, approve and submit to the Owner all Shop Drawings, Product Data, Samples and other Submittals required by the Contract regardless of whether the document originated with the Contractor or with some other Subcontractor or supplier. They shall be submitted at the time required by the Contract, or, if no time is specified, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of separate Contractors. Submittals made by the Contractor that are not required by the Contract may be returned without action or may not be returned at all.

Informational Submittals that do not require the Owner to take responsive action may be so identified in the Contract.

The Contractor shall submit electronically a copy of any Submittal required by the Contract or when requested by the Owner's Representative. In addition, the Contract may also require the Contractor to provide information about the products and materials it proposes to incorporate into the Work and to provide samples of such products and materials for inspection or testing. The Contractor shall be responsible for all Submittals presented to the Owner for review, no matter what their point of origin may have been.

The Contractor shall not perform a portion of the Work that requires the Owner to review a Submittal until the respective Submittal has been reviewed by the Owner as outlined below. Such work shall be performed in accordance with Submittals that conform to the Contract Documents.

When tendering a Submittal to the Owner for review, the Contractor represents that it has determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and has checked and coordinated the information contained with such Submittals with the requirements of the Work and of the Contract. The Contractor shall expressly note where any submittal differs from or varies from the requirements of the Contract, notwithstanding any belief on the part of the Contractor that the variance is obvious.

The Owner's review of any Submittal does not relieve the Contractor from its responsibility to follow the requirements of the Contract. The Owner is not responsible for ensuring that Submittals are correct. Failure of the Owner to discover that a submittal varies from the requirements of the Contract Documents does not relieve the Contractor of its responsibilities to conform to the Contract nor provide a basis for a Change Order. Nevertheless, the Owner's Representative shall review any Submittals provided in order to make a general determination about whether they appear to meet Contract requirements or the intended design of the Project. The Contractor remains responsible for following the Contract, including, but not limited to:

- Confirming and correlating all dimensions.

- Fabricating and construction techniques.
- Coordinating the work with that of all other trades and Subcontractors.
- Satisfactorily performing the Work in strict accordance with the Contract Documents.
- The means and methods of construction.
- Conforming to all the requirements of the Contract.

The Owner's Representative shall have fourteen (14) days to review any Submittals. Submittals returned to the contractor as "REVISE AND RESUBMIT" OR "REJECTED" and subsequently resubmitted shall have fourteen (14) days for each additional review. The Owner's Representative will review the Submittals and return them electronically to the Contractor stamped with one of the following notations:

- "NO EXCEPTIONS TAKEN": If the Submittal is marked, "NO EXCEPTIONS TAKEN," this means that the Contractor immediately can begin the work encompassed by the Submittal.

- "MAKE CORRECTIONS NOTED": If the Submittal is marked "MAKE CORRECTIONS NOTED" the Contractor is required to make any revisions suggested by the Owner's Representative and, upon correction, may immediately begin the work indicated by the Submittal or may incorporate the material or equipment covered by the Submittal into the Work.

- "REVISE AND RESUBMIT": If the Submittal is marked "REVISE AND RESUBMIT," the Contractor is required to revise the Submittal and resubmit it to the Owner's Representative. No work shown on the Submittal, or which is dependent upon review of the Submittal or material or equipment covered by the Submittal, may be incorporated into the Work until the Contractor has made the necessary revisions, resubmitted the Submittal and received the Submittal back marked either "NO EXCEPTIONS TAKEN" or "MAKE CORRECTIONS NOTED."

- "REJECTED": If the Submittal is marked "REJECTED" it means that the Owner's Representative has found the Submittal, material or product data to be unacceptable and not in conformance with the Contract. Generally speaking, rejection of a Submittal simply indicates the Owner's Representative's belief that the defects in the Submittal are so great that it cannot be revised in order to make it conform to the Contract, as indicated in paragraph I (3) above. The Contractor may not begin work indicated by the Submittal, nor incorporate material or equipment, nor proceed with Work dependent upon review of the Submittal, into the Work based on any Submittal, product data or material that has been marked "REJECTED."

The following rules about Contract Time shall apply to Submittals. Contract Time will not be extended if:

- The Contractor's delay resulted from the Owner's use of the full amount of allotted time under the Contract to review the Contractor's Submittal;
- The Contractor's delay resulted from its own failure to provide a submittal in a timely manner;
- The Contractor's delay resulted from a submittal that properly was marked "Revise and Resubmit," "Rejected;" or
- The Contractor did not understand what it was required to submit and failed to inquire about it in a timely manner.

The Contractor shall keep a current schedule of submittals available for the Owner's Representative to review.

## 5.1 Extra Work and Contractor Change Orders

Owner and Contractor mutually agree that changes in Plans, quantities, or details of the Work are inherent in the nature of construction and may be necessary or desirable. Therefore, without impairing the Contract, the Owner reserves the right to require changes determined necessary or desirable to complete the proposed construction within the general scope of the Work provided for in the Contract or to order Extra Work if that is required. Performance of changed or Extra Work shall be in accordance with requirements of the Contract.

When the Owner's Contract Administrator is contemplating changed or Extra Work, a Notice of the proposed changed or Extra Work together with a solicitation for a quotation for the performance of the changed or Extra Work shall be issued to the Contractor, in writing, by the Owner's Contract Administrator.

During construction, any change that the Contractor performs that varies from the approved Contract requires a change order submitted and approved by PGE prior to commencing work. A Contractor change order will require review by multiple PGE individuals and PGE will be allowed fourteen (14) days before the change order is approved or denied. A contractor's failure to notify PGE in advance of the change being performed will be denied for payment and time extensions.

During construction, the contractors site Project Manager and the PGE Site Inspector will need to maintain regular discussions with the PGE engineering team. It is expected that changes that occur are addressed far enough ahead to not impact the overall project schedule. On-site weekly meetings discussing

upcoming work should address possible change issues far in advance before a change order is submitted.

Contractor will be responsible to submit with the change orders all supporting e-mails and documentations supporting the change order request. Copies of all invoices from material suppliers are to be included with the change order to support costs outlined in a change order.

When preparing its Change Order, or when beginning any portion of the Work, the Contractor shall use the following order of precedence to resolve any Extra Work and Change Order requests:

For Change Orders for a Maximum of $5,000 Value:

- PGE Site Inspector can give verbal approval for the contractor to proceed based on a follow-up written Change Order submittal by the contractor.

- Contractor submits a Change Order request via SharePoint and also to the PGE Contract Administrator and CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order request cost. The Change Order submittal shall be no greater than 15 days from the change.

For Change Orders over $5,000 but No Change to Project Scope or Schedule:

- Contractor discusses the requirement for the Change Order with the PGE Site Inspector but does not proceed.

- Contractor submits a Request for Information (RFI) to PGE via the SharePoint site or requests technical support from PGE Engineering immediately or within 5 business days of Change Requirement.

- PGE will respond to the RFI or technical request to the Contractor within 5 business days after the RFI or technical request.

- Contractor submits the Change Order to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order costs. The Change Order submittal shall be no greater than 15 days from the original contractor RFI or technical request from PGE. Greater than 15 days shall be allowed with a PGE approval per Change Order.

- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE Engineering discuss the Change Order.

- PGE Contract Administrator approves/denies the Change Order with PGE PM and PGE Engineering support.

For Change Orders to Revise the Project Scope - Regardless of Cost:

- Contractor discusses the requirement for the Scope Change/Change Order with the PGE Site Inspector but does not proceed on the work.

- Contractor requests information from PGE Engineering through an RFI submittal within 5 business days.

- PGE will respond to the RFI or technical request to the Contractor within 5 business days after the RFI or technical request.

- Contractor submits the Change Order to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change Order costs. The Change Order submittal shall be no greater than 15 days from the original contractor RFI or technical request from PGE. Greater than 15 days shall be allowed with a PGE approval per Change Order.

- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE Engineering discuss the Scope Change.

- PGE Contract Administrator approves/denies the Change Order after PGE PM and PGE Engineering approval.

For Change Orders to Revise the Overall Project Schedule - Regardless of Cost:

- Contractor discusses the requirement for the Schedule Change with the PGE Site Inspector.

- Contractor discusses the schedule change with the PGE PM and the PGE Contract Administrator.

- PGE will respond to a schedule change request within 5 business days after the request.

- Contractor submits a Change Order for the Schedule change to the PGE Contract Administrator before proceeding. CC's the PGE PM. The Change Order request will include supporting documentation, e-mails and material costs supporting the Change. The Change Order shall be submitted no greater than 15 days from the original schedule discussions with PGE.

- PGE Contract Administrator, PGE Site Inspector, PGE PM and PGE Engineering discuss the Schedule Change.

- PGE Contract Administrator approves/denies the Schedule Change on the Change Order after PGE PM and PGE Engineering approval.

## 6.1 Differing Site Conditions

The Contractor shall promptly, and before the conditions are disturbed, give written Notice to the Owner's Representative of:

- Pre-existing subsurface or latent physical conditions at the site which differ materially from those indicated in this Contract, or;

- Pre-existing unknown physical conditions at the site, of an unusual nature, which differ materially from those ordinarily encountered and generally recognized as inherent in the work of the character provided for in the Contract.

After receipt of the Notice, the Owner's Representative will investigate the conditions encountered by the Contractor promptly. If the Representative finds that the conditions are materially different and cause a material increase or decrease in the Contractor's cost of, or the time required for, performing any part of the Work under this Contract, whether or not changed as a result of the conditions, an Equitable Adjustment to the Contract will be made under this clause and the Contract modified in writing accordingly. If possible, Owner and Contractor shall agree on the adjustment to be made. If they are unable to agree, the Representative will determine the amount of the Equitable Adjustment and adjust the time to perform if appropriate. If the Representative finds that differing site conditions do not exist, that decision is final and binding upon the Contractor.

Contractor has waived its right to bring a Claim for additional compensation or Contract Time for encountering a differing site condition unless the Contractor has given the Notice required by the Paragraph above. No request by the Contractor for an Equitable Adjustment to the Contract as a result of a differing site condition will be allowed if the request is made after Final Payment under this Contract.

## 7.0 AUTHORITY OF THE OWNER'S REPRESENTATIVE'S

The Work shall be performed to the complete satisfaction of the Owner's Field Inspector and Contract Administrator.

Work will not be considered completed until it has passed final inspection by the Owner's Field Inspector and is accepted by the Owner. The authority of the Owner's Field Inspector is such that the Contractor shall at all times carry out and

fulfills the instructions and directions of the Owner's Representative's in so far as they concern the work to be done under the Contract.

The Owner's Contract Administrators decisions will be final, binding and conclusive on the Contractor on all questions that arise regarding the quantity of materials and work, the quality of materials and work, the acceptability of materials furnished and work performed, the acceptable rate of progress of the work, the interpretation of the Plans and Specifications, the measurement of all quantities, the acceptable fulfillment of the Contract on the part of the Contractor, and payments under the Contract.

If the Contractor fails to comply with any reasonable order made under the provisions of this Subsection, the Owner's Contract Administrator shall have the authority to cause unacceptable work to be remedied or removed and replaced, and unauthorized work to be removed, and to deduct the costs thereof from any money due or to become due the Contractor.

Nothing in this Subsection or elsewhere in the Contract shall be construed as requiring the Owner's Field Inspector and Contract Administrator to direct or advise the Contractor on the method or manner of performing any work under the Contract. No approval or advice as to the method or manner of performing or producing any materials to be furnished shall constitute a representation or warranty by the Owner that the result of such method or manner will conform to the Contract, relieve the Contractor of any of the risks or obligations under the Contract, or create any liability to the Owner because of such approval or advice.

An Architect, Engineer, Designer or other person hired or employed by Owner under a separate Contract is not the Owner's Field Inspector nor Contract Administrator, unless the Contract Documents expressly state otherwise. Contractor will be notified if the Owner's Representatives have been changed.

The Owner's Field Inspector and Contract Administrator may assign Inspectors, assistants and other persons to advise the Owner whether the work and materials meet Contract requirements. Such determination may extend to any or all parts of the Work and to the preparation or manufacture of materials to be used.

In the event that assigned personnel discover defective materials or work not being performed safely or in accordance with Contract requirements, the Owner's Contract Administrator shall have the authority to reject the materials or to suspend the Work.

Assigned personnel, including but not limited to, Inspectors and assistants, are not authorized to approve or accept any portion of the Work, to accept materials, to issue instructions or to give advice that is contrary to the Contract. Work done or material furnished that does not meet Contract requirements shall be at the

Contractor's risk, and does not provide a basis for a Claim even if it is asserted that assigned personnel changed Contract requirements.

In the event that assigned personnel or the Owner's Representatives fail to observe, call out or note faulty work, defective materials, errors, or the Contractor's failure to comply with Contract requirements, that failure does not constitute acceptance or approval of that particular portion of the Work. If this occurs, the Contractor remains obligated to perform the Work in accordance with the Contract Documents, without additional compensation or Contract Time.

The provisions of this Subsection do not apply to Regulatory Inspectors.

If any Owner's Representatives note faulty work, defective materials, errors or the Contractor's failure to comply with Contractor requirements, it will notify the Contractor's Representative.

## 8.0 Project Meeting Requirements

The contractor shall provide an onsite location where at least bi weekly meetings (every other week) shall be held between PGE and the contractor. PGE representatives will include the Project Manager, Contract Manager, Project Engineer, Site Inspector, and may include others. The meeting time and dates will be scheduled in advance and agreed to by both parties. The meetings will review project progress, discuss future work, and work out other outstanding issues.

## 9.0 Progress Reports

Weekly progress reports will be provided by the contractor to the Project Manager and Contract Manager.

**END OF SECTION**

# SECTION 2100 Erosion and Sediment Control Plan (ESCP) and NPDES Stormwater Discharge Permits (1200-C or 1200-CN)

## 1.0 General

### 1.1 Scope:

The work covered by this specification includes: furnishing of all labor, equipment and materials required for creating and providing an Erosion and Sediment Control Plan (ESCP) and submittal for a 1200-C or 1200-CN permit.

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit as required by the Department of Environmental Quality (DEQ) or its local agent. A copy of the approved permit and associated documents shall be kept onsite at all times and properly maintained and updated.

Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

### 1.2 Submittals

A. All 1200-C or 1200-CN documents (application, action plan, ESCP plan and /or drawings, narratives, inspection forms, etc.) shall be kept in a 3-ring binder or booklet as a minimum. Documents shall meet all requirements by the Oregon DEQ and/or local municipalities.

B. Contractor shall submit all necessary application forms, drawings, and other required documents to Owner for review prior to submitting to DEQ.

### 1.3 Additional Information and Links

Information regarding application process and required submittals can be found at the Oregon Department of Environmental Quality NPDES Stormwater Discharge Permits – Construction Activities website:

http://www.deq.state.or.us/wq/stormwater/construction.htm

## END OF SECTION

# SECTION 2110 CLEARING & GRUBBING

## 1.0 General

1.1 Scope:

The work covered by this specification includes: furnishing of all labor, equipment and materials required for clearing, grubbing, removal, and disposal of all rocks, trees, vegetation, rubbish, refuse trash and debris within the grading limits of the site, including access roads, drainage ditches, and other designated areas as shown on the drawings or specified herein.

## 2.0 Execution

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

Clearing: Contractor shall remove and dispose of trees, stumps, logs, limbs, sticks, vegetation, rubbish, debris, and other material on the natural ground surface. All areas within the designated grading limits or as required for access to the site or other purposes shall be cleared.

Grubbing: Contractor shall completely remove and dispose of roots, stumps, buried logs, debris, rocks and other materials that protrude through the surface within the site grading and site access limits.

All debris shall be disposed off-site by the Contractor.

Off-site disposal of debris shall be completed according to prevailing laws, ordinances, regulations, and rules, and at no additional cost to the Owner. The Contractor shall have on file a copy of the disposal permits or agreements.

**END OF SECTION**

# SECTION 2120 SITE GRADING

## 1.0 General

1.1 Scope:

The work covered by this specification includes: furnishing labor, equipment and materials required for removal of topsoil, cutting, grading, filling, rough contouring, and compacting materials as required to establish the subgrade elevations for the site including interior and exterior access roads as shown on the drawings and specified herein.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

AASHTO T 176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test

AASHTO T 180 Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/$ft^3$ (2,700 kN-m/$m^3$))

ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Oregon Department of Environmental Quality (DEQ) Environmental Protection Agency (EPA)
National Pollution Discharge Elimination System (NPDES) Occupation Safety and Health Administration (OSHA)

1.3 Submittals

A. Contractor shall submit:

1. Aggregate suitability using a gradation (AASHTO T 27) and sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.
2. Maximum dry density and optimum moisture content. Refer to ASTM D 1557, D 698, AASHTO T 180, Method D.
3. Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The contractor shall verify that the aggregate and fill material meets Geotechnical engineering and state specifications.

## 2.0 Materials

2.1 General

Materials used for construction of embankments as shown on the drawings shall comply with the following:

2.2 **FILL TYPE RG-1** [In-Situ]: Re-use excavated and native material, as recommended in the Geotechnical Report and drawings. If a Geotechnical Report is not available, existing soil may be used for backfill if approved by Owner representative. Backfill shall be unsaturated, free of clay lumps, deleterious materials or stones larger than four inches in greatest dimension. Inorganic or organic silts, clays and peat soil types (ASTM soil group symbol ML, CL, MH, CH, OL, OH and PT) are not suitable for backfill. No frozen material shall be used as backfill.

2.3 **FILL TYPE RG-2** [Imported Fill]: Imported fill free of friable material and debris; graded in accordance with ASTM T 27; within the following limits:

A. Gradation (per AASHTO T 27)

| Sieve Size | Percent Passing |
|---|---|
| 4 inch | 100 |
| 3 inch | 88 to 100 |
| ¾ inch | 70 to 90 |
| No. 10 | 40 to 60 |
| No. 40 | 20 to 40 |
| No. 200 | less than 15 |

B. Sand Equivalent: 30 minimum per AASHTO T 176

2.4 Road Finish Rock: Imported fill consisting of untreated base course material meeting state Department of Transportation (DOT) requirements. Also refer to Section 2170 – Road Finish Rock

2.5 Aggregate Base Course: Imported fill as specified in Section 2150

## 3.0 Execution

3.1 Construction Layout and Surveying

Contractor shall provide all surveying work as required to maintain the lines, grades, and elevations required and shown on the drawings. Contractor shall set up temporary north-south and east-west base line markers outside the area to be graded so they will not be disturbed. Contractor shall set necessary cut and fill stakes. Before any earthwork, Owner shall approve all markers and stake locations.

After grading, Contractor shall establish and maintain horizontal and vertical references for locating all structures, fence lines and station equipment during construction.

Survey precision; for purposes of grading, elevations shall be within 0.1 feet and 0.01 feet for top of foundations and markers. Horizontal precision shall be sufficient to insure ease of erection of structures and placement of station equipment.

Contractor shall establish five permanent base line markers after station surfacing is complete. Markers shall be steel pins (rebar) extending below frost depth. The marker at the intersection of the lines shall be set about three inches below finished grade. The remaining four markers shall be set on the line, approximately three feet inside the fence. All markers shall be punched marked where the lines cross.

3.2 Excavation

Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

Excavation work shall include the removal and subsequent handling of all soil materials excavated or otherwise removed in performance of excavation work. Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area.

Topsoil material removed is deemed "unsuitable" for use in embankments or as a subbase for roads or substation subgrade. Contractor shall excavate the unsuitable material to the depth shown on the drawings and haul to an off-site disposal location. Location of a suitable disposal site is Contractor's responsibility.

After completion of topsoil removal, Contractor shall excavate to establish subgrade elevations in "cut" areas of the site. Excess excavated material not used in embankment shall be removed from the site and disposed of by the Contractor. The Contractor shall meet the recommendations in the Geotechnical Report and Drawings.

3.3 Embankment

Embankment shall consist of the construction of fills and placing of miscellaneous backfills, to the lines, grades, dimensions and typical sections shown on the plans and according to the Geotechnical Report.

All embankments shall be constructed from material type (**RG-1 and RG-2**) as defined above.

When constructing embankments on existing slopes, slopes shall be benched to
½ horizontal to 1 vertical (1/2H: 1V) prior to placement of fill material.

If it should become necessary, because of weather or other conditions, to

suspend grading operations, the entire area worked upon shall be bladed until smooth, free of depressions, and ruts, and crowned so that no water can collect or be impounded.

Embankment material shall be placed in uniform layers not to exceed nine (9) inches in loose thickness, for the entire width of the embankment. Each layer of embankment shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density. Each lift shall be conditioned to near optimum moisture content and compacted to a density equivalent to at least ninety-five (95%) or ninety-eight (98%) percent of the maximum dry density obtainable by the ASTM D 1557 or ASTM D 698 respectively or as recommended in the Geotechnical Report. In-place field density shall be measured in accordance with ASTM D 1556 (sand cone) or ASTM D 6938 (nuclear gauge).

3.4 Road Finish Rock

Road Finish Rock consists of installation of untreated road base material on areas designated on the drawings for roadways or parking. Prior to placing road finish rock materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment. Areas that pump or significantly deflect shall be over excavated as required and the material replaced with Road Finish Rock. Refer to Section 2170 – Road Finish Rock for placement and compaction.

3.5 Aggregate Base Course

Aggregate Base Course material shall be placed on areas designated on the drawings. Prior to placing Aggregate Base Course materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment. Areas that pump or significantly deflect shall be over excavated as required by the Geotechnical Report and replaced with Aggregate Base Course. Refer to Section 2150 – Aggregate Base Course for placement and compaction.

**END OF SECTION**

# SECTION 2130 GENERAL EXCAVATION & BACKFILL

## 1.0 General

### 1.1 Scope

This section covers the backfill and compaction of excavations for footings, foundations, and other miscellaneous facilities. Included are specifications for excavation, compaction and backfill materials. Contractor shall review appropriate drawings for the following typical installations:

A. General Backfill and Compaction:

Backfill and compaction required to bring low areas, miscellaneous excavation work, and replace soft spots to required contours and elevations.

B. Structural Backfill and Compaction:

Backfill and compaction required to restore the grade around footings, foundation walls, retaining walls, slab and pier foundations to required contours and elevations.

C. Roadway Backfill and Compaction:

Backfill and compaction for the installation of access roads, substation interior roads and parking areas to required contours and elevations

### 1.2 Codes and Standards

| | |
|---|---|
| AASHTO T 180 | Moisture-Density Relations of Soils Using a 10-lb (4.54-kg) Rammer and an 18-in. (457-mm) Drop |
| ASTM C33: | Standard Specification for Concrete Aggregates ASTM |
| C136: | Method for Sieve Analysis of Fine and Coarse Aggregates. |
| ASTM D 698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) |
| ASTM D 1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)) |
| ASTM D 1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 6938 | Standard Test Methods for In-Place Density and Water |

Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 Submittals:

Contractor shall submit gradation test results per ASTM C136 and moisture-density relationships per ASTM D698, D1557 or AASHTO T180 to the Owner for approval for all imported aggregate materials two weeks prior to start of backfilling.

1.4 Field Measurements:

Contractor shall verify that survey bench mark and intended elevations for the work are as shown on drawings. Locate all underground utilities prior to starting excavation work.

1.5 Information Supplied by Owner:

Contractor shall obtain a copy of the Geotechnical Report which shall provide site specific geotechnical recommendations. If a Geotechnical Report is not available, the Owner will determine if existing soils are suitable for use as backfill.

## 2.0 Materials

2.1 Fill Materials:

A. Fill Type **RG – 1** [In-Situ]: Re-use excavated and native material, or as recommended in the Geotechnical Report and drawings. If a Geotechnical Report is not available, **e**xisting soil may be used for backfill if approved by Owner representative. Backfill shall be unsaturated, free of clay lumps, deleterious materials or stones larger than four inches in greatest dimension. Inorganic or organic silts, clays and peat soil types (ASTM soil group symbol ML, CL, MH, CH, OL, OH and PT) are not suitable for backfill. No frozen material shall be used as backfill.

B. Fill Type **RG-2**: Imported fill free of friable material and debris; graded in accordance with ASTM T-27; within the following limits:

Gradation (per AASHTO T 27)

| Sieve Size | Percent |
|---|---|
| Passing 4 inch | 100 |

| | |
|---|---|
| 3 inch | 88 to 100 |
| ¾ inch | 70 to 90 |
| No. 4 | 40 to 60 |
| No. 40 | 20 to 40 |
| No. 200 | less than 15 |

C. Aggregate Base Course: As specified in Section 2150.

D. Road Finish Rock: As specified in Section 2170. (APWA or state specified untreated base coarse)

## 3.0 Execution

3.1 Preparation

A. Prior to commencement of any land disturbing activities greater than one acre (>1 acre or as stipulated), contractor (or Owner) shall obtain a 1200-C or 1200-CN erosion control permit to be posted on site (refer to Section 2100). Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the Erosion and Sediment Control Plan (ESCP). If at any time during construction the Contractor encounters or exposes any abnormal condition, which indicates the presence of a hazardous material, toxic or hazardous waste, work shall be immediately suspended and the Owner notified. Work in the affected areas shall not resume until so directed by the Owner.

B. Identify required lines, levels, contours, and datum.

C. Protect plant life, lawns, and other features remaining as a portion of final landscaping.

D. Protect bench marks, existing structures, foundations, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

E. Maintain and protect existing above and below grade utilities.

F. Over excavate and remove any unsuitable soft native soils. Backfill as recommended in the Geotechnical Report. If a Geotechnical Report is not available backfill with Road Finish Rock as defined in Section 2170. Road Finish Rock shall be conditioned to within +/- 2% of optimum moisture and compacted to at least 95% of the maximum dry density according to ASTM D 1557 or 98% of the maximum dry density according to ASTM D 698.

3.2 Excavation

A. Excavate subsurface soils as required for the installation of the work per the drawings.

B. Do not interfere with the bearing splay of existing foundations, about $45^{o}$ from the foundation base.

C. Manually remove loose, lumped or frozen subsoil, boulders, rock greater than three (3") inches in diameter and other deleterious matter.

D. Correct areas over excavated under the direction of the Geotechnical Engineer or Owner Engineer.

E. Stockpile excavated material in an area where they will not contaminate other soils or Yard Finish Rock. If excavated soil is suitable for backfilling, designate an area within the construction limits and remove excess material not being used, from the site.

3.3 Backfill

A. Backfill in accordance with the typical cross-sections, contours and elevations as shown on the drawings. Backfill materials shall be placed without frozen lumps, snow or entrained ice.

B. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Correct these areas under the direction of the Geotechnical Engineer or Owner Engineer.

C. Employ a placement method that does not disturb or damage existing foundations, utilities, conduit duct, cable or wire. Backfill simultaneously on each side of unsupported foundation walls until support is in place.

D. Condition soil to be used as backfill within +/- 2% optimum moisture content. Properly place backfill materials in (9") nine-inch loose horizontal lifts and compact as shown on the drawings. Each lift shall be compacted to at least 95% of maximum dry density per ASTM D 1557 modified.

Contractor shall notify Owner prior to any backfill operation so equipment and intended compaction methods can be reviewed for approval by Owner.

3.4 Tolerances

The top surface of backfilling shall match surrounding grade after compaction. Yard or Road Finish Rock shall be applied after completion of backfill work as required by drawings. Refer to Section 2160, Yard Finish Rock and Section 2170, Road Finish Rock.

3.5 Field Quality Control

Owner shall hire an approved independent testing agency to perform compaction tests accordance ASTM D 6938. Work not meeting specified requirements shall be removed, replaced, compacted, and retested at the Contractors expense.

Test frequency shall be a minimum of one test per two-hundred (200 square feet (surface) or as determined by the Geotechnical Report or Owner Engineer.

Testing agency shall meet laboratory requirements according to ASTM and be certified in both AASHTO Materials Reference Laboratory (AMRL) and Cement and Concrete Reference Laboratory (CCRL).

3.6 Protection of Finished Work

Contractor shall protect footings, foundation walls, piers, flat foundations, and embedded anchor bolts as required to prevent damage during backfill and compaction work.

**END OF SECTION**

# SECTION 2140 TRENCH EXCAVATION & BACKFILL

## 1.0 General

### 1.1 Scope

This section covers the installation of electrical utilities, piping, conduits, culverts and other underground facilities. Included are specifications for excavation, compaction, bedding and backfill materials. Methods for excavation, placement of the utility and backfill differ for each utility installed and on site conditions. Contractor shall review appropriate drawings for typical installed trench cross sections.

In general, they are as follows:

A. Grounding: Main ground girds are placed in narrow trenches and at termination and crossing points in wider excavations. Trenches are backfilled with in-situ soils only.

B. Conduit Banks: Conduit banks are placed in trenches either singularly or in groups. Main runs are placed on a sand bed and covered with a layer of sand, fluidized thermal backfill, red concrete, or red control density fill.

D. Culverts and Underground Piping: Culverts and piping installations vary and are specified in the drawings.

Contractor shall furnish all material, labor, tools and equipment necessary to install utilities as shown on the drawings and as specified herein.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Society of Testing and Materials (ASTM)

ASTM C 33 Standard Specification for Concrete Aggregates ASTM C

136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

ASTM D 698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

ASTM D 1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/$ft^3$ (2,700 kN-m/$m^3$))

ASTM D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

ASTM D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

## 1.3 Submittals

Contractor shall submit gradation test results per ASTM C 136 and moisture-density relationships per ASTM D 698 or D 1557 to the Owner for approval for all imported aggregate materials two weeks prior to start of backfilling.

## 1.4 Field Measurements

Contractor shall verify that survey bench mark and intended elevations for the Work are as shown on drawings. Locate all underground utilities before starting excavation work.

## 1.5 Coordination

Contractor shall coordinate all substation work and verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

## 1.6 Information Supplied by Owner

Contractor shall obtain a copy of the Geotechnical Report which shall provide site specific geotechnical recommendations. If a Geotechnical Report is not available, the Owner will determine if existing soils are suitable for use as backfill.

## 2.0 Materials

### 2.1 Fill Materials

A. Soil Fill Type [In-situ]: Re-use excavated and/or native material as recommended in the Geotechnical Report and drawings. If a Geotechnical Report is not available, soil may be used for backfill if approved by Owner representative. Backfill shall be unsaturated, free of clay lumps, deleterious materials or stones larger than four inches in greatest dimension. Inorganic or organic silts, clays and peat soil types (ASTM soil group symbol ML, CL, MH, CH, OL, OH and PT) are not suitable for backfill. No frozen material shall be used as backfill.

B. Aggregate Base Course: As specified in Section 2150

C. Aggregate Surfacing – Road Finish Rock: As specified in Section 2170

D. Concrete: Structural concrete conforming to Section 3000 with a compressive strength of 3,000 psi

E Controlled Density Fill: As specified in Section 3010

## 3.0 Execution

### 3.1 Preparation

A. Prior to commencement of any land disturbing activities greater than one acre (>1 acre), If required, contractor shall obtain a Storm Water Pollution Prevention Plan (SWPPP) General Permit or Notice of Intent (NOI) to be posted on site. Contractor shall adhere to the Best Management Practices (BMP's) as indicated in the SWPPP.

B. Identify required lines, levels, contours, and datum.

C. Protect plants, lawns, and other features remaining as a portion of final landscaping.

D. Protect benchmarks, structures, foundations, fences, sidewalks, paving, and curbs from excavation equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities which are to remain.

F. Over excavate and remove any unsuitable soft native soils. Backfill as recommended in the Geotechnical Report. If a Geotechnical Report is not available, reference table 1 for appropriate backfill.

## 3.2 Excavation

A. Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area.

B. Excavate trenches sufficiently wide to enable installation of utilities and allow room for inspection.

C. Excavations shall not interfere with the bearing splay of foundations, about $45^{o}$ from the foundation base.

D. Manually remove loose, lumped or frozen subsoil, boulders, rock greater than two (2”) inches in diameter and other deleterious matter.

E. Correct areas over excavated under the direction of the Geotechnical Engineer or Owner Engineer.

F. Stockpile excavated material in an area where they will not contaminate other soils or Yard Finish Rock. If excavated soil is suitable for backfilling, designate an area within the construction limits and remove excess material not being used, from the site.

## 3.3 Backfilling

A. Backfill trenches in accordance with the typical cross sections, contours and elevations shown on the drawings. Backfill materials, listed above, shall be placed without frozen lumps, snow or entrained ice.

B. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Correct these areas under the direction of the Geotechnical Engineer or Owner Engineer.

C. Employ a placement method that does not disturb or damage conduit duct, cable or wire in trench.

D. Condition soil to be used as backfill within +/- 2% optimum moisture content. Properly place backfill materials in (9”) nine-inch loose horizontal lifts and compacted to the required density shown in table

1. Contractor shall notify Owner before any backfill operation so equipment and intended compaction methods can be reviewed for approval by Owner.

E. At some locations, as shown on the drawings, a red concrete protective cap, or warning tape shall be installed over the cover backfill. Refer to construction drawings.

## 3.4 Tolerances

The top surface of backfilling shall match surrounding grade after compaction. Yard Finish Rock shall be applied after completion of backfill work as required by drawings.
Trenches for duct banks shall be excavated to lines indicated on the drawings or at other locations acceptable to the Owner Engineer and to within ½ of depth required.

## 3.5 Field Quality Control

Owner shall hire an independent testing agency to perform compaction tests accordance ASTM D 6938 Work not meeting specified requirements shall be removed, replaced, compacted, and retested at the Contractors expense.

Test frequency shall be a minimum of one for every 50 lf of trench installed or as determined by the Geotechnical Engineer.

## 3.6 Protection of Finished Work

Contractor shall provide adequate protection of excavated side slopes as recommended by Occupation Safety and Health Administration (OSHA) and the Geotechnical Report to protect all personnel and to prevent "sloughing or cave in" into the work area. Removed soil from the excavation shall be stored away from the trench to avoid sloughing into the trench. Protection from freezing and water accumulation shall be provided for the bottom of excavations and soil adjacent to and beneath adjacent foundations.

**Table 1**
**Materials, Compaction, and Testing Requirements**

| Material | Gradation Requirements | Plasticity Require-ments | Maximum Density | Maximum Density Test Frequency | Required Field Density | Field Density Test | Frequency | Field Water Content | Field Water Content Test | Lift Thicknes | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Trench subgrades | - | - | | | | | | | | - | Trench subgrades shall be firm, dense, free from mud, and sufficiently stable to remain firm and intact. |
| 30 inch pipe or smaller Crushed rock or crushed gravel embedment | Perform at least two gradation tests; at least 95% passing 1/2" sieve and not more than 5% passing No. 4 sieve | Nonplastic | ASTM D4253 and ASTM D4254 | 2 initial tests; further tests as directed | 70% Relative Density | ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167) | One test per 100 feet of trench for each lift | - | - | 8" max | Minimum 4 passes with a vibratory flat plate tamper |
| Sand embedment | Perform at least two gradation tests; at least 95% passing No. 4 sieve and not more than 5% passing No. 100 sieve | Nonplastic | ASTM D698, Method C | 2 initial tests; further tests as directed | 95% Max. Dry Density | ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167) | One test per 100 feet of trench for each lift | - | - | 8" max | Clean sand |
| Groundwater barrier | - | Cohesive material (Soil Classifi-cation GC, SC, CL, or ML as indicated in ASTM D2487, Table 1 | ASTM D698, Method C | 2 initial tests; further tests as directed | 95% Max. Dry Density | ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167) | One test for each groundwater barrier | -2% to +2% of optimu m water content | ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D 2167) | 8" max | Material may be finely divided suitable job excavated material, free from stones, organic matter, and debris |

**Table 1**
**Materials, Compaction, and Testing Requirements**

| Material | Gradation Requirements | Plasticity Require-ments | Maximum Density | Maximum Density Test Frequency | Required Field Density | Field Density Test | Frequency | Field Water Content | Field Water Content Test | Lift Thicknes | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Trench backfill | 3" max particle size | LL < 40 PI < 15 | ASTM 698, Method C | 2 initial tests; further tests as directed | 90% Max Dry Density | ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167) | One test per 100 feet of trench for each lift | -2% to +2% of optimu m water content | ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D 1556 or ASTM D 2167) | 8" max | - |
| Trench backfill traversing subgrades of streets, roads, railroads, parking areas, underground piping, underground electrical ducts and conduit, and other facilities subject to damage by settlement | 3" max particle size | - | ASTM D698, Method C | 2 initial tests; further tests as directed | 95% Max Dry Density | ASTM D6938; and ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167) | One test per 100 feet of trench for each lift | -2% to +2% of optimu m water content | ASTM D6938; ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASATM D2167) | 8" max | |

# END OF SECTION

# SECTION 2150 AGGREGATE BASE COURSE

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Aggregate Base Course as shown on the drawings, geotechnical report, and specified herein.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| AASHTO T 27 | Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 176 | Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test |
| AASHTO T 180 | Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop |
| ASTM D 698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) |
| ASTM D 1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)) |
| ASTM D 1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

1.3 Submittals

A. Contractor shall submit:
   1. Aggregate suitability using a gradation (AASHTO T 27) and sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.
   2. Maximum dry density and optimum moisture content. Refer to

ASTM D 1557, D 698, and AASHTO T 180, Method D.

3. Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The contractor shall verify that the aggregate and fill material meets Geotechnical Engineering and state specifications.

## 2.0 Materials

Aggregate Base Course material shall be sound, hard, durable crushed rock uniformly graded from coarse to fine. The aggregate shall conform to the following specifications unless otherwise approved by Owner.

A. Gradation (per AASHTO T 27)

| Sieve Size | Per Cent |
|---|---|
| 3” | 100 |
| 2-½” | 85-100 |
| 1-¼” | 55-75 |
| 3/8” | 30-45 |
| #10 | 15-25 |
| #40 | 10-20 |
| #200 | 0-7 |

B. Sand Equivalent (per AASHTO T 176) Minimum of 30

C. Fractured Face

Provide at least one mechanically fractured face for a minimum of 50% of particles retained on the #4 US Standard size sieve.

## 3.0 Execution

Aggregate Base Course material shall be placed on areas designated on the drawings. Prior to placing Aggregate Base Course materials, the subgrade shall be proof rolled with a fully loaded dump truck or similar equipment. Areas that pump or significantly deflect shall be over excavated as required by the Geotechnical Report and replaced with Aggregate Base Course. Aggregate Base Course material shall be placed in uniform layers not to exceed (9) nine inches in loose thickness, for the entire width of the surface. Each layer of Aggregate Base Course shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density.

Each lift shall be conditioned to +/- 2% of the optimum moisture content and compacted to a density at a minimum of ninety-five (95%) percent of the maximum dry density according to ASTM D1557modified, ninety-eight (98%) percent of the maximum dry density according to ASTM D 698, standard or as recommended by the Geotechnical Engineer. In place, field density shall be verified in accordance with ASTM D 1556 or ASTM D 6938.

## END OF SECTION

# SECTION 2160 YARD FINISH ROCK

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Yard Finish Rock as shown on the drawings and specified herein.

Yard Finish Rock shall be sourced from Knife River Materials (Watters Quarry) and/or K & E Excavation (Davis Creek Quarry) and shall meet the criteria in section 2.0.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

AASHTO TP 61 Determining the Percent of Fracture in Coarse Aggregate

American Society of Testing and Materials Standards (ASTM)

ASTM D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate

### 1.3 Submittals

A. Contractor shall submit:
   1. Aggregate suitability using a gradation (AASHTO T 27) within the gradation limit as stated in section 2.0.
   2. Name of supplier, date sampled and location of source.
   3. Five gallon bucket sample of proposed yard finish rock to the Owner for testing.

   Sample shall be submitted to the Owner for review, testing, and approval prior to placing any material.

## 2.0 Materials

Yard Finish Rock used to surface the substation yard as shown on the drawings shall be sound, hard, durable, clean angular crushed rock.

The rock shall meet the following criteria:

A. Sieve Analysis (per AASHTO T27)

| Sieve Size | Percent Passing By |
|---|---|
| 1½" | 100 |
| 1" | 20-85 |
| ¾" * | 0-30 |
| ⅝" * | 0-30 |
| 1/4" | 0-5 |

*Material must meet either the ¾-inch or ⅝-inch sieve requirement, but not both.

B. Rock Quality (per AASHTO TP 61, or ASTM D 5821)

Fractured Faces: At least one mechanically fractured face on 95% of all particles retained on each sieve 1/4-inch and above. In addition, at least three mechanically fractured faces on 70% of the same particles.

C. Rock Resistivity

A minimum wet resistivity of 3,000 ohm-m is required for all Yard Finish Rock.

## 3.0 Execution

Yard Finish Rock shall be evenly spread and roller compacted on the designated areas of the yard as shown on the drawings. Final depth of Yard Finish Rock shall be four inches (4") or as shown on the drawings. Subgrade layer shall be prepared per section 2130 General Excavation & Backfill. Surface of Yard Finish Rock shall be free from corrugations or waves.

**END OF SECTION**

# SECTION 2170 ROAD FINISH ROCK

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of Road Finish Rock as shown on the drawings and specified herein.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| AASHTO T 27 | Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates |
| AASHTO T 176 | Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test |
| AASHTO T 180 | Standard Method of Test for Moisture-Density of Soils Using a 4.54-kg (10-lb) Rammer and a 457-(18-in.) Drop |
| AASHTO T 89 | Standard Method of Test for Determining the Liquid Limit of Soils |
| AASHTO T 90 | Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils |
| ASTM D 698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)) |
| ASTM D 1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)) |
| ASTM D 1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

### 1.3 Submittals

A. Contractor shall submit:
   1. Aggregate suitability using a gradation (AASHTO T 27) and

sand equivalent (AASHTO T 176), within the gradation limit as stated in section 2.0.

2. Maximum dry density and optimum moisture content. Refer to ASTM D 1557, D 698, AASHTO T 180, Method D.
3. Name of supplier, date sampled and location of source.

All imported fill material shall be submitted to the Owner for review and approval prior to placing any material. The contractor shall verify that the aggregate and fill material meets Geotechnical engineering and state specifications.

## 2.1 Materials

Road Finish Rock material shall be sound, hard, durable, crushed rock uniformly graded from coarse to fine. The Road Finish Rock shall conform to the following specifications unless otherwise approved by Owner.

A. Gradation (per AASHTO T 27)
Percent passing based on total aggregate (dry weight), and fine and coarse aggregate having approximately the same bulk specific gravities.

| Sieve Size | Percent |
|---|---|
| 1-½" | 100 |
| 1" | 90 - 100 |
| ¾ " | 70 - 85 |
| ½ “ | 65 - 80 |
| 3/8” | 55 – 75 |
| #4 | 40 - 65 |
| #16 | 25 - 40 |
| #200 | 7 - 11 |

B. Sand Equivalent (per AASHTO T 176) Not less than 30

C. Fractured Face (per AASHTO TP-61)
Provide at least one mechanically fractured face for a minimum of 50% of particles retained on the #4 US Standard size sieve.

D. Liquid Limit/ Plastic Index (per AASHTO T 89, T 90) Non-plastic

## 3.0 Execution

Road Finish Rock material shall be placed on areas designated on the drawings for roadways or parking. Prior to placing road finish rock the

subgrade shall be smoothed and compacted to required specification. Road finish rock shall be placed in uniform layers not to exceed nine inches (9”) in loose thickness, for the entire width of the road surface. Each layer of road finish rock shall be completed, leveled and uniformly compacted before the succeeding layer is placed. Water shall be added or removed, as necessary, in order to obtain the required density. Each lift shall be conditioned to near optimum moisture content and compacted to a density equivalent to at least ninety-five (95%) of the maximum dry density according to ASTM D 1557 or a minimum of ninety-eight (98%) of the maximum dry density according to ASTM D 698, or as recommended in the Geotechnical Report. In place field density shall be measured in accordance with ASTM D 1556 or ASTM D 6938.

## END OF SECTION

# SECTION 2180 DRAIN ROCK

## 1.0 General

1.1 Scope

The work covered by this specification includes the furnishing of all labor, equipment and materials required for placement of Drain Rock as shown on the drawings and as specified herein.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO T 27 Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates

1.3 Submittals

A. Contractor shall submit gradation (AASHTO T 27) tests to Owner for review and approval prior to placing any material.

## 2.0 Materials

Drain Rock used for backfilling of oil containment pits or yard drain systems as shown on the drawings shall be sound, hard, durable, clean angular rock. The rock shall meet the following criteria:

A. Gradation (per AASHTO T 27)

| Sieve Size | Percent Passing |
|---|---|
| 2" | 100 |
| 1 1/2" | 90 - 100 |
| 1" | 20 - 55 |
| 3/4" | 0 - 15 |

Drain rock shall meet the void ratio requirements specified in the drawings.

B. Rock Quality

Fractured Faces: At least one mechanically fractured face on 95% of all particles retained on each sieve. In addition, at least three mechanically fractured faces on 70% of the same particles.

C. Rock Resistivity

A minimum wet resistivity of 3,000 ohm-m is required for all aggregate surfacing.

## 3.0 Execution

Drain Rock shall be placed in a careful manner to prevent damage to drain piping or liner materials. Drain Rock shall be installed to the elevations or grades as shown on the drawings.

**END OF SECTION**

# SECTION 2190 GEOTEXTILES

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of geotextile as shown on the drawings and specified herein.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

AASHTO M 288 Geotextile Specification for Highway Applications

1.3 Submittals

A. Prior to use: Contractor shall submit manufacturers certificate that each fabric complies with requirements of this section and drawings.

## 2.0 Materials

**Silt Fence Geotextile** - Silt Fence Fabric: See AASHTO M 288 (Table 6 – Temporary Silt Fence Property Requirements)

**Drainage Geotextile** – Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as specified by the Owner. Notify Owner if soil conditions are different than shown on the drawings.

Non-woven geotextile shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum non-woven geotextile properties are as follows: Grab tensile

| | |
|---|---|
| strength ASTM D 4632 | 120 lb. |
| Grab elongation ASTM D 4632 | 50% |
| Mullen Burst ASTM D 3786 Mod. | 230 psi |
| Puncture strength ASTM D 4833 | 50 lb. |

| | |
|---|---|
| Apparent opening size ASTM D 4751 | ≤ # 70 sieve Permittivity |
| ASTM D 4491 | 1.50 $sec^{-1}$ |
| Ultraviolet stability ASTM D 4355 | 70 % strength retained |

**Erosion Control Geotextile** – Furnish non-woven drainage geotextile as specified in AASHTO M 288 with in-situ soil designations as shown on the drawings or as specified by the Owner. Notify Owner if soil conditions are different than shown on the drawings.
Non-woven geotextile shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum non-woven geotextile properties are as follows: Grab tensile

| | |
|---|---|
| strength ASTM D 4632 | 205 lb. |
| Grab elongation ASTM D 4632 | 50% |
| Mullen Burst ASTM D 3786 Mod. | 350 psi |
| Trapezoidal Tear ASTM D 4533 | 85 lb |
| Puncture strength ASTM D 4833 | 110 lb Apparent |
| opening size ASTM D 4751 | ≤ # 80 sieve Water flow |
| rate ASTM D 4491 | 110 gpm/ $ft^2$ |
| Ultraviolet stability ASTM D 4355 | 70 % strength retained |

**Separation Geotextile** - Furnish Class I fabric as specified in AASHTO M288 with Apparent Opening Size of 0.22 mm maximum average roll value.

**Non-woven geotextile** - Non woven geotextile shall meet the minimum requirements as per Drainage Geotextile.

**Woven geotextile** is a slit film. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum woven geotextile properties are as follows: Grab tensile

| | |
|---|---|
| strength ASTM D 4632 | 315 lb. |
| Grab elongation ASTM D 4632 | 15% |
| Mullen Burst ASTM D 3786 Mod. | 675 psi |
| Puncture strength ASTM D 4833 | 150 lb |

| | |
|---|---|
| Trapezoidal Tear ASTM D 4533 | 120 lb Apparent |
| opening size ASTM D 4751 | ≤ # 40 sieve Water Flow |
| Rate ASTM D 4491 | 4 gpm/ft$^2$ |
| Ultraviolet resistance ASTM D 4355 | 70 % strength retained |

**Stability Geotextile and Geogrid** – Furnish Class II fabric as specified in AASHTO M288 with Apparent Opening Size of 0.22 mm maximum average roll value.

**Woven Geotextile** – Woven geotextile shall meet the minimum requirements as per Separation Geotextile.

**Geogrid** is an integrally formed biaxial geogrid. This is a polypropylene, positive mechanical interlock system suitable for base reinforcement and subgrade improvement.
Minimum Biaxial Geogrid properties are as follows:

| | |
|---|---|
| Aperture Dimensions | 1 inch |
| Minimum Rib Thickness | 0.05 inch Tensile |
| strength @ 2% strain ASTM D 6637 | 410 lb. |
| Tensile strength @ 5% strain ASTM D 6637 | 810 lb. Ultimate Tensile |
| Strength ASTM D 6637 | 1310 lb Junction Efficiency GRI-GG2-05 93% |
| Flexural Stiffness ASTM D 5732 | 750,000 mg-cm |
| Aperture Stability | 0.65 m-N/deg |
| Resistance to Installation Damage ASTM D 6637 %SC/%SW/%GP | 90/90/90 |
| Ultraviolet resistance ASTM D 4355 | 100 % strength retained |

**Weed Barrier Geotextile** – Furnish fabric as specified in AASHTO M288 with elongation less than 50 percent.

**Woven to Non-woven geotextile** shall be composed of a polypropylene, staple fiber, needle punched, oriented into a stable network which will retain its relative structure during handling, placement and service. The geotextile shall be free of treatments or coatings that will significantly reduce permeability and be resistant to environmental conditions expected at the site.

Minimum woven to non-woven mix geotextile properties are as follows:

| | |
|---|---|
| Weight (Oz/Sq Yd) | 5.0 oz/sq avg. |
| Grab tensile strength ASTM D 4632 | 100 lb. |
| Grab elongation ASTM D 4632 | 50% |

| | |
|---|---|
| Mullen Burst ASTM D 3786 Mod. | 210 psi |
| Puncture strength ASTM D 4833 | 50 lb. |
| Trapezoid Tear ASTM D 4533 | 70 lb |
| Water permeability ASTM D 4491 | 12 gal/min/SF |
| Ultraviolet resistance ASTM D 4355 | 70 % strength retained |

**Cushion Fabric Geotextile–** is a polypropylene, stable fiber, needle punched non-woven geotextile. Fabric shall be installed according to drawings and manufacturers recommendations.

Geotextile cushion fabric shall be used for protection of the impermeable membrane and shall meet as a minimum of the following requirements:

| | |
|---|---|
| Grab tensile strength ASTM D 4632 | 380 lb. |
| Grab elongation ASTM D 4632 | 50% |
| Mullen Burst ASTM D 3786 Mod. | 750 psi |
| Puncture strength ASTM D 4833 | 240 lb. |
| Apparent opening size ASTM D 4751 | ≤100 US Std Sieve |
| Permittivity ASTM D 4491 | 0.7 $sec^{-1}$ |
| Ultraviolet stability ASTM D 4355 | 70 % strength |

The manufacturer of the liner shall approve Geotextile fabric used for underlayment of spray on liner system.

## 3.1 Execution

A. General

1. Place geotextile on areas that are smooth, and free of projections or depressions.
2. Install geotextile by unrolling fabric across subgrade. Orient the geotextile and install in the direction of traffic, if applicable.
3. Place first lift at a minimum of 6 inches of suitable fill material over geotextile without driving directly on the material. Do not end dump on the geotextile material.
4. Minimize driving and turning on the first lift of soil placed.

B. Install Drainage Geotextile

1. Excavate trench as specified on the drawings meeting section 02122 Trench Excavation and Backfill.
2. Cut geotextile to width and place in trench. Geotextile should begin from one side of the trench and finish on the opposite side while lining the bottom of the trench.
3. Overlap each sheet over the next sheet by 12 inches for placement in trench.

4. Anchor the geotextile using pins with a minimum of 18 inches in length or boulders at the top of the trench prior to backfill.
5. Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

C. Install Erosion Control Geotextile

1. Install as per drawings or as directed by the Owner.
2. If installing with rip rap at ends of pipe culvert, place geotextile under culvert.
3. Overlap the geotextile a minimum of 2 feet or as indicated by the manufacturer's specifications.
4. Overlap each sheet over the next downhill sheet for placement on slopes.
5. Anchor the geotextile using pins with a minimum of 18 inches in length.
6. Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

D. Install Separation Geotextile

1. Install as per drawings or as directed by the Owner.
2. Overlap the geotextile a minimum of 1 foot at all longitudinal and tranverse joints or as indicated by the manufacturer's specifications.
3. Anchor the geotextile using pins with a minimum of 18 inches in length.
4. Place fill beginning with overlapped sheets to hold the geotextile while the remainder is backfilled.
5. Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

E. Install Stabilization Geotextile or Geogrid

1. Install as per drawings or as directed by the Owner.
2. Overlap the geotextile a minimum of 2 feet at all longitudinal and tranverse joints or as indicated by the manufacturer's specifications.
3. Anchor the geotextile using pins with a minimum of 18 inches in length.
4. Place fill beginning with overlapped sheets to hold the geotextile while the remainder is backfilled.
5. Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.

F. Install Weed Barrier Geotextile

1. Place geotextile on areas that are smooth, and free of large stones or undesirable vegetation.
2. Cut an “X” over each plant and push geotextile under plant base if placing over an existing bed. Roll geotextile over soil and cut an “X” of each plant hole if placing over a new bed. Fold excess geotextile under and cover with soil or specified landscaping materials.
3. Anchor the geotextile using pins with a minimum of 18 inches in length.
4. Place a minimum of 4-inches of approved landscaping material on all areas as indicated on the drawings or as directed by the Owner. Do not leave any of the geotextile exposed to direct sunlight.
5. Repair any damaged areas by placing a patch over area and overlapping by at least 3 feet.
6. Maintain surfaces and supply additional landscape materials where necessary including areas affected by erosion.

**END OF SECTION**

# SECTION 2200 DRILLED PIERS

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for installation of drilled concrete piers as indicated on the drawings and specified herein.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

Federal Highway Administration (FHWA) Standard Specifications for Construction of Roads and Bridges on Federal Highway Projects, Section 565 dated 2003, FP-03

ASTM D6760 Crosshole Sonic Logging (CSL)

FHWA-NHI-10-016, Drilled Shaft Construction LFRD Design Methods

## 2.0 Materials

Concrete and reinforcing steel shall comply with the requirements of section 3000.

Anchor rods shall comply with the requirements of section 5110.

## 3.0 Qualifications and Submittals

Submit the following for review at least 10 working days before constructing drilled piers. Owner review of the Contractor's personnel qualifications and installation plan does not relieve the Contractor of the responsibility for obtaining the required results in the completed work.

### 3.1 Personnel Qualifications

**Construction Personnel**. Use a foreman with at least 3 years of experience in the construction of drilled piers. Foreman must remain on- site during all drilled pier installation activities. Upon request provide a resume of job experience, project description, the owning

agency's name and current phone number.

**Post Construction Testing Personnel**. Personnel performing the nondestructive cross-hole sonic logging (CSL) shall have a licensed professional engineer supervising the testing and interpretation of results. The CSL consultant shall be provided by the contractor. The CSL consultant shall be an independent testing agency with at least three years of experience in CSL testing. The on-site person(s) performing the testing shall have at least 12 months experience in performing CSL testing. Provide a resume of job experience, project description, owning agency's name and current phone number. Provide experienced labor support as needed to adequately perform the required tests.

3.2 Submittals

Furnish the following in the installation plan:

A. An overall construction plan and the sequence of drilled pier construction.

B. Details of proposed pier drilling methods; methods for removing materials from the piers; procedures for maintaining correct horizontal and vertical alignment of the excavation; and a disposal plan for the excavated material.

C. A description, including capacities, of the proposed equipment to be used including cranes, drills, drilling unit, augers, bailing buckets, and final cleaning equipment.

D. Demonstrate an understanding of the subsurface conditions at the site.
Reference the available geotechnical report and/or any other subsurface data provided by the Owner or Contractor.

E. Details of methods to be used to ensure drilled pier hole stability during excavation and concrete placement. Include a review of the chosen method's suitability for the anticipated site and subsurface conditions. If temporary casings are proposed or required, provide casing dimensions and detailed procedures for temporary casing installation and removal.

F. Details of reinforcement placement including bracing, centering centralizers, and lifting and support methods.

G. Details of concrete placement including proposed operations procedures for free fall, tremie, or pumping methods.

H. The method used to form an emergency horizontal construction joint during concrete placement.

3.3 Other Required Submittals

1. Concrete Mix Design
2. Grout Mix Design(for grouting CSL Tubes, when required)
3. Reinforcing Steel Certifications
4. Drilled Pier Installation Record
5. Densified Drilling Fluid(when applicable)

3.4 Drilled Shaft Installation Preconstruction Meeting

A drilled shaft installation preconstruction meeting shall be held at least five (5) working days prior to the Contractor beginning any shaft construction work at the site to discuss investigative boring information, construction procedures, personnel and equipment to be used, and to review proposed shaft installation plan. Those attending shall include:

**Representing the Contractor** at the meeting will be the superintendant, on site supervisors, foreman and other key personnel identified by the contractor. If slurry is used to construct the shafts, the slurry manufacturer's representative and a Contractor's employee trained in the use of slurry.

**Representing Owner** at the meeting will be the Project Civil Engineer, key Owner inspection personnel and other appropriate representatives.

## 4.0 Execution

4.1 Drilling Operations

A. Excavate holes according to the installation plan. Report all deviations from the plan to the onsite inspector.

B. When required, casings shall be installed as the drilling proceeds or immediately after the equipment is withdrawn to prevent sloughing and caving of the excavation walls. Casing shall be advanced ahead of the drilling operation in order to maintain a soil plug capable of producing a positive seal at the

bottom that prevents piping of water or other material into or out of the hole.

C. Slurry may be used to stabilize the excavation; however a specific plan, including the material to be used, must be submitted for Owner review prior to use. Refer to FHWA Standard Specifications for Construction of Road and Bridges, Section 565 “Drilled Shaft Installation” for all slurry use requirements.

D. Steel casings of ample strength to withstand handling and installation stresses shall be used. Use casing with the outside diameter equal to or greater than the specified diameter of the pier and the inside diameter not exceeding the specified diameter of the pier by more than 6 inches. Casings are to be removed as the concrete is placed. Casing extraction shall not be aided by the use of a vibratory extractor, unless authorized by the Owner. During removal, the casing shall be kept plumb and the concrete head shall be maintained at a level to offset the water head outside the casing. As a minimum, a concrete head of 4 to 5 feet shall be maintained above the bottom of the casing during the casing removal.

E. Each drilled pier shall be accurately located, sized and plumbed. The maximum deviation of the drilled pier from its designated location shall not be more than 2 inches at its top elevation. The drilled pier shall not be out of plumb more than 1 inch in 5 feet of height. Deviation of the drilled pier location within the specified limits shall not be cause for deviation in anchor bolt or concrete cap location. Adjustment shall be made for all concrete embedments.

F. Each drilled pier excavation shall be made to the approximate depth indicated on the drawings. All weathered and loose material shall be removed. The Owner shall verify the final tip elevation before concrete placement. The Contractor shall remove excavated materials from the site. Classification of the excavated materials will not be made except for identification purposes. Drilled pier excavation shall include the removal and handling of all excavated materials.

G. Blasting to accommodate drilling operations will not be permitted on the site.

H. All drilled pier excavations will be inspected by the Owner before the placement of concrete. All drilled pier excavations that

cannot be visually inspected shall be treated as a wet hole. Refer to wet method for concrete placement.

4.2 Reinforcing Steel and Placement of Crosshole Sonic Logging Access Tubes

A. Reinforcing steel shall conform to Section 3000.2.6.

B. Reinforcing steel shall be tied at all (100%) intersections of vertical and horizontal bars. Individual or loose bars are not permitted.

C. Securely wire together contact reinforcing steel lap splices. Tie and support the reinforcing steel so it remains within the required tolerances. Securely tie concrete spacers or other approved spacing devices at filth points around the cage perimeter and space at internals not to exceed 10 feet along the length of the cage. Use spacers of approved material at least equal in quality and durability to the pier concrete. Acceptable feet made of plastic, or concrete shall be provided to ensure that the bottom of the cage is maintained at the proper distance above the base of the excavation unless the cage is suspended from a fixed base until concrete has set sufficiently to support the weight of the cage at the proper elevation.

D. Place reinforcing steel cage as a unit immediately after the pier excavation is completed and inspected prior to concrete placement. Handle reinforcing cages to avoid distortion or racking of the steel. During concrete placement, provide positive support from the top of the reinforcing steel cage. Maintain the top of the reinforcing steel cage no more than 6 inches above and no more than 3 inches below the required position. All bracing steel used to stabilize the cage during placement shall be removed prior to concrete placement.

E. Provide cross-hole sonic logging access tubes for all drilled piers of 6 feet in diameter or greater and/or 50 feet or greater in length, and all wet method construction. Install (1) access tube for every foot of diameter.

F. Provide cross-hole sonic logging access tubes of standard weight black steel pipe per ASTM A53 with nominal inside diameter of 2 inches. Use pipe and pipe joints that have a round, regular internal diameter, free of defects or obstructions, and will result in watertight access tubes that permit the free, unobstructed passage of source and receiver probes. Use

access tubes that are free of corrosion, that have clean internal and external faces to ensure probe passage, and that have a good bond between the concrete and tubes.

G. Fit the access tubes with a water-tight shoe on the bottom and a removable cap on top.

H. Secure tubes firmly to the interior of the reinforcement cage. Install the tubes in a regular, symmetric pattern such that each tube is the maximum possible distance from each adjacent tube. Tubes shall be as near to parallel as possible. The tubes shall be installed from ½ foot above the pier bottom to at least 2 feet above the ground surface. Do not bend or damage the tubes during reinforcement installation operations.

I. Completely fill access tubes with water and maintain water level until Cross-hole sonic logging tests can be performed.

J. Contractor shall provide independent CSL testing agency.

K. Contractor is responsible to fully grout access tubes after Cross-hole sonic logging tests are approved by the Owner. Grout for filling access tubes shall be a cement grout with a maximum water/cement ratio of 0.45.

4.3 Concrete Placement

A. Dry Method

Use the dry construction method at sites where the groundwater level and soil conditions are suitable to permit construction of the pier in relatively dry excavation and where the sides and bottom of the pier may be visually inspected before placing concrete.

i. Unless otherwise accepted by the Owner, concrete shall be placed in drilled pier holes within 24 hours of completing excavation.

ii. All water and loose materials shall be removed from the holes and reinforcement shall be thoroughly cleaned before concrete is placed.

iii. Concrete shall be placed with a tremie or funnel to prevent segregation. Use free-fall placement only in dry holes with a maximum 6-foot free-fall height or Owner approved height. The concrete shall fall directly to the pier base without

contacting either the rebar cage or hole sidewall. If concrete placement causes the pier excavation to cave or slough or if the concrete strikes the rebar cage or sidewall, reduce the height of free-fall and reduce the rate of concrete flow into excavation. If placement cannot be satisfactorily accomplished by free-fall, use tremie or pumping to place concrete.

iv. Concrete shall be rodded or vibrated in the top third of the drilled piers to provide a dense mass free of voids. As placed, the concrete shall have a slump between 6 to 8 inches. During the filling of the drill holes, if water begins to accumulate on the top of the concrete, the amount of water in succeeding batches shall be reduced. When scum or laitance accumulates on the top of the concrete, it shall be removed and replaced to the proper elevation.

v. Concrete shall be placed in a continuous process. The quantity of concrete required to fill the drilled hole of the pier shall be available at the site when concrete is placed in each hole. If concrete placement for any pier is suspended for more than 30 minutes, laitance and water shall be removed from the joint surface and the joint surface shall be coated with epoxy bonding compound before placement is resumed. Epoxy bonding compound shall be at the site before the concrete placement is started.

vi. Drilled piers shall be reinforced as indicated on the drawings. Reinforcement shall be installed and secured to prevent shifting during concrete placement. Each drilled pier shall be cured as specified in the specification 3000.

vii. All casings shall be removed unless approved by the Owner. If approved casings are left in place, the void areas between the form and the excavation walls shall be filled with lean concrete mix. The lean concrete or grout mix shall be placed and tamped to fill the annular space.

viii. Records of the exact volume of each drilled pier excavation shall be kept. This volume shall be compared to the volume of concrete actually placed in each drilled pier. If the concrete volume placed is less than the calculated drilled pier volume, the Owner shall be notified.

ix. Concrete shall maintain a minimum 6-inch slump for the duration of the pour. For all concrete pours with a duration

of 6 hours or more the contractor shall provide a slump loss test with concrete submittal.

B. Wet Method

Use the wet construction method or the casing construction method for piers that do not meet the above requirements for the dry construction method.

i. Concrete shall not be deposited under water except with Owner permission. The proportions for underwater concrete mix shall be adjusted to provide 7 to 9 inches of slump and the cement factor shall be increased by one sack per cubic yard.

ii. Underwater concrete shall be placed through a tremie equipped with a seal at the lower end and a hopper at the upper end. The tremie shall be watertight and large enough to allow a free flow of concrete. After the flow of concrete is started, the lower end of the tremie shall be kept below the surface of the deposited concrete. The entire mass of concrete shall be placed as quickly as possible and shall flow into place without shifting horizontally under the water. Make the tremie inside diameter at least 6 times the maximum aggregate size used in the concrete mix.

iii. The water shall be quiescent when concrete is deposited. After placing, the ground water level in the area adjacent to the drilled pier shall be kept static (no pumping) until the concrete has taken its initial set.

iv. Concrete shall maintain a minimum 7 inch slump for the duration of the pour. For all concrete pours with duration of 6 hours or more the contractor shall provide a slump loss test with concrete submittal.

v. When the wet method is used the water level shall be maintained to obtain hydrostatic equilibrium throughout the construction operation at a height required to provide and maintain a stable hole, but not less than 5 ft above the water table.

4.4 Drilled Pier Installation Record

An accurate record of the drilled concrete pier installation shall be completed that contains as a minimum the following information for

each. The Contractor shall submit the installation record to the Owner Field Representative at the end of each day. It will not become official until the Owner Field Representative agrees with the accuracy and completeness and approves the document.

The drilled pier installation record shall contain the following information:

- Contractor's name
- Drilled Pier number and location
- Depth to bedrock
- Depth to water
- Final depth if different from design drawings
- Note any caving, sloughing of excavation and drilling difficulties
- Casing insertion, size and length, and whether or not removed
- Date and time of start and finish excavation
- Length and diameter of reinforcing bar cage if different from design drawings
- Date and time concrete placed
- Calculated volume of excavation based on diameter of pier
- Total quantity of concrete placed
- Concrete Yield Plot
- Concrete batch plant ticket numbers

4.5 Timing of the Cross-hole Sonic Logging (CSL)

The drilled shaft shall be tested no sooner than three (3) calendar days after placement of concrete but within 45 days after placement.

After all CSL testing has been completed, and after acceptance of the drilled shaft test results by the Owner, the Contractor shall remove the water in the tubes, place grout tubes extending to the bottom of the access tube and fill all access tubes in the drilled shaft with grout. Cut CSL tubes at surface as indicated on drawings or flush with top of concrete.

## END OF SECTION

# SECTION 2210 ASPHALTIC CONCRETE PAVING

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of labor, equipment and materials required for preparing the sub-base, subgrade, and placing of hot mix asphalt pavement as shown on the drawings and as specified herein.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| ASTM D2041 | Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures (Rice) |
| ASTM D 946 | Penetration-Graded Asphalt Cement for Use in Pavement Construction |
| ASTM D 1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN- m/m$^3$)) |
| ASTM D 1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |
| AASHTO T 19 | Unit Weights and Voids in Aggregate |
| TAI MS-2 | Mix Design Methods for Asphalt Concrete and Other Hot Mix Types |
| TAI MS-3 | Asphalt Plant Manual |
| TAI MS-8 | Asphalt Paving Manual |
| TAI MS-19 | Basic Asphalt |

1.3 Submittals

A. Submit mix design at least 10 working days before paving.

B. Submit Road Finish Rock to be used as sub grade material according to Section 2170 Aggregate Surfacing – Road Finish Rock.

C. Submit new mix design if materials used change during construction. Provide written documentation explaining the reason for the change in material.

## 2.0 Materials

All materials shall be in accordance with the above referenced specifications. Aggregate and asphalt mix design shall be submitted for review prior to construction.

## 3.0 Execution

3.1. Sub-base

Contractor shall grade and compact the sub-base layer prior to placing road finish rock (untreated base course) as recommended in the Geotechnical Report or as directed by the Owner. Owner shall inspect sub base layer prior to placing road finish rock.

3.2. Sub Grade

Contractor shall place road finish rock according to section 2120 Site Grading. Road finish rock shall meet specification Section 2170 Aggregate Surfacing – Road Finish Rock and drawings.

3.3. Surface Preparation

A. Locate, reference, and protect all utility covers, monuments, curb and gutter and other components affected by the paving operations.

B. Remove all moisture, dirt, sand, leaves, and other objectionable material from the prepared surface before placing mix.

C. Do not place HMA on frozen base or during adverse climatic conditions such as precipitation or when roadway surface is icy or wet.

3.4 Primer

Contractor shall apply primer in accordance with manufacturer instructions on aggregate and all contact surfaces. Excess primer shall be blotted with clean sand.

3.3 Tack Coat

Contractor shall apply a tack coat in accordance with manufacturer instructions and TAI MS-19. Apply tack coat on all contact surfaces to a minimum rate of 1/3 gallon per square yard. Allow sufficient cure time for prime coat/tack coat before placing hot mix asphalt.

3.4 Placing Single Course Asphalt Pavement

Contractor shall place a minimum of three inches of asphalt within 24 hours of applying primer and tack coats. Compact pavement with rolling equipment or in tight areas with hand operated compactors. Perform rolling to with consecutive passes to achieve even and smooth surface without voids or roller and compactor marks. Compaction requirements see section 3.7.

3.5 Tolerances

Final surface shall be within ¼ inch in 10 feet and allow surface water to freely drain the finished surface.

3.6 Protection

A. Contractor shall immediately after placement, protect pavement from mechanical injury for 24 hours or until surface temperature is less than 140 ºF.

B. Do not allow construction vehicles, general traffic, or rollers to pass over the uncompacted end or edge of freshly placed mix until mat temperature drops to a point where damage or differential compaction will not occur.

C. Taper the end of a course subjected to traffic at approximately 50:1 (horizontal to vertical).

1. Remove the portion of the pass that contains the tapered end before placing fresh mix.

2. Tack the contact surfaces before fresh mix is placed against the compacted mix.

D. Use a motor grader, spreader box, or other approved spreading methods for projects under 180 square yards, irregular areas, or for miscellaneous construction such as detours, sidewalks, and leveling courses.

3.7 Compaction and Density

A. Use a small compactor or vibratory roller at structures in addition to normal rolling.

B. Create a rolling pattern to drive approaches and aprons to aid in compaction.

C. Owner will provide a testing agency to verify compaction efforts according to ASTM D6938. A field sample of HMA shall be taken every 200 feet or once daily for small projects. Laboratory tests shall include ASTM D 2041 (Rice). Contractor shall reach a minimum average target for in-place density of 95% of the theoretical maximum specific gravity and density of bituminous paving mixtures (Rice). No test shall be less than 92%.

D. Asphalt which does not meet these requirements or is suspect shall be verified at the contractor's expense by providing a minimum of one core every 100 feet.

E. Contractor obtains cores within two days after the pavement is placed.
   a. Coring locations shall be marked by Owner for in-place density verification.

   b. Move transversely to a point 2 feet from the edge of the pavement for in-place density if random location for coring falls within 2 feet of the edge overall pavement section (shoulders).

   c. Fill core holes with HMA or high AC content cold mix and compact.

   d. Owner approved testing agency witnesses the coring operation, takes possession of the cores immediately, and begins testing the cores within 24 hours of density acceptance.

## END OF SECTION

# SECTION 2220 CULVERTS

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of labor, equipment and materials required for installation of corrugated steel, concrete and plastic pipe culvert, joints, accessories, bedding and slope protection at pipe end.

### 1.2 References

| | |
|---|---|
| AASHTOT 180 | Moisture-Density Relations of Soils Using a 10-lb. (4.54-kg) Rammer and an 18-in. (457-mm) Drop |
| ASTM A 760 | Standard Specification for Corrugated Steel Pipe, Metallic- Coated for Sewer and Drains |
| ASTM C 14 | Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe |
| ASTM C 76 | Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe |
| ASTM C 443 | Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets |
| ASTM D 698 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 lbf/ft3 (600 kN-m/m3)) |
| ASTM D 1557 | Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$ (2,700 kN-m/m$^3$)) |
| ASTM D 1556 | Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method |
| ASTM D 6938 | Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth) |

### 1.3 Submittals

Contractor shall submit manufactures product data and installation instructions on pipe, fittings and accessories. Any special procedures required to install specified products shall be noted. Submittals shall be received at least two weeks before start of work.
Contractor shall provide submittals as required by Section 02122 Trench Excavation and Backfill.

1.4 Pre-Installation Conference

Contractor shall convene a Pre-Installation Conference one week before commencing work of this Section, if required under provisions of local, state or federal highway encroachment permits.

1.5 Regulatory Requirements

Conform to applicable highway specifications and codes for materials and installation of the work of this section within local, state and federal highway right- of-way.

## 2.0 Materials

2.1 Culvert Pipe

A. Corrugated Steel Pipe:

1. ASTM A 760 II zinc metallic coated.

2. Shape: Circular or elliptical with nominal dimensions as shown on the drawings.

3. Tapered Ends: Same material as pipe, machine cut, for joining to pipe end.

4. Coupling Bands: Galvanized steel, 0.052 inches thick x 10 inches wide; connected with two neoprene "O" ring gaskets and two galvanized steel bolts.

B. Concrete Pipe:

1. ASTM C 14, Class 3; un-reinforced; plain end joints:

2. Shape: Circular with a nominal diameter as shown on the drawings.

3. Concrete Pipe Joint Devices: ASTM C 443, rubber compression gasket joint.

C. Reinforced Concrete Pipe

1. ASTM C 76, Class IV with Wall Type B bar reinforcement; bell and spigot end joints:

2. Shape: Circular with a nominal diameter as shown on the drawings.

3. Reinforced Concrete Pipe Joint Device: ASTM C 443, rubber compression gasket joint.

2.2 Bedding and Backfill Materials

Bedding and backfill material shall be crushed aggregate surfacing as defined in Section 2170 Road Finish Rock.

2.3 Accessories

A. Filter Fabric: not required.

B. Materials at Pipe Ends: As required by permitting agency. Alternatives are soil cement material blend with 6 percent cement, premixed and burlap bagged for moist cure on site; rip rap rock with a nominal size of 12 inches.

C. End of Culvert Gratings: not required.

## 3.0 Execution

3.1 Trench Excavation

A. Excavate culvert trench to 6 inches below pipe invert and to the depth and width shown on the drawings. If excavating through soft silty clay soils, use a smooth edge bucket to avoid disturbance of the bottom of the trench.

B. Cut trenches sufficiently wide to enable installation of culvert and allow room for compaction of backfill around the pipe and inspection.

C. Excavations shall not interfere with the bearing splay of foundations, about $45^{o}$ from the foundation base.

D. Excavate by hand for accurate placement of pipe to elevations indicated.
Remove loose, lumped or frozen subsoil, boulders, rock greater than two (2”) inches in diameter and other deleterious matter which could damage piping or impede consistent backfilling or compaction.

F. Correct areas over excavated by backfilling with bedding

material as defined below.

G. Stockpile excavated material, if suitable for backfilling, in area designated within the construction limits and remove excess material not being used, from the site.

3.2 Examination

Before installation of culvert pipe, verify that trench base and excavations are true to the dimensions and elevations that are as indicated on the layout drawings.

3.3 Bedding

Place bedding material at trench bottom and level bedding materials in one continuous layer not exceeding 6 inches in compacted depth. Compact to 92 percent of maximum dry density as determined by ASTM D 1557.

Backfill around sides to the top of the pipe. Tamp and compact each lift a minimum of (92%) ninety-two percent of the maximum dry density as determined by ASTM D 1557. Do not displace or damage pipe when placing or compacting backfill.

Maintain +/- 2% of optimum moisture content of the bedding material to attain the required soil density.

3.4 Installation - Pipe

Install pipe and accessories in accordance with manufacturer's instructions.

Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding. Protect pipe and bedding from damage or displacement until backfilling operation is in progress.

Lay pipe to slope gradients noted on layout drawings with maximum variation from true slope of 1/8 inch in 10 feet.

Shore pipe to required position to ensure pipe remains in correct alignment and at the required slope until after compaction of adjacent fills is completed.

Repair surface damage to pipe protective coating with two coats of compatible bituminous paint coating.

3.5 Materials at Pipe Ends

Place materials at pipe ends as defined in section 2.3A, at embankment slopes and as indicated on the drawings, to the subscribed average thickness.

3.6 Laying Tolerances

| | | | |
|---|---|---|---|
| Culvert invert elevation: | ½" | Alignment offset: | 1" |
| Profile: | 1% | | |

3.7 Field Quality Control

All field-testing and inspection shall be performed by an independent testing agency hired by the Owner.

Inspection and testing will be performed before and immediately after placing aggregate cover over pipe. Inspection shall include checking for compliance with erection tolerances and placement specifications. Testing shall check compliance with bedding and backfill materials, and compaction. Tests shall be performed in accordance with ASTM D 1557, D 698 and D 6938.

If inspections and tests indicate work does not meet specified requirements, the work shall be removed, replaced, inspected and tested.

Test and inspections shall be performed for each culvert at road crossings or every 50 linear feet of culvert.

**END OF SECTION**

# SECTION 2230 SEEDING AND EROSION CONTROL

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required by the Erosion and Sediment Control Plan (ESCP). Excluded are areas within the substation fence.

## 2.0 Materials

Materials shall meet the following requirements:

Matting: Matting shall be biodegradable as the grasses become established.

Fertilizers: Standard commercial manufacture.

Mulch: Provide mulch materials free of noxious weed seeds and plants. Mulch shall be processed to have the ability to cover and hold grass seed in contact with the soil.

Seed: Supplied by a state certified seed vendor. Seed mixture shall include a variety of grasses, all of which are suitable to the local climate.

## 3.0 Execution

Contractor shall perform this work between August 1 and November 15 and when local weather conditions are favorable. Contractor shall adhere to the post construction and soil stabilization Best Management Practices (BMP's) as indicated in the ESCP.

Remove all rocks, weeds, debris and matter detrimental to seed germination and growth. Cultivate surface soil to a condition favorable to seed growth. Form minor ridges in the fill and cut slopes to retard erosion and improve germination.

Apply seed and fertilizer as recommended by the seed supplier. Contractor shall use hydroseeding techniques to apply seed and mulch.

In ditches and where running water is possible Contractor shall apply matting. Matting shall be placed in strips in the direction of water flow. Place matting in contact with the ground at all points and secure in place with wire staples.

## END OF SECTION

# SECTION 2240 SOIL STERILIZATION

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for application of soil sterilant as shown on the drawings and specified herein.

1.2 Submittals

Contractor shall submit the following for Owner records:

A. Copy of applicators license (if required by state regulations or Department of Environmental Quality (DEQ))
B. Material Safety Data Sheets (MSDS) for selected herbicide.

## 2.0 Materials

Contractor shall be responsible for selecting herbicide(s) which are most effective for the given season of application, soil conditions and plant material at the substation site and which minimize the potential for environmental impact to surrounding areas. Herbicide(s) shall be selected and applied in a manner to prevent plant growth for a minimum period of one year from date of application. Extra precaution in herbicide selection is necessary if the substation site is accessible to wetlands or waterways. Only herbicide(s) with current EPA registration shall be used.

## 3.0 Execution

Contractor shall obtain a certified applicator's license if restricted use herbicides are applied. Contractor shall also obtain all necessary state licenses for application of selected herbicide(s). Herbicide(s) shall be applied in strict accordance with manufacturer's instructions and in a manner to avoid migration outside treated areas.

Unless otherwise indicated or shown on the drawings, Contractor shall apply herbicide(s) over all areas within the substation and five (5) feet outside the substation fence.

Storage and disposal of herbicide(s) is the responsibility of the Contractor. Contractor shall follow manufacturer's instructions for herbicide storage and disposal. Contractor shall be responsible for proper handling and disposition of any unused herbicide(s).

# END OF SECTION

# SECTION 3000 REINFORCED CONCRETE

## 1.0 General

1.1 Scope

Furnish all material, equipment, accessories, tools, services, transportation, labor, and supervision required for the supply and installation and testing of cast in place concrete. The index to this specification is as follows:

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| ACI 211 | Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete. |
| ACI 212 | Chemical Admixtures for Concrete |
| ACI 301 | Specifications for Structural Concrete for Buildings |
| ACI 304 | Guide for Measuring, Mixing, Transporting and Placing Concrete |
| ACI 305 | Hot Weather Concreting |
| ACI 306 | Cold Weather Concreting |
| ACI 315 | Details and Detailing of Concrete Reinforcement ACI 318 Building Code Requirements for Structural Concrete ACI 347 Guide to Formwork for Concrete |

American Welding Society D12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction

Concrete Reinforcing Steel Institute (CRSI), as noted.

## 2.0 Materials

2.1 Cement shall be Portland Cement conforming to ASTM C 150, Type II. All cement supplied shall be of one manufacturer.

2.2 Water used in mixing shall be clean and free from deleterious amounts of acids, alkalis, organic matter, or other impurities likely to be injurious to concrete.

2.3 Admixtures:

A. Chemical Admixtures shall conform to "Chemical Admixtures for Concrete" (ASTM C 494) and shall not be used unless prior approval in writing is obtained from the Owner. Where approved, the admixture shall maintain or improve the strength of concrete of the original design mix. Admixtures shall be used in strict accordance with the manufacturer's recommendations and shall be accompanied by the services of the qualified field representative of the manufacturer to supervise the use thereof. A certificate from an approved laboratory attesting that the admixture equals or exceeds ASTM C 494, Type D will be required.

B. Air Entraining Admixtures shall conform to "Specifications for air-Entraining Admixtures for Concrete" (ASTM C 260). Air content shall be determined in accordance with ASTM C 231. The agent and the cement proposed for use shall be selected well in advance of concrete placing. Approved air-entraining admixtures are as follows:

Darex AEA (Grace Construction Materials) MB-VR (Master Builders Company) Sika AER(Sika Chemical Corporation)

C. The use of accelerators shall not be allowed unless approved by the Owner.

2.4 Aggregate:

A. Fine aggregate shall conform to "Concrete Aggregates" (ASTM C 33), except for gradation which shall be as follows:

| Sieve Size | Percent Passing by Weight |
|---|---|
| 3/8 inch | 100 |
| No. 4 | 95-100 |
| No. 16 | 45-80 |
| No. 50 | 7-30 |
| No. 100 | No More Than 7% |

B. Course aggregate shall conform to "Concrete Aggregates" (ASTM C 33), except for gradation which shall be as follows:

| Sieve Size | Percent Passing by Weight |
|---|---|
| 1 inch | 100 |
| 3/4 inch | 90-100 |

| | |
|---|---|
| 3/8 inch | 20-55 |
| No. 4 | 0-10 |

2.5 Concrete Quality:

A. All concrete shall meet the quality requirements specified in ACI 318, Chapter 4.

B. The 28 day compressive strength, fc', of the concrete shall not be less than 4000 psi or as specified on the drawings.

C. Method of proportioning shall be in accordance with ACI 211.1, "Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete."

D. The determination of the water-cement ratio to attain the required strength shall be in accordance with ACI 301, Method 2 (For combinations of materials previously evaluated or to be established by trial mixes), and with ACI 211.1. In addition, the maximum water-cement ratio (by weight) shall be 0.45 and the minimum cement content shall be six (6) sacks per cubic yard.

E. From the test results of the aforementioned procedures, a curve shall be plotted showing relationship between the water-cement ratio and compressive strength, and the maximum water-cement content ratio to be used shall be the value shown by the curve to produce the strength a minimum of 25 percent greater than the strength specified.

F. The concrete mix design shall be submitted to the Owner for approval at least two weeks prior to beginning of any concrete work.

G. Maximum aggregate size shall meet the requirements of ACI 318, Section 3.3.

H. Unless otherwise noted or approved, all concrete shall be air-entrained. Air entertainment shall be accomplished using an approved admixture.

I. Air Content shall be 3.5 to 6.5 percent.

J. Slump shall be between two (2) and four (4) inches, except for drilled piers. See specification 02200 for drilled pier concrete slump requirements.

K. Mixing, transporting and placing concrete shall conform to applicable portions of ACI 211, ACI 212 and ACI 304 and as specified herein.

2.6 Reinforcement:

A. Deformed reinforcing steel bars shall conform to ASTM A 615, Grade 60 unless noted otherwise. Bars shall be tagged with marked number and size before shipment. Welding of ASTM A615 bars is not permitted. Where welding of deformed bars is required, such bars shall conform to ASTM A 706.

B. Coated Bars: if specified by the drawings, reinforcing bars shall be either galvanized or epoxy coated. Galvanized-coated reinforcement shall be Class I hot dipped after fabrication zinc coated in accordance with ASTM A 767. If the galvanized surface is damaged prior to placement of concrete, it shall be repaired in accordance with ASTM A 780. Epoxy coated reinforcement shall be epoxy coated in accordance with ASTM A 775. If the epoxy surface is damaged prior to placement of concrete, it shall be repaired with 3M Scottcoat 306 in accordance with manufacturer's specifications.

C. Welded Wire Fabric shall conform to "Welded Steel Wire Fabric for Concrete Reinforcement" ASTM A 185.

D. All cold-drawn steel wire for concrete reinforcement shall be in accordance with ASTM A 82.

E. Synthetic reinforcing fibers shall be collated fibrillated polypropylene, as manufactured by Fibermesh, Inc. or equal.

F. Accessories shall conform to CRSI Manual of Standard Practice of Reinforced Concrete Construction. Include all devices necessary for proper placing, spacing, supporting, and fastening steel reinforcement in place. Accessories shall be galvanized after fabrication if underside of concrete will be exposed.

G. Concrete squares shall be approximately two inches square and of a thickness adequate to provide the cover for the reinforcing steel as called for on the plans. The squares shall be made using a mixture of one part Portland Cement to three parts sand (fine aggregate) and the tie wires shall be cast integrally with each square.

2.7 Formwork:

A. Formwork shall be designed for loads and lateral pressures outlined in Chapter 1, Guide to Formwork for Concrete (ACI 347) and wind loads as specified by the controlling local building code. Formwork design and construction are the responsibility of the Contractor.

B. Forms shall be constructed of wood, steel, or other approved material. Material shall be chosen based on strength and concrete finish requirements.

2.8 Embedded Items:

A. Anchor rods shall comply with section 05110.

B. Embedded metals shall comply with section 05100.

C. Waterstops shall be of the dumbbell or center built type made from either rubber, PVC or TPER unless otherwise noted on the drawings. The Owner representative before installation shall approve type and material of water stop.

D. Expansion joint filler shall be ½" thick and shall meet the requirements of ASTM D 1751 for bituminous type or ASTM D 1752 or ASTM D 2628 for non-bituminous type. Where required or shown on the drawings a non- impregnated compressible foam backer rod shall be installed in the expansion joint prior to applying joint sealer. The backer rod shall be 1/8” inch larger in diameter than the joint width and shall be placed in the joint to provide a clear depth above the backer rod from the finished concrete surface equal to one half the joint’s width.

E. Joint sealer shall conform to ASTM D 1190. Sealant used in expansion joints requiring backer rods shall be a non-priming urethane sealant conforming to ASTM C 920.

F. Subsurface covering shall be polyethylene sheeting 6 mil (0.006") thick natural clear conforming to ASTM D 2103.

G. Felt joints shall be 15-lb. asphalt felt shall conform to ASTM D 250.

## 3.0 Execution

3.1 Preparation:

A. In no case shall concrete be placed on muddy, spongy, or frozen subgrade.

B. All wood scraps and debris shall be removed from the areas in which concrete is to be placed.

C. All areas where concrete is to be placed shall be thoroughly cleaned to ensure proper placement and bonding.

D. Forms and subgrade shall be wetted and all standing water removed prior to placing concrete.

E. All transporting and handling equipment shall be thoroughly cleaned.

3.2 Form-work:

A. Installation: Forms shall be constructed to the shape, line, and grade required and shall be maintained sufficiently rigid to prevent deformation under load, including placing and compacting of concrete. Set forms and screens for floor and decks to provide uniform slopes to drains and positive drainage for exterior slabs and steps. Forms shall be tight enough to prevent leakage of mortar. Formwork shall be secured to prevent sagging, yielding, bulging, depressions, waves, or other defects in the finished work. Forms shall be smooth and free from warp. Temporary openings shall be provided at base of column and wall forms for cleaning and inspection. All debris including mud shall be removed before placing concrete. Use of patented prefabricated panel sections for forming straight wall sections shall receive prior approval of type and procedure including type of ties to be used. Lumber once used shall be carefully cleaned and oiled before reuse.

B. Earth Sides: Earth sides shall not be used except for drilled piers where the top is formed to at least six inches below finished grade.

C. Chamfering: Exposed corners of concrete shall have ¾" chamfers or tooled edges unless shown otherwise.

D. Form Treatment:

1. Board Forms: Keep wet previous to placing concrete; wet thoroughly just before placing.

2. Plywood Forms: For surfaces to be painted use silicone type bondbreaker, Burke, West Chemical or approved equal, applied in accordance with manufacturer's directions. Coat other surfaces with approved stainless form oil, using minimum quantity required for satisfactory removal.

3. Metal Forms: Approved type release compound, applied in accordance with manufacturer's directions.

E. Form Removal: Side forms of walls and beams can be removed after 1 to 3 days. Load-supporting forms and shoring shall not be removed until after 7 days or two-thirds of designed 28 day compressive strength is obtained or the 7-day test cylinders have been tested and

results indicate an average strength adequate to support the load imposed on the concrete. All forms shall be completely removed after setting of concrete together with all temporary supports, etc., employed for construction purposes. Forms shall be readily removable without hammering or prying against the concrete. Days having temperatures below 40$^{o}$F are not to be counted for form removal unless thermal protection for the concrete has been provided.

3.3 Reinforcement:

A. Detailing and Fabrication:

1. Reinforcing steel shall be detailed and fabricated in accordance with ACI 315.

2. The fabricating Contractor shall prepare complete placing drawings and bending schedules. All shop drawings shall be submitted to the Owner Representative for review. No fabrication or reinforcing steel shall be done until drawings have been reviewed.

B. Splicing:

1. Bar splices shall be made in accordance with ACI 318 Chapter 12 unless noted otherwise on the design drawings. Any deviation will require approval of the Owner representative.

2. When welded splices are specified on the design drawings, the welding shall conform to AWS D 12.1.

3. Splices in welded wire fabric shall be made by lapping a minimum of one spacing of outermost cross wires of each fabric sheet plus two inches.

C. Installation: Before being placed, reinforcing shall be free from loose flaky rust, oil, grease, mud, or other coating, including ice that would reduce or destroy the bond. Reinforcement shall be accurately placed and properly secured in position by pre-cast concrete squares, metal chairs or spacers. The use of heat to bend or straighten reinforcing will not be permitted. Tolerances, spacing, splices, and concrete protection shall conform to Chapter 7 and 12 of the ACI 318 Building Code.

D. Ties: With the exception of temperature reinforcement, which shall be tied to main steel, reinforcement shall be accurately placed and

securely tied at all intersections and splices with 18 gauge black annealed wire, and shall be securely held in position during the placing of concrete by spacers, chairs, squares, or other approved supports. Wire tie ends shall point away from the form. Unless otherwise indicated, the number, type, and spacing of supports shall conform to ACI 315 Manual.

E. Stirrups: All stirrups, except ties, shall be held in place by two spacer bars extending the full length of the beam or girder.

F. Mesh: Reinforcing mesh shall be installed by one of the following methods to obtain the spacing indicated on the drawings:

1. Deposit a layer of concrete and strike off at the level required for the indicated spacing. Lay the mesh on the struck-off surface, place reinforcing bars, if required, and then continue pouring to full slab thickness. Use this method only when position of mesh is critical.

2. Place mesh on pre-formed concrete blocks wired to the mesh, pour concrete, and adjust mesh as required. This is the preferred method when exact positioning is not critical.

G. Watertight Construction: Standard accessory items (i.e. chairs, etc.) shall not be used in the construction of tanks, reservoirs, basins or other structures to contain water or sewage. All reinforcing steel in the walls, beams, columns and slabs of such structures shall be supported on and held away from the forms by using pre-cast concrete "squares" so that no metal is exposed on the face of the concrete when the forms are stripped.

H. Synthetic Fiber Secondary Reinforcement: When indicated on the drawings, synthetic fiber secondary reinforcement shall be added to concrete mix to provide concrete crack control. Method of fiber addition to concrete, amount of fibers added, and mixing time shall be in accordance with manufacturer's recommendations.

3.4 Embedded Items:

A. No pours are to be made until all embedded items, anchor rods, electrical conduits, steel frames, pipe supports, etc., are properly positioned and secured. The Contractor shall be responsible for and coordinated with other trades to obtain necessary data and information.

B. All sleeves, inserts, anchor rods, waterstops, and other embedded items shall be positioned accurately and supported against displacement.

C. Anchor Rods:

1. Fabrication: Anchor rods shall be fabricated in accordance with specification 05110.

2. Installation: Anchor rods shall be set true to the lines and grades shown on the drawings and shall be set plumb and be securely braced to prevent displacement during placing of concrete. Exposed threads shall be protected by coating with oil or grease and encasing them in burlap or paper. Upon completion of concrete placement, anchor rods shall be rechecked for correct location and elevations. When any anchor rod exceeds acceptable tolerances such corrections as are necessary shall be made at no additional cost to the Owner.

3. Anchor Tolerances: Tolerance limits in setting of anchor rods shall be as follows:

| | |
|---|---|
| Location, sleeved: | 3/16 inch Location, |
| unsleeved: | 1/8 inch |
| Projection: | plus 1/4 inch, minus 0 inch |

D. Embedded Metals:

1. Fabrication: embedded metals shall be fabricated in accordance with specification 5100.
2. Installation: All embedded curb angles, beams, frames, pipe sleeves, etc. shall be set true to the lines and grades shown on the drawings. Embedded items shall be secured and braced to prevent shifting during concrete placing. Where dissimilar metals are to be embedded in direct contact with one another, the contacting surfaces shall be heavily coated with bituminous mastic or other Owner-approved surface treatment to prevent galvanic coupling.

3.5 Mixing Concrete:

A. The mixer and mixing time shall be in accordance with ACI 304. Hot weather concreting shall comply with ACI 305, and cold weather concreting with ACI 306.

B. No additional water shall be added to batched concrete without the permission of the Owner. The water shall be incorporated by additional mixing equal to at least half of the total mixing required for the batch. Any addition of water above that permitted by the limitation on water-cement ratio shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio.

C. Concrete shall be mixed only in such quantities as are required for immediate use. The maximum allowable time between charging of the material in the mixing drum and final placing for mean ambient temperatures below 90$^{o}$F shall be ninety (90) minutes or 300 drum revolutions, whichever comes first. Concrete to be delivered when the mean ambient temperature exceeds 90$^{o}$F shall be mixed and delivered in accordance with the requirements of ACI 305 "Recommended Practice for Hot-Weather Concreting". Concrete not placed within these time limits, or if an initial set has developed, shall not be used. Tempering concrete by adding water or by other means will not be permitted.

3.6 Placing Concrete:

A. Concrete shall not be placed prior to a recorded pre-placement inspection and/or authorization to proceed by the Owner representative.

B. Concrete delivered without batch tickets shall not be accepted. Copies of concrete delivery tickets shall be provided to the inspector.

C. The slump may be increased up to 6 inches if concrete pumping is to be used. The proposed mix design for pumped concrete shall be approved by the Owner representative.

D. Conveying and placing of concrete shall be in accordance with ACI 304.

E. Each day's pour shall be properly scheduled to assure that concrete surfaces can be finished correctly and the use of cold joints can be minimized.

F. All concrete shall be mechanically vibrated, except for slabs on grade that are six inches or less in thickness. See specification 02200 for concrete consolidation requirements for drilled piers.

G. Concrete shall be placed in layers not over 24 inches deep. Each layer shall be consolidated by mechanical internal-vibrating equipment supplemented by hand spading, rodding, and tamping to work concrete into all angles and narrow places. Duration of vibration shall

be limited to time necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrators shall be applied vertically and at uniformly spaced points not farther apart than the visible effectiveness of the machine. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall not be used to transport concrete inside forms. The use of form vibrators or form tamping will not be permitted.

H. The free fall on concrete from the end of the spout or chute, or from a transporting vehicle, shall not exceed 10 feet for thin walls (10 inches or less in thickness) or more than 5 feet for other types of construction.

I. A tremie or flexible metal spout shall be used when the distance through which concrete must be dropped vertically exceeds the maximum specified above. Flexible metal spouts shall be composed of conical sections not more than three feet long, with the diameter of the outlet and the taper of the various sections such that the concrete will fill the outlet and be retarded in its flow.

J. Chutes, troughs, or pipes used as aids in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. Chutes and troughs shall be of metal or metal-lined. When steep slopes are necessary, the chutes shall be equipped with baffle boards or a reversed section at the outlet. Open troughs and chutes shall extend, if necessary, down inside the form or through holes left in the forms; or the ends of such chutes shall terminate in vertical downspouts. All chutes, troughs, and pipes shall be kept clean and free from coatings or hardened mortar by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged outside of the forms.

K. The concrete shall be deposited, as nearly as possible, in its final position and shall not be caused to flow laterally in the form any considerable distance. Each pour shall be completed in a continuous operation with no interruptions in excess of forty-five minutes. Each layer shall be placed and compacted before the preceding layer has taken initial set.

L. The placing sequence shall always be arranged to allow for the effects of settling and shrinkage. Walls 10'-0” and over in height shall be stopped about 1 foot short of the top and allowed to settle one hour minimum before topping out. Walls and columns bearing superimposed slabs or beams shall be allowed to settle a minimum of two hours before pouring slabs or beams. Laitance shall be removed before pouring superimposed structural members.

3.7 Bonding:

A. The existing surfaces shall be thoroughly cleaned of all foreign material and laitance before depositing new concrete on old concrete or against concrete which has set. Existing surfaces shall be coated with a bonding agent in accordance with ASTM specification C 881 (Sika Chemical Corporation's Sikadur 32, High-Mod structural epoxy adhesive meets this specification).

3.8 Joints:

A. Construction and control joints shall be placed as indicated on drawings.

B. Use of construction and control joints, not shown on the drawings, shall be in accordance with ACI 318, Chapter 6.4, and subject to approval of the Owner representative.

C. Waterstops shall be installed as shown on the drawings, forming a continuous diaphragm in each joint. Support for waterstops shall be provided and waterstop material shall be protected from damage. Field joints in waterstops shall be fabricated in accordance with manufacturer's instructions.

D. Saw cutting of contraction joints shall be done as soon as concrete hardens sufficiently (normally 4-12 hours) so as not to be torn or damaged by the blade. Sawing shall not be done while concrete temperature is falling. Construction and control joints shall be filled with an approved sealant with pre-molded joint filler and backer rod as shown on the drawings.

E. Joints not specified on the design drawings shall be in accordance with ACI 301, Chapter 6, and Section 11.5.

F. All reinforcing shall be continued across construction joints. Keys shall be provided only if required by the design drawings.

G. When called for on the design drawings, the concrete surface at construction joints shall be roughened uniformly to approximately 1/4 inch. Laitance, loosened aggregate or damaged surface concrete shall be removed.

H. Paving or slab construction joints, when not specified on the design drawings, shall be located at column centerlines and at intermediate intervals so that each panel shall be not more than 400 square feet in

the area, unless slab is reinforced, in which case the area shall not be more than 600 square feet. Maximum spacing of construction joints in un- reinforced slabs shall not exceed twice the slab thickness in inches (i.e., 6 inch slab: 12 feet) nor 1-1/2 times the width for narrow slabs such as sidewalks. Concrete shall be placed in checkerboard patterns or in alternate paving lanes utilizing construction and contraction joints to provide panels of the size shown on the drawing (when shown).

3.9 Finishing Concrete:

A. Form ties shall be broken back 1 inch from the surface of the concrete. Seal patching using 1-to-2 mix of cement-sand mortar shall fill the remaining holes.

B. All voids and honeycomb in formed concrete shall be filled with a 1-to-2 cement-sand mortar mix. Form ridges and other projections shall be removed immediately, after forms are removed. Exposed form concrete shall be rubbed with a carborundum brick and a thin cement grout shall be applied as necessary to produce a true, even, finished surface. Grout shall extend at least 3" below finished backfill grade on grade walls.

C. Concrete surfaces left low for grouting shall be roughened to expose aggregate and all loose particles and laitance removed. Anchor rod threads shall be wire brushed, and greased, after concrete has set. Nuts and washers shall be placed on the rods.

D. Finish for Floors and Walls:

1. Interior building slabs including pit floors shall be screeded, floated, and steel trowelled.

2. Exterior slabs shall be screeded, floated, trowelled, and broomed.

3. Special care shall be exercised on floors that have drains or trenches. Floors shall be sloped uniformly to provide even fall for drainage.

D. Screeding, Floating, Troweling, Brooming & Nonslip Finishing:

1. Surfaces shall be screeded to the elevations shown on the drawings. "Con-Film" or Owner-approved equal shall be sprayed on the screeded surface in conformity with manufacturer's directions if the air temperature is expected to

reach 80$^{o}$F or above before cure is complete.

2. Floating shall start as soon as the screeded surface has stiffened sufficiently. Floating shall be performed as necessary to produce a smooth, even, textured finish. Floating shall be performed by hand using magnesium tools.

3. The slab surface shall be tested for accuracy with a straight edge after the first floating finish is completed. Any depressions shall be filled and high areas shall be cut down and reworked. Straight edge testing and refloating shall continue until there are no deviations of more than 1/8 inch under a ten-foot straight edge.

4. Interior slabs shall be troweled except as noted on drawings or specified otherwise. Steel troweling shall begin after straight edge testing is finished and while concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint. Steel troweling shall produce a smooth troweled finish per ACI Standard 301, Section 11.7.3 "Trowel Finish". Time lapse and number of trowelings to produce a hard surface will vary depending on weather conditions.

5. Exterior slabs and other surfaces, as noted, shall be broomed after final floating to provide a nonskid surface. A soft bristled push broom shall be used, with a swirling motion.

6. Surfaces indicated shall have a nonslip finish obtained by sprinkling not less than 1/4 pound of abrasive aggregate over each square foot of the screeded and floated concrete, and finishing immediately with a steel trowel. The abrasive aggregate shall consist of not less than 55 percent aluminum oxide or silicone-carbide abrasive ceramically bonded together to form a homogeneous material that will be sufficiently porous to provide a good bond with Portland cement. The aggregate shall have an abrasive hardness of not less than 40 as determined by the test for wear resistance in the National Bureau of Standards Report BMS 98.

3.10 Curing and Sealing:

A. All finished concrete shall be cured by a curing method compatible with the final floor finish for a minimum of 7 days in accordance with ACI 301 Chapter 12. One or more of the following methods may be used, if approved by the Owner, except where specified curing method is called for:

1. Water curing by ponding or continuous wetting of sand or burlap.

2. Form curing by leaving on the forms and wetting for seven days.

3. An approved sprayed on curing compound applied in accordance with the manufacturer's instruction.

4. Steel troweled floor slabs, not covered with other materials shall receive a coat of Cenco Seal 301 surface hardener applied after all other equipment and work in the building has been installed and/or completed and the floor has been thoroughly cleaned of all dust, dirt, masks, and foreign matter. Floor surfaces designated to receive tile or other treatment shall not be treated with sealers or hardeners.

3.11 Cold Weather Concrete:

A. Thorough preparation for protection against cold weather damage to concrete shall be made well in advance. Cold weather concreting shall be performed in accordance with ACI 306.

B. Concrete shall be protected from freezing for not less than the first 48 hours after placing after the first frost, or when the mean 24-hour temperature at the job site falls below $40^{o}$F.

C. The placing temperature of the concrete shall be maintained above $50^{o}$F when the mean 24-hour temperature falls below $40^{o}$F.

D. The temperature of fresh-placed concrete shall be between 50 and $60^{o}$F.

3.12 Hot Weather Concrete:

A. Thorough preparation for protection against hot weather damage to concrete shall be made well in advance. Hot weather concreting shall be performed in accordance with ACI 305.

B. The maximum concrete temperature, at time of placement, shall be limited in accordance with ACI 305, Figure 2.1.4. The evaporation rate of the mixing water shall not exceed 0.2 pounds of water per square foot per hour.

C. One or more of the ingredients may have to be cooled to keep the temperature of the concrete from being excessive at time of placement. The replacement of part of the mixing water with an

equal weight of crushed ice is recommended for effective cooling per ACI 305, figure 2.3.6.

D. In-place concrete shall be protected and cured so as to minimize drying and absorption of heat.

3.13 Pumped Concrete:

A. The Owner shall approve the use of pumped concrete in each case.

B. The proposed mix design for each class of concrete to be pumped, including all necessary background data of test results, shall be submitted to the Owner for approval.

C. All slump and cylinder test samples shall be taken from the end of the discharge line.

3.14 Testing and Inspection:

A. Testing and acceptance of tests of concrete shall be done in accordance with ASTM C 31, C 39, C 94, C 143, C 172, and C 173, D 75 and C 136.

B. A testing laboratory engaged by the Owner will be responsible for:

1. Supplying the test cylinder molds to the job-site and taking the cylinder samples.

2. Testing for air, slump, temperature, compression strength and aggregate gradation.

3. Preparing test reports.

C. The Contractor shall supply concrete for all tests.

D. Concrete shall be sampled, cured, tested and accepted for compressive strength in accordance with ASTM C 172, C 31, C39, and C 94. Compressive test cylinders shall be prepared in sets of three cylinders for each test. Specimens for each set shall be obtained from the same batch of concrete after about one half of the batch has been placed in the forms. The rate of sampling shall be as follows:

1. Structures and Foundations and Slabs on Grade

One set per 50 cubic yards of concrete or one set at the

beginning of each days concreting.

2. Underground Duct Envelopes and Fireproofing

   One set taken at the beginning of concreting work. Subsequent testing may be performed at the discretion of the Owner representative.

3. All Other Concrete

   See Paragraph 3.14.D.1 above.

E. Test cylinder sets shall be dated, numbered consecutively, and identified as to location.

F. All cylinders shall be immediately stored under wet sand or burlap for about 24 hours after preparation. All vibration or impact shall be avoided during this critical period.

G. After initial storage, the cylinders (still in their molds) shall be packed in sealed polyethylene bags, wet sand or other resilient material for shipment to the testing laboratory.

H. Concrete slump tests shall be made in accordance with ASTM C 143 and shall be taken as necessary to assure well-placed concrete.

I. In-Place Tests: Where questions as to the quality of the concrete placed, Owner representative may require tests per ASTM C 42 or order a load test on structures as outlined in Chapter 20 of ACI 318, Building Code Requirements for Structural Concrete.

J. Inspection: All forms, reinforcement, and anchor rods shall be inspected and approved by the Owner representative before concrete is placed. If work is found unsatisfactory, the work shall not proceed until all defects have been remedied. The Owner representative shall approve repaired work. Such approval will in no way relieve the Contractor of his obligation to produce finished concrete as required by the drawings and specifications.

3.15 Submittals:

Three (3) copies of the following shall be submitted to the Owner representative for review before proceeding:

A. MIX DESIGN: Design of concrete mixes in accordance with this specification and ACI 301, Chapter 3.

B. Copies of concrete delivery batch tickets.

C. SHOP DRAWINGS: Reinforcing steel shop drawings, bar lists and bending and erection drawings.

D. TEST REPORTS: Test Reports and material certifications as noted elsewhere in this specification.

## END OF SECTION

# SECTION 3010 CONTROLLED DENSITY FILL

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for placement of non-settling backfill mixtures described as a Controlled Low Strength Material-Controlled Density Fill. Hereafter referenced by the acronym: CLSM-CDF. (Fill mixtures are sold commercially under a variety of producer names: K-Krete®, M-Crete, Darafill®, Flash Fill®, Flowable Fill, Flowable Mortar, Unshrinkable Fill, etc.) CLSM-CDF is used as a low strength, high slump self-consolidating fill material that provides support strength for traffic loads and which can be easily excavated at a later time. It may be used as a trench backfill, structural backfill, pipe bedding, or pipe filling for abandonment in place.

### 1.2 Codes and Standards:

| | |
|---|---|
| ACI SP-150 | Controlled Low-Strength Material ACI 229R Controlled Low-Strength Materials |
| ASTM C33 | Standard Specification for Concrete Aggregates |
| ASTM C150 | Standard Specification for Portland Cement |
| ASTM C618 | Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete |
| ASTM D6103 | Standard Test Method for Flow Consistency of Controlled Low Strength Material (CLSM) |
| ASTM D6023 | Standard Test Method for Unit Weight, Yield, Cement Content and Air Content (Gravimetric) of Controlled Low Strength Material (CSLM) |
| ASTM D5971 | Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material Standard |
| ASTM A 674 | Practice For Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids Standard Test |
| ASTM D 1558 | Method for Moisture Content Penetration Resistance Relationship of Fine- Grained Soils Standard Test Method for Preparation and Testing |
| ASTM D 4832 | of Controlled Low Strength Material (CLSM) Test Cylinders Standard Test Methods for Measurement of |
| ASTM D 5084 | Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter |

### 1.3 Submittals

A. Before manufacture of any CLSM-CDF mixture, the Contractor shall comply with the following requirements.

B. Demonstrate the ability to produce a uniform CLSM-CDF mixture as outlined in this specification. The National Ready Mix Concrete Association's (NRMCA) plant and truck certification will satisfy the producer certification requirement.

C. Certified engineering data, for the proposed mixture to be used, shall be submitted for twenty eight (28) and ninety (90) day unconfined compressive strength (C') tests as described in ASTM D 4832, except that cylinders will not be capped.

D. Yield and dry unit weight (ASTM D6023)

E. Flowability (ASTM D6103)

F. Removability (Removability Modulus RE =<1.0)

G. Mixture's components (cement, water, fly ash, filler aggregate etc.) and sources (company and location): Previous test results, on the same mixtures using the same mixture components, will satisfy this requirement. If it is determined, that for the engineering data presented, flowability, adequate strength, and removability requirements are not acceptable, the use of this mixture will not be allowed.

## 2.0 Materials

CLSM-CDF Materials

Materials for CLSM-CDF mixtures will be the responsibility of the Contractor. All mixture components must be environmentally acceptable. A Material Safety Data Sheet (MSDS) for each component in the mixture must be available upon request.

Materials for CLSM-CDF mixtures shall be evaluated as non-corrosive by appropriate ASTM standards including ASTM A 674. If the CLSM-CDF mixture has an electrical resistivity value of less than 5000 W cm, then to ensure compatibility with any proposed or encountered metal conduit, a polyethylene encasement shall be required conforming to ASTM A 674.

The CLSM-CDF shall have a 28 day unconfined compressive strength of 50 psi to a maximum of 100 psi. Total air content shall not exceed 30 percent. The mix shall have a flow of 6 to 8 inches when tested in accordance with ASTM D6103. Pumpable CLSM-CDF shall be proportioned to allow transport by pumping methods without segregating or excessive bleeding.

2.1 Portland Cement: ASTM C150, Type I or Type II.

2.2 Fly Ash: ASTM C618, Class F. Fly ash shall not inhibit air entrainment.

2.3 Air-Entraining Admixture: ASTM C260

2.4 Aggregate: ASTM C33, graded aggregate, maximum size of 3/8 inch, and the 3/8 inch aggregate shall comprise no more than 20 percent of the total aggregate. Amount passing a No. 200 sieve shall not exceed 12 percent. No plastic fines shall be present.

2.5 Water: Water used for the mixture shall be free from oil, salts, acid, strong alkalis, vegetable matter, and other impurities that would have an adverse effect on the quality of the backfill material.

## 3.0 Materials

3.1 Proportioning of Mixtures

The proportioning of CLSM-CDF mixtures is the responsibility of the Contractor. The mixture will be rejected for failure to meet, or sustain, the mixture's consistency for the previously stated properties.

Where gas leak, odor migration, is a concern for the identification of possible gas leaks, the CLSM-CDF material shall meet a minimum permeability coefficient (k) of one x 10-5 (cm/sec), or more, based on ASTM D 5048.

3.2 Placing (Pouring)

The CLSM-CDF mixture shall be placed directly into the trench or excavation. The material's flow characteristic will be such that no labor will be required in the trench or excavation. No vibration or compaction equipment shall be used. If the trench or excavation contains water, the CLSM-CDF mixtures may be used to displace the water.

A Fast Setting Mixture shall be used for backfilling trenches under pavement when it is deemed that the pavement must be quickly reopened to traffic so as to minimize inconvenience to vehicular traffic as shown on the plans. The use of a Fast Setting Mixture is intended to allow for placement of an asphaltic concrete pavement within two hours after mixture placement. Fast Setting Mixture shall produce a load bearing strength of 20 psi in two hours as measured with a penetrometer using the 1.124" diameter head (ASTM D 1558).

3.3 Construction Requirements

The trench or excavation shall have vertical wall limits that confine the flowable CLSM-CDF mixture in a given area. For long trenches, requiring large amount of CLSM-CDF material, bulkheads can be used to control required placement quantities.

The CLSM-CDF material shall be brought up uniformly to the lines or limits shown on the plans or as directed by the Engineer. The placing of Portland cement concrete and/or asphaltic concrete pavements can be performed when a load bearing strength of 20 psi is achieved as referenced in Section 3.2.

A. The following limitations of operations shall govern:

1. The mixtures shall not be placed on frozen ground.

2. The placed mixtures shall be protected from freezing.

3. Each filling stage shall be as continuous as possible.

4. Setting time of CLSM-CDF may be affected by temperature. At temperatures near freezing, or below, additional time may be needed for proper setting of the material prior to any type of paving operation.

3.4 Acceptance of Material and Field Test Requirements The material acceptance will be based on the following.

A. Contractor certification (Section 03010.1.3)

B. Field testing for flowability (ASTM D6103)

C. Sampling freshly mixed CLSM (ASTM D5971)

D. Cylinder (3" x 6") strengths (ASTM D 4832). Six (6) cylinders will be required for any placement of 50 cubic yards and each 50 cubic yards thereafter. Three (3) cylinders will be broken at 28 and three at 90 days. If the placement is less than 50 cubic yards, three (3) cylinders will be taken every day of production. Two cylinders will be broken at 28 days and one (1) cylinder at 90 days.

The Contractor shall be responsible for the curing and protection of the cylinders until such time that they are ready to be picked up by the testing laboratory. The contractor shall coordinate this activity. A testing laboratory will hold the cylinders until the required breaking

date.

E. Unit weight tests (ASTM D6023) will be performed when cylinders are made.

All tests shall be performed by laboratories approved by the Owner. Copies of all test reports shall be submitted to the Owner. If the produced CLSM-CDF material fails any of these acceptance tests, indicating future removal difficulty (RE > 1.0), the material will be rejected with the possibility of removal. All CLSM-CDF tests are to be performed by qualified testing personnel.

**END OF SECTION**

# SECTION 3020 CONCRETE REPAIR

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for the preparation of damaged concrete foundations and application of repair materials.

1.2 Submittals

A. Submit under provisions of Section 01300 the following information.

B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

C. Manufacturer's Certificate: Certify that specified products meet or exceed specified requirements.

1.3 Qualifications

A. Materials Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

1.4 Delivery, Storage, and Handling

A. Deliver, store, protect and handle products under provisions of manufacture instructions for storage, shelf life limitations, and handling.

## 2.0 Products

2.1 Manufacturers

A. Mortar: Sika Corporation; Product SikaRepair SHA

B. Steel Primer: Sika Corporation; Product SikaArmatec 101 EpoCem

C. Latex: Sika Corporation; Product SikaLatex (R)

D. Substitutions: All substitutions shall meet the specifications below and be approved by the Owner.

2.2 Patching Materials

A. Patching material shall be a fast setting, on component, cementitious repair mortar meeting the following minimum characteristics:

| Characteristic | Test Method | Results |
|---|---|---|
| Bond Strength | ASTM C 882 (Modified) | 1,800 psi Flexural |
| Strength | ASTM C 293 | 1,100 psi |
| Compressive Strength | ASTM C 109 | 5,000 psi at 28 days |

B. Reinforcement primer shall be moisture-tolerant, epoxy-modified, cementitious product specifically formulated as a bonding agent and an anti- corrosion coating.

| Characteristic | Test Method | Results |
|---|---|---|
| Splitting Tensile Strength | ASTM C 496 | 600 psi at 28 days |
| Flexural Strength | ASTM C 348 | 1,250 psi |
| Compressive Strength | ASTM C 109 | 8,500 psi at 28 |

C. Acrylic-polymer latex, shall be a general-purpose admixture to produce polymer-modified concrete and mortar.

| Characteristic | Test Method | Results |
|---|---|---|
| Bond Strength | ASTM C 882 | >500 psi |

2.3 Mixing Cementitious Materials

A. Mix cementitious mortar in accordance with manufacturer's instructions for purpose intended.

B. Include latex polymer as a substitute for mixing with water.

## 3.0 Execution

3.1 Surface Preparation

A. Remove all deteriorated, broken and soft concrete. Cut all edges to sound surface concrete to a minimum depth of ¼-in. Clean concrete and exposed reinforcing steel surfaces of corrosion from steel, dirt, oil, grease, laitance, corrosion, or other contamination by high-pressure water blast, scabbler, wire brush or other appropriate mechanical means. Concrete shall obtain an aggregate fractured surface profile of

1/16-in. Rinse surface, flush out cracks and voids and allow to dry to a saturated surface dry (SSD) condition with no standing water.

3.2 Application of Cementitious Mortar

A. Apply the mixed cementitious mortar by working it well into the primed surface, filling all pores and voids. Compact well. Force the material against edge of repair working towards the center, thoroughly compacting towards the center. If multiple lifts are required, score the top surface on each lift and allow the lift to harden before applying fresh material. The final surface shall be finished smooth with steel trowel.

B. Cure as per ACI recommendations for portland cement concrete. Curing compounds must be pretested for compatibility. Protect fresh mortar form direct sunlight, wind, rain and frost.

**END OF SECTION**

# SECTION 4000 FENCING AND GATES

## 1.0 General

1.1 Scope

This section includes specifications for furnishing all materials, labor, tools, and equipment necessary to construct the substation perimeter fence and gates.

1.2 General Requirements

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

## 2.0 Materials

2.1 Concrete

Reinforced concrete for the fence and gate foundations shall meet the requirements of Section 3000 Reinforced Concrete.

## 3.0 Execution

Perimeter fence and gates shall be installed in accordance with drawings provided by the Owner.

**END OF SECTION**

# SECTION 5100 STRUCTURAL STEEL FABRICATION

## 1.0 General

### 1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for fabrication of structural steel as shown on the drawings and specified herein.

### 1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| ASTM A6 | Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Steel Piping, and Bars for Structural Use |
| ASTM A36 | Standard Specification for Carbon Structural Steel ASTM |
| A53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless (Grade B type E or S only) |
| ASTM A143 | Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement |
| ASTM A307 | Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength |
| ASTM A325 | Standard Specification for Structural Bolts, Steel, Heat Treated, 120/205 ksi Minimum Tensile Strength |
| ASTM A500 | Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes |
| ASTM A563 | Standard Specification for Carbon and Alloy Steel Nuts |
| ASTM A572 | Standard Specification for High-Strength Low-Alloy Columbium- Vanadium Structural Steel |

ASTM A992 Standard Specification for Structural Shapes

ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability (replaces A 570)

ASTM F436 Standard Specification for Hardened Steel Washers

American Institute of Steel Construction (AISC) "Code of Standard Practice

for
Steel Buildings and Bridges", AISC 303.

American Institute of Steel Construction (AISC) "Specification for Structural Steel Buildings" including "Commentary", ANSI/AISC 360.

American Institute of Steel Construction (AISC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts", Prepared by Research Council on Structural Connections (RCSC) Committee A.1.

American Welding Society "Structural Welding Code - Steel D 1.1"

1.3 Submittals

A. Contractor shall submit manufacturer's mill certificates certifying that products meet or exceed specified chemical composition, yield strength and other specified requirements.

B. Where Owner provided drawings are not sufficiently detailed for fabrication or where Contractor produces drawings for fabrication purposes, such drawings shall be issued to Owner for review and approval prior to fabrication.

## 2.0 Materials

All materials shall conform to the following specifications unless otherwise approved by Owner

| | |
|---|---|
| W-Shapes | ASTM A992 |
| Misc. Channels | ASTM A36 |
| Channels | ASTM A36 |
| Angles | ASTM A36 |
| Plates & Bars | ASTM A36 |
| Plates for Tubular Sections | ASTM A572 Grade 65 Sheets<br>ASTM A1011 CS Type B |

| | |
|---|---|
| HSS (Rectangular) | ASTM A500 Grade B |
| HSS (Round) | ASTM A500 Grade B |
| Pipe | ASTM A53 Grade B, |

All steel shall have a silicon content between 0.0% - 0.04% or 0.15% - 0.25% only

| | |
|---|---|
| Bolts | ASTM A325 Type 1<br>ASTM A307 Grade A |
| Nuts | ASTM A563 Grade DH |
| Washers | ASTM F436 Type 1 |

## 3.0 Execution

3.1 General

All workmanship and finish shall be equal to the best modern practice for fabrication of structural steel. All parts of the structure shall be neatly finished and free from kinks or twist. All holes, blocks and chips shall be clean-cut without torn or ragged edges. Fabrication shall be in strict accordance with detail drawings. Welding of two or more pieces to obtain the length of a member will not be accepted.

Structural steel shall be fabricated in accordance with the following requirements:

3.2 Straightening Material: Structural steel shall be straight and shall be clean of all rust before being laid off or worked in any manner. Straightening of material shall be done by a method that will not injure the metal.

3.3 Shearing and Cutting: Shearing and cutting shall be performed so that edges are not distorted or jagged; and all edges that will be exposed to view shall have a smooth finish. Copes and re-entrant cuts shall be filleted before cutting.

3.4 Holes: All holes shall be cylindrical and perpendicular to the member's surface. To avoid hole distortion, holes close to the points of bend shall be made after bending. The use of burning torch for cutting holes will not be permitted. Punched holes shall be made with a punch that is equal to the diameter of the specified hole, and the die shall be not more than 1/16" larger than the diameter of the punch.

3.5 Hole Correction: Misdrilled or mispunched holes may be corrected by filling holes with weld and redrilling or punching. Welding shall be in accordance

with AWS D1.1. The following procedure shall be used for filling holes:

A. All surfaces within the area of the weld shall be stripped of galvanizing and free from scale, slag, rust, grease or other foreign material that will prevent proper weld.

B. Electrodes used shall be of a classification that will provide weld metal of the tensile strength of the base metal being welded.

C. Welds shall be made in a flat position with the use of a suitable chill plate.
The arc shall be carried around the periphery of the hole and then in a spiral path to the center of the hole, fusing and depositing a layer of weld metal in the bottom of the hole. The arch shall then be carried back to the periphery of the hole and the procedure repeated, fusing and depositing successive layers to fill the hole. Slag covering the weld metal shall be kept molten until the weld is finished. If the arch is broken, the slag must be allowed to cool and be removed before restarting the weld.

D. The surface of the completed weld shall be ground flush with the original surface prior to redrilling or repunching of the hole.

3.6 Welding: All welding shall be performed in accordance with the latest edition of the "Structural Welding Code" AWS D1.1. A shielded arc-welding process shall be used. All welds shall be of the type specified on the drawings and shall be made in such a manner that residual shrinkage stresses will be reduced to a minimum. For material to be galvanized; all welds shall completely seal; there shall be no voids or seams between adjoining surfaces into which pickling acids or other fluids may enter. The welding process and the welding operators employed in performing the work covered by these specifications shall be qualified, in accordance with American Welding Society Standard Qualification Procedure.

3.7 Bending: The inside radius of cold bends in plates shall be: 3 times the thickness of plates up to 0.5 inches thick; 4 times the thickness of plates between 0.5 inches and 1.0 inches thick; and 6 times the thickness of plates between 1.0 inches and 1.5 inches thick. These cold bend radii may be reduced by 50% when the bend lines are transverse to the direction of the plate rolling. Angles and other sections requiring tension bends of the out-standing element greater than 3.375:12 or compression bends of the outstanding element greater than 5.625:12 shall be formed by cutting and welding one leg of the angle or the flanges of the section.

3.8 Marking: All individual pieces shall be marked clearly with the correct designation shown on the drawings. The marks shall be stamped into each

piece with a ½" high metal die before galvanizing; and the letters shall be clearly legible after galvanizing. In addition, all piece marks shall be circled with water-resistant marking pen after galvanizing.

3.9 Inspection: All material shall be subject to inspection. Contractor shall notify Owner after completion of fabrication and before galvanizing that the structures are complete and ready for inspection. Owner will have the option to waive inspection or will have 72 hours to inspect the structures before they are sent to be galvanized. This inspection or waive of inspection by Owner shall not relieve Contractor from entire responsibility for materials, workmanship, and all other liabilities under the contract.

Final inspection will be at the site of construction after complete installation. Final acceptance will be after the material has been completely installed and found to comply with all requirements of the specifications.

Contractor shall notify Owner of all discrepancies and drawing errors found during fabrication.

**END OF SECTION**

# SECTION 5110 ANCHOR RODS

## 1.0 General

1.1 Scope

The work covered by this specification includes the requirements for furnishing, detailing, fabrication, delivering and installing anchor rods including nuts, washers, anchor rod sleeves and accessories.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall apply.

American Institute of Steel Construction (AISC) “Code of Standard Practice for Steel Buildings and Bridges”, AISC 303.

American Institute of Steel Construction (AISC) “Specification for Structural Steel Buildings” including “Commentary”, ANSI/AISC 360.

| | |
|---|---|
| ASTM A6 | Standard Specification for General Requirements for Rolled Steel Plates, Shapes, Steel Piping, and Bars for Structural Use |
| ASTM A53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless (Grade B type E or S only) |
| ASTM A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM F436 | Standard Specification for Hardened Steel Washers ASTM |
| A563 | Standard Specification for Carbon and Alloy Steel Nut ASTM |
| F1554 | Standard Specification for Anchor Bolts, Steel, 36, 55, and 150- ksi Yield Strength American National Standards |

Institute (ANSI):

B1.1, Unified Inch Screw Threads
B18.2.2, Square and Hex Nuts (Inch Series)

1.3 Submittals

The Contractor shall submit two copies of material certifications and shop detail drawings to confirm that anchor material supplied is in conformance with applicable codes and standards, this specification and the design drawings.

1.4 Quality Assurance

Manufacturer's material certificates or the mill test reports, as required by the applicable codes or standards, shall be submitted to the Owner with the delivery of the anchor rods to the project site.

## 2.0 Materials

2.1 Unless noted otherwise on the drawings, materials shall be in accordance with the following.

| | |
|---|---|
| Anchor Rods | ASTM F1554 Grade 55 |
| Sleeves | ASTM A53 Grade B Nuts (Heavy Hex) |
| | ASTM A563 Washers ASTM F436 |
| Anchor Plates | ASTM A36 |

2.2 Galvanizing for anchor rods, nuts, washers, sleeves and plates shall be in accordance with Specification Section 05140 Hot Dip Galvanizing.

## 3.0 Execution

3.1 General

Installation of anchor rods shall be in accordance with AISC Code of Standard Practice for Steel Buildings and Bridges, Section 7.5

3.2 Protection of Anchor Rods

Anchor rod threads shall be protected against damage. Damaged anchor rods shall be repaired or replaced. Welding (including tack welding) to anchor rods is **not permitted**.

3.3 Setting of Anchor Rods

Templates shall be provided for all anchor rods. Templates shall be designed and constructed of sufficiently thick and rigid material to hold the rods to the lines and elevation as set.

Anchor rods shall be accurately located and set to the line and elevation

before concrete is poured. Accuracy of position of anchor rods shall be maintained throughout the placing and finishing of concrete.

Anchor rods shall not vary from the dimensions on the erection drawings by more than the following:

1/8" center to center of any two rods within an anchor group or individually from the dimension line

¼" center to center of adjacent anchor rod groups

½" elevation of the top of anchor rods

¼" maximum accumulation of error per hundred feet along established line

3.5 Leveling Nuts:

Leveling nuts shall NOT be used unless noted specifically on drawings provided by Owner. Structures shall be set directly on foundations.

If use of leveling nuts is specified, the leveling nuts shall be set to the required elevation. The space between the bottom of the leveling nut and the top of concrete shall not exceed one anchor rod diameter. A flat washer shall be set on top of the leveling nut prior to setting the structure.

3.6 Tightening

Nuts for anchor rods shall be brought to a snug-tight condition, followed by an additional one-quarter of a full turn. Snug-tight is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

**END OF SECTION**

# SECTION 5120 STRUCTURAL STEEL ERECTION

## 1.0 General

1.1 Scope

The work covered by this specification includes the furnishing of all accessories, tools, equipment, services, scaffolding, transportation, labor and supervision necessary for the erection of fabricated steel.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall govern.

American Institute of Steel Construction (AISC) "Code of Standard Practice for Steel Buildings and Bridges", AISC 303.

American Institute of Steel Construction (AISC) "Specification for Structural Steel Buildings" including "Commentary", ANSI/AISC 360.

American Institute of Steel Construction (AISC) "Specification for Structural Joints Using ASTM A325 or A490 Bolts", Prepared by Research Council on Structural Connections (RCSC) Committee A.1.

American Society of Testing and Materials, (ASTM), as noted in the specification American Welding Society, (AWS), Structural Welding Code - Steel D 1.1

1.3 Storage and Handling

Contractor shall store materials to permit easy access for inspection and identification. Steel members shall be stored off the ground. Protect steel members and packaged materials from corrosion and deterioration.

## 2.0 Materials

2.1 Miscellaneous Materials

A. Electrodes for Welding - AWS A5.1, Class E70 Series

B. Wedges, shim packs and other adjusting devices.

2.2 Corrections of Shop Errors

The erector shall perform moderate amounts of reaming, chipping and cutting to allow proper fit-up of structural members. Any errors, which prevent the proper assembly of the structure, must be reported to the fabricator who is responsible either to correct the error or approve the most efficient and economical method of correction to be made by the erector. The cost of such corrections shall be borne by the fabricator.

2.3 Correction of Design Errors

If the erector deems a misfit of structural steel a design error the erector must notify Owner. If an error is determined, Owner shall provide resolution.

## 3.0 Execution

3.1 Inspection

Observe areas and conditions under which structural steel is to be installed and notify Owner of conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected and approved.

3.2 Erection

A. General

1. Comply with the AISC Specifications and Code of Standard Practice as herein specified. Erection tolerances as listed in the AISC Code shall apply unless otherwise specified herein or indicated on the drawings.

2. Verify elevations of bearing surfaces and locations of anchor rods before erection work proceeds. Do not proceed with erection until

   corrections have been made, or until compensating adjustments to the structural steel work have been made.

B. Setting Bases

1. Set base plates and bearing plates for structural members directly on foundation surface. Leveling nuts shall NOT be used unless otherwise indicated on the drawings. Shims shall be used as necessary to level and plumb structures.

2. Nuts for anchor rods shall be brought to a snug-tight condition, followed by an additional one-quarter of a full turn after the structural steel is plumbed. Snug-tight is defined as the tightness attained by a few impacts of an impact wrench, or the full effort of a man using an ordinary spud wrench. The space between the bottom of the base plate and the top of the concrete shall not be grouted unless indicated otherwise.

C. Bracing

1. The erector is responsible for the stability of the structure during its erection.

2. Any bracing shown on the erection drawings has been designed to provide a stable structure upon the completion of erection. Permanent bracing shall be installed as each level of steel is erected.

3. The erector shall design and install all additional temporary bracing or guying required to meet loading imposed during erection, consistent with the erection sequence used, or required at the end of any work period to ensure safe and stable conditions.

D. Field Assembly

1. Set structural members in accordance with approved drawings accurately to the lines and elevations indicated. Align and adjust the various members forming a part of the complete frame or structure before permanently fastening. Before assembly clean bearing surfaces and other surfaces which will be in permanent contact.

2. Level and plumb individual members of the structure within specified AISC tolerances.

3. Splice members only where shown or specified.

4. Erection Bolts. On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

5. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

6. Gas Cutting. Do not use gas cutting torches in the field for correcting fabrication errors in the structural framing. Cutting may be permitted only on secondary members and subject to the approval of Owner.

7. Provide temporary bracing or anchors in formwork for metal fabrications that are built into concrete or similar construction.

E. Installation of High Strength Bolts

1. Pretensioned Bolts. All high strength bolts shall be pretensioned by the Turn-of-Nut-Method as described in AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts. Alternate methods that ensure pretensioned bolt installation shall be approved by the Owner. Bolts shall be installed in all holes of the connection and brought to a "snug tight" condition. Snug tightening shall progress systematically from the most rigid part of the connection to the free edges until all bolts are simultaneously snug tight and the connection is fully compacted.

Following this initial operation, all bolts shall be tightened further by the application of the rotation specified in the following table:

**Nut Rotation from Snug Tight Condition**

| | Disposition of Outer Face of Bolted Parts | | |
|---|---|---|---|
| Bolt Length (underside of head to end of bolt) | Both faces normal to bolt axis | One face normal to bolt axis and other sloped not more than 1:20 (beveled washer not used) | Both faces sloped not more than 1:20 from normal to the bolt axis (beveled washer not used) |
| Up to and including 4 diameters | 1/3 turn | ½ turn | 2/3 turn |
| Over 4 diameters but not exceeding 8 dia. | ½ turn | 2/3 turn | 5/6 turn |
| Over 8 diameters but not exceeding 12 dia. | 2/3 turn | 5/6 turn | 1 turn |

**Table Notes**

i. Nut rotation is relative to bolt regardless of the element (nut or bolt) being turned. For required nut rotations of ½ turn and less, the tolerance is plus or minus 30 deg; for required nut rotations of 2/3 turn and more, the tolerance is plus or minus 45 degrees.

ii. This table is only applicable to connections in which all materials within the grip of the bolt are steel.

iii. During the tightening operation, there shall be no rotation of the part not turned by the wrench. Tightening shall progress systematically from the most rigid part of the joint to the free edges.

2. Snug-Tightened Bolts. When indicated in the drawings snug-tightened bolts shall be installed with locking devices such as lock washers or locknuts. Snug tight is defined as the tightness that exists when all plies are in firm contact and can be attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.

F. Attachment to Existing Steel

1. Connections of new steel to existing shall be performed according to the drawings showing hole layout where existing steel must be drilled or punched to provide connections for new members.

2. All bolting of new steel to existing shall be made using high strength bolts (A 325 or A 490) unless otherwise indicated on the drawings.

3. Previously used high strength bolts shall not be reused but shall be replaced with new high strength bolts of the required size and length.

4. When shown on the drawings, connections of new steel to existing may be welded. All welding shall be performed in accordance with AWS Structural Welding Code - Steel D1.1.

G. Repair of Finish

1. After erection is complete, all protective coatings damaged during transportation and erection shall be touched in accordance with Specification 05130, "Painting of Structural Steel", or Specification 05140, "Hot Dip Galvanizing".

H. Inspection and Examination

1. All work is subject to inspection and examination by Owner for full compliance with all the requirements of this Specification and the design drawings.

2. Owner may retain the services of an independent inspection agency to perform inspections and examinations. Owner's testing agency will not be available for the erector contractor's use.

**END OF SECTION**

# SECTION 5130 PAINTING STEEL

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for shop painting and field touch-up of fabricated steel.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| ASTM D16 | Standard Terminology for Paint, Related Coatings, Materials, and Applications |
| NACE | Industrial Maintenance Painting |
| NPCA | Guide to U.S. Government Paint Specifications SSPC |
| | Steel Structures Painting Manual |

1.3 Submittals: Submit three copies of each requested item for review by the Owner.

A. Product Data: Provide data on all finishing products.

B. Samples: Submit 2 samples, ½ x 1½ inch in size illustrating selected color.

## 2.0 Materials

2.1 Primer

Primer shall be Tnemec Typoxy Series 27WB or equivalent. Color shall be Gray (33GR), unless indicated otherwise on the drawings.

2.2 Top Coat

Top Coat shall be Tnemec Typoxy Series 27WB or equivalent Color shall be Gray (33GR), unless indicated otherwise on the drawings.

Coating system performance:

a) VOC: Un-thinned 11 grams per liter; thinned 25% 11 grams per liter HAPS 0 Lbs/gal per solids

b) Adhesion: Method ASTM D3359B Crosshatch Adhesion Requirement: No less than a rating of 5

c) Salt Spray (Fog): Method ASTM B117

2.3 Approved Manufacturer Information Tnemec Company Incorporated
P.O. Box 165770
North Kansas City,MO 64116 Phone: 1-800-TNEMEC-1

## 3.0 Execution

3.1 Preparation

a) Bare Steel:

After fabrication, all steel shall be solvent cleaned of oil, grease, wax or other contaminants in accordance with SSPC SP-1. All welds shall be properly cleaned of slag and splatter removed. Surfaces to be painted shall be sandblast cleaned in accordance with SSPC SP-6 commercial blast.

b) Galvanized Steel:

All exterior surfaces shall receive a high-pressure wash – 3,000 psi at 3.5 gallons per minute minimum. Care should be taken not to damage or remove galvanizing. Rust should be removed from old galvanized steel by hand or power tool cleaning in accordance with SSPC-SP2 or SP3.

c) Field Retrofit of painted steel:

Remove all loose mill scale, loose rust, loose paint and other loose detrimental foreign matter by the use of power-assisted hand tools in accordance with SSPC SP3 requirements.

3.2 Application of Coatings

a) Shop Application on Bare Steel: All coatings shall be applied in the

shop in strict accordance with paint manufacturer's instructions. Apply one coat of Tnemec Typoxy, Series 27WB at 5.0 to 7.0 mils dry film thickness. This is a self-priming product. Additional coats may be applied as required or specified in the drawings.

b) Shop Application on Galvanized Steel: Apply one coat of Tnemec Typoxy, Series 27WB at 5.0 mils (minimum) dry film thickness.

c) Field Retrofit of painted steel:

Spot prime bare steel areas with on coat of Tnemec Typoxy Series 27WB at 3.0 to 5.0 mils dry film thickness. Apply top coat of Tnemec Typoxy Series 27WB at 5.0 to 7.0 mils dry film thickness.

3.3 Repair of Damaged Coating

Areas damaged during handling, transport or erection shall be cleaned with wire brush and coated with two coats of paint. Field repair shall only be performed during dry weather conditions with temperatures above 50 degrees and below 90 degrees or as allowed by paint manufacturer.

**END OF SECTION**

# SECTION 5140 HOT DIP GALVANIZING

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for hot dip galvanizing of fabricated structural steel and fasteners.

1.2 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern.

| | |
|---|---|
| ASTM A123 | Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products |
| ASTM A143 | Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement |
| ASTM A153 | Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware |
| ASTM A384 | Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies |
| ASTM A385 | Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip) |
| ASTM A767 | Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement |
| ASTM A780 | Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings |

## 2.0 Materials

2.1 Owner shall approve coating applicators.

2.2 Steel materials shall be geometrically and chemically suitable for galvanizing as described in ASTM A384 and A385. Steel materials suitable

for galvanizing include structural shapes, pipe, sheet, fabrications and assemblies. Recommended steel materials for hot dip galvanizing include:

| | |
|---|---|
| W-Shapes | ASTM A992 |
| Misc. Channels | ASTM A36, A572 Grade 50 |
| Channels | ASTM A36, A572 Grade 50 |
| Angles | ASTM A36, A572 Grade 50 |
| Plates & Bars | ASTM A36, A572 Grade 50 or 65 |
| Sheets | ASTM A1011 CS Type B HSS |
| (Rectangular and Round) | ASTM A500 Grade B Steel Pipe |
| | ASTM A53 Grade B |

All steel shall have a silicon content between 0.0% - 0.04% or 0.15% - 0.25% only

| | |
|---|---|
| Bolts | ASTM A325 Type 1 |
| | A307 Grade A or B |
| Nuts | ASTM A563 Grade DH |
| | A563 Grade A |
| Washers | ASTM F436 Type 1 |

## 3.0 Execution

3.1 Pre-clean steelwork to produce an acceptable surface for quality hot dip galvanizing.

3.2 Application of Coating:

A. Galvanize steel members, fabrications, and assemblies by the hot dip process in accordance with ASTM A123.

B. Galvanize bolts, nuts, washers, and steel hardware components in accordance with ASTM A153.

C. Safeguard products against steel embrittlement in conformance with ASTM A143.

D. Galvanize reinforcing steel in accordance with ASTM A767.

E. Handle all articles to be galvanized in such a manner as to avoid any mechanical damage and minimize distortion.

F. Long tubular steel structures, which require double dipping to galvanize, shall be galvanized using a process in which the fluxing is a complete separate operation from the zinc dip (dry process).

3.3 Coating Requirements:

A. Coating Weight: Conform to paragraph 5.1 of ASTM A123, Table 1 of ASTM A767, or Table 1 of ASTM A153, as appropriate.

B. Surface Finish: Continuous, adherent, as smooth and evenly distributed as possible and free from any defects detrimental to the stated end use of the coated article.

C. Adhesion: Withstand normal handling consistent with nature and thickness of the coating and normal use of the article.

3.4 Testing:

A. Inspection and testing of hot dip galvanized coatings shall be done in accordance with ASTM A123, A767 or A153 as applicable to determine the thickness of the zinc coating on the metal surface.

3.5 Repair of Damaged Coating:

A. The maximum area to be repaired as defined in accordance with ASTM A123, Section 4.6, current edition.

B. Repair areas damaged during handling, transport or erection by one of the approved methods in accordance with ASTM A780 whenever damage exceeds 3/16 inch in width. Minimum thickness requirements for the repair are those described in ASTM A123, Section 4.6, current edition. Approved product is “Cold Galvanizing Compound” as manufactured by ZRC Corporation.

3.6 Delivery, Storage and Handling:

A. Store and protect products from damage to coating.

B. Load and store galvanized articles in accordance with acceptable industry standards.

**END SECTION**

# SECTION 6000 STATION EQUIPMENT

## 1.1 General

## 1.2 Scope

Except where material is specified to be supplied by the Owner, the Contractor shall furnish all material, labor, tools and equipment necessary to the station equipment as specified on the drawings and in the Owner's Specifications.

## 1.3 Codes and Standards

Except as otherwise shown or specified, the Contractor shall comply with the provisions of the National Electrical Safety Codes, Owner and Industry specifications and standards. The latest edition of the code or standard shall govern.

## 1.4 Submittals

The Contractor shall submit to Owner a manufacturer's specification and/or data sheet for all material the Contractor wishes to be considered as a substitute for what the Owner has specified. No substitutions are to be made without prior Owner approval.

## 2.0 Materials

All materials furnished by Contractor shall comply with the specification and be approved by Owner.

## 3.1 Execution

## 3.2 Common Requirements

Detailed information on type, rating and amount of equipment is shown on the drawings. At the time of installation, the Owner will furnish to Contractor one copy of manufacturers' drawings for assembling and installing major equipment.

Major equipment labeling shall be permanent and include type and location information.

Any equipment that is delivered to the site in crates shall be uncrated by Contractor. All equipment shall be completely assembled; including the installation of any accessories that may be shipped detached. All equipment shall be adjusted and lubricated in accordance with the manufacturers' instructions or as directed by Owner, so that all equipment is left in a satisfactory operating condition. Extreme care shall be exercised in handling porcelain or glass parts to avoid chipping or breakage.

Contractor shall perform all field drilling as required and attach any brackets, extensions or switch clip angles necessary for securely mounting the equipment. All field drilled holes shall be painted with ZRC (Zinc Rich Coating) as manufactured by Sealtube Owner of Wakefield, Massachusetts, or equivalent. Application shall be in accordance with the manufacturer's recommendations. Such field drilling and treatment shall not be a basis for additional compensation.

## 3.3 Power Transformers

The Contractor shall be responsible for assembling and preparation of the power transformer. The power transformer shall be "Readied for Service" by Contractor under the supervision of the Owner's Representatives. Unless otherwise stated, the transformer shall be placed on the foundation with the centerlines of the tank installed directly above the centerlines of the foundation.

Assembling includes installing all bushings, arresters, radiators and auxiliary equipment. Contractor shall supply dry breathable air and purged through the transformer while work is being performed inside the transformer or any time any portion of the transformer is open. When all inside work has been completed, a pressure of 3 psi will be put on the transformer with dry breathable air to check for leaks. Unit must stand for 24 hours and maintain pressure. Some transformers come oil filled and ready for service.

The Owner will vacuum fill the transformer with oil if required.

## 3.4 Power Circuit Breakers

Contractor shall unload and place breakers in their final position on the foundation and install the bushings as required. The breaker shall be affixed to the foundation in the method specified on the drawings.

For $SF_6$ type of breakers, the gas will be shipped in separate containers provided by the Owner. All gas containers, full, partially full, or empty are to be retained for proper inventory and returned to the Owner at the point of delivery. Contractor shall maintain a log of the amount of gas used for each piece of equipment, the gas container tracking number, equipment PGE number, date received, date used and date returned to Owner.

Contractor, please note that $SF_6$ gas is not toxic but care is advised.

## 3.5 Air Break Disconnect Switches

The three-pole group-operated switches, including ground blades, if

supplied, shall be mounted as indicated on the drawings, with manual and control mechanisms to provide for operation from the ground. The switch mechanisms shall be adjusted for proper operation in accordance with manufacturer's instruction data.

### 3.6 Control Enclosure

The Contractor shall be responsible for assembling and preparation of the control Enclosure. The control house shall be placed on the foundation as recommended by the manufacturer.

Assembling includes installing all racks, external wiring, cable tray, and auxiliary equipment.

### 3.7 MetalClad Switchgear

The Contractor shall be responsible for assembling and preparation of the switchgear. The switchgear shall be placed on the foundation as recommended by the manufacturer.

Assembling includes installing all bushings, external wiring, bus connections, and auxiliary equipment.

### 3.8 Potential Transformers

Contractor shall install the potential transformers on the specified structure as indicated on drawings.

The secondary junction boxes shall be assembled by the Contractor and mounted as shown on the drawings.

### 3.9 Lightning Arresters

The Contractor shall install the lightning arresters on the structure provided and as shown on the drawings.

### 3.10 Shunt Capacitors

The Contractor shall assemble and install the capacitor rack elevating structures, in accordance with the manufacturer's instructions and on the foundations indicated on the drawings. The capacitor racks and current limiting reactors, if required, shall be installed on the elevating structures by the Contractor and as shown on the drawings. The Contractor, if specified, shall also be required to install the individual capacitor unit fuses.

### 3.11 Junction Boxes and Capacitor Bank Control Cabinets

The Contractor is to assemble boxes, and cabinets, if assembly required, and mount them in the location on the structures as indicated on the drawings.

### 3.12 Current Transformers

The Contractor shall install the current transformers in the locations on the structures as indicated on the drawings.

### 3.13 Reactors

Reactors will be delivered with coils, insulators and foundation fittings packed separately. The Contractor is to assemble the units per the manufacturer's mounting instructions and install on the structure as shown on drawings.

### 3.14 Incidental Work

The Contractor shall provide and install the phase letter plates, high voltage warning signs, and the switch and equipment number plates as shown on the construction drawings or as directed by the Owner's representative.
This work shall be considered incidental to the station equipment and the cost thereof shall be included in the contract prices for installation of station equipment.

### 3.15 Gas Insulated Switchgear (GIS)

The Contractor shall be responsible for erection and preparation of the GIS under manufacturer technical advisor's advices and document. Refer to GIS installation and scope of supply document in the attachment.

Erection includes receiving, unloading, hauling, cleaning, erection on foundations, complete assembly of GIS equipment, adjustment, and other works necessary to place all equipment into successful operation.

## END OF SECTION

# SECTION 6010 BUS, CONNECTORS, and SHIELD WIRES

## 1.0 General

1.1 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials (except supplied by Owner) required to install the tubular and wire bus, bus vibration damping, flexible steel shield wires, suspension and pedestal insulators, supports, fittings and connectors. Contractor shall also make connections to all equipment installed by Contractor.

1.2 Codes and Standards

Contractor is to comply with the appropriate provisions of the National Electric Safety Codes, Owner and Industry specifications and standards except as otherwise specified or shown on the drawings. The latest edition of the code or standard shall govern.

1.3 Submittals

The Contractor shall submit a manufacturer's specification and data sheet for all material the Contractor wishes to be considered as a substitute for what the Owner has specified. No substitutions are to be made without prior Owner approval.

## 2.0 Materials

All material furnished by the Contractor shall comply with the specification and be approved by the Owner.

## 3.1 Execution

**3.2 Bus Erection.** The bus, connectors and supports furnished by the Contractor shall be of the type and manufacture as shown on the drawings.

**3.3 Aluminum Bus.** The Contractor shall unpack, clean, and check all aluminum bus immediately upon receipt from the carrier. Bus delivered by the carrier with unsatisfactory finish shall be rejected. The Contractor shall remove all materials which might damage the bus finish and shall store the bus in such a manner that the finish will be protected. The Contractor shall be responsible for maintaining the finish on bus accepted from the carrier. Defective bus finish discovered after initial unpacking and inspection shall be the

responsibility of the Contractor. All costs associated with the cleaning of minor black marks, abrasions, and scratches shall be included in the Contractor's bid. Any stored or erected bus found to have unsatisfactory finish shall be refinished or replaced by the Contractor at the option of the Project Field Manager. All expense for such refinishing or replacement shall be borne by the Contractor.

All bus shall be carefully handled and erected to provide a complete bus system without dents, abrasions, discolorations, or other structural or surface damage. Any bus so damaged shall be replaced by the Contractor at his expense.

Prior to the installation of fittings for the bus, conductors for vibration dampening, as required by the drawings, shall be installed within all horizontal buses for the full length of each bus.

Filler wires or rods shall be of 4043 aluminum alloy and of the proper diameter to suit the various applications. Installation of dampening wire shall be as shown in the drawings.

**3.4 Field Bends.** All field bends of bus shall be made with a hydraulic type bender which is acceptable to the Project Inspector. Each bend shall be smooth and uniform and shall retain the original inside bus diameter.

Bend radii shall be as indicated on the drawings. Each bend in 2 inch bus shall have a center line radius of at least 9-1/2 inches. Each bend in bus larger than 2 inches shall have a center line radius of at least five times the inside diameter of the bus.

**3.5 Alignment.** All bus components shall be aligned and supported prior to and during the welding operation. Support and alignment shall be as required to provide a finished bus arrangement with center lines of adjacent sections coincident. Bus shall be aligned for welding in such a manner that the welded bus remains essentially straight after removal of erection supports.

During splicing operations, each piece of bus shall be supported at not less than three points in approximately equal spans of 12 feet or less.

**3.6 Fittings.** The joint components to be welded shall be fitted to allow for expansion and contraction during welding without loss of alignment. The joint design shall be in accordance with manufacturers' recommendations. Connections shall be positioned and located to prevent the retention of water or drainage from copper or copper alloys to aluminum surfaces. The Contractor shall locate bus splices in locations that will not impose a moment on the splice hence damaging the splice. The location of maximum bending

moment usually exists at the midspan and at the bus support. The Contractor shall not locate a bus splice within a distance of 10 percent of the total span length from the bus midspan or from the bus support. Only one bus splice is allowed within one bus span.

**3.7** Weep Holes. Weep holes shall be provided as required. Weep holes shall be ¼" cleaned and deburred, at a minimum, one weep hole will be located approximately mid span for all horizontal bus spans. Weep holes shall be circled with a black marker for easy verification.

**3.8 Wire Bus Fittings.** Wire bus fittings for aluminum conductors shall be compression type only. Wire bus fitting for copper conductors shall be clamp type with high-strength nonferrous bolts and spring washers supplied with the fittings. Contractor shall leave all bolts thoroughly tightened. Compression connections shall be installed as shown on the drawings. Compression tools used shall be of the type and size that is recommended by the connector manufacturer or as approved by Owner. For all terminal connections involving the bolting together of an aluminum terminal connector with a bronze connector, all surfaces shall be thoroughly cleaned and an oxide-breaking, corrosion-inhibiting compound shall be applied to the contact surfaces before being bolted together. The Contractor shall leave all bolts thoroughly tight.

**3.9 Cable Jumpers.** Cable jumpers and vertical cable taps shall be installed as specified on the drawings and be of such length and form as to maintain maximum clearance from surrounding objects and to give assurance that such contour will be stable.

**3.10 Cleaning.** Immediately prior to welding, each surface to be joined by the weld shall be thoroughly cleaned. Greases, oils, waxes, etc., shall be removed by standard degreasing solutions as recommended by the manufacturer. Oxides shall be removed from the areas to be welded by vigorous scrubbing of the surfaces with stainless steel wire brushes.

**3.11 Welding.** Welding processes and methods shall be subject to code qualification and acceptance by the Engineer. Only the following welding methods will be permitted for joining bus sections and fittings:

- Gas metal arc welding.
- Gas tungsten arc welding.

Shielding gas for each process shall be welding grade argon when welding material is less than 3/4 inch thick. A combination of helium and argon shall be used for each process when the welding material is 3/4 inch thick and greater.

Welding energy and filler metal requirements shall be as recommended by AWS D10.7-86, "Recommended Practices for Gas Shielded Arc Welding of Aluminum and Aluminum Alloy Pipe." The following from AWS D10.7 shall apply:

**3.12 Welding Qualifications.** The Contractor shall prepare written welding procedure specifications. The procedure shall be qualified as defined below. Welding procedure specifications, procedure qualification reports, and welder qualification reports shall be submitted to the Owner and Engineer for review. Welding shall not begin until the Owner's and Engineer's review is complete.

All procedure qualification testing and welder qualification testing shall be in accordance with the methods defined in AWS D10.9-80, "Specification for Qualification of Welding Procedures and Welders for Piping and Tubing."

Testing shall be conducted to the requirements of AR-1 qualification level under the following conditions:

| | |
|---|---|
| Materials | P-Number 23, aluminum base alloys |
| Weld | Groove |
| Position | 6G |

All qualification testing shall be performed by an acceptable independent testing laboratory. Report formats shall be similar to the examples in AWS D10.9-80 for the following:

Typical Welding Procedure Specification (WPS).

Typical Contractor's Procedure Qualification Test Record (PQR). Typical

Contractor's Welder Qualification Tests Record.

All costs for testing, including material costs, shall be paid by the Contractor.

Welders, after qualification, shall not be replaced on this welding duty unless such action is acceptable to the Project Field Manager.

**3.13 Handling of Bus.** The tubular bus, wire bus and bus fittings, including corona shields or grading rings, shall be handled in such a manner that insures no surface damage will occur. The outer surfaces of all installed conductors and fittings shall remain smooth and free from scratches, nicks, dents or any other surface damage. Methods of handling and transportation of all material will be subject to the approval of Owner.

**3.14 Repair of Damaged Bus & Fittings.** All damaged material shall be repaired or replaced to full satisfaction of Owner. Damage is considered to include all surface defects, which can be felt by the fingers as well as all visible defects. Minor damage to the tubular bus, the bus fittings and the corona shields or grading rings may be repaired by filing and smoothing out the damaged area with a fine emery cloth. Damaged areas will be considered restored when no surface defect can be felt on the damaged piece. Tubular bus that is severely damaged shall be repaired. The damaged portion shall be cut out and replaced with a coupling or as directed by Owner. Severely damaged fittings and corona or grading rings shall be replaced.

All tubular bus repaired and items replaced because of damage after delivery to the Contractor shall be the responsibility of the Contractor. All bus, repair couplings and other repair or replacement items are to be furnished by the Contractor.

**3.15 Handling of Cable Conductor.** The cable conductor shall be handled in such a manner that no surface or internal damage will occur. The outer surface of all installed conductor shall remain as smooth and free from scratches, nicks, dents or other surface damage as it does on reels at the time of delivery to the Contractor. Contractor shall reinforce the reels or if required, rewind on new reels to permit handling without damaging the conductor. Methods of handling and transportation of all material will be subject to the approval of Owner.

**3.16 Installation of Insulators.** The Contractor shall furnish insulators as specified on the Bill of Materials, unless otherwise specified. All suspension and pedestal type of insulators shall be located and installed as shown on the drawings. Any surplus material shall be properly identified, tagged and returned to the designated Owner storeroom.

**3.17 Bus Supports.** Bus supports of the type and size specified on the drawings or Bill of Materials list shall be supplied by the Contractor and installed as indicated on the drawings.

**3.18 Connections.** The Contractor shall make all cable and bus connections to the installed equipment as directed and as specified on the drawings. Any changes as to type of connector, bus or cable size and type, method of connecting, or any other deviations from what is specified on the drawings shall not be made without approval from the Owner.

**3.19 Shield Wire.** If required the Contractor will supply steel shield wire unless otherwise specified. The Contractor is to install the shield wire in the locations and as specified in the drawings

## END OF SECTION

# SECTION 6040 CONTROL AND POWER CABLE

## 1.1 General

## 1.2 Scope

Insulated cable, conductors, and conductor accessories shall be furnished and installed in accordance with the requirements of this section of these specifications. Insulated cable, conductors, and conductor accessories shall be furnished in quantities sufficient for a complete installation as indicated in the circuit lists, on the drawings, and in these specifications.

Cable reels shall be stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface to prevent contact between cable insulation and earth due to sinking of the reel.

Installation shall be defined to include placement, terminating conductors, coiling and taping of spare conductors, identification, testing, and verification of each circuit, cable, and conductor. Installation of cable in existing trays or cable trench shall also include removal and replacement of existing cable tray or cable trench covers.

Terminating a conductor shall include installing cable termination kits for shielded cable, attaching the conductor at its designated location and insulating the entire connection where specified or required by the application.

## 1.3 Codes and Standards

Contractor shall comply with the appropriate provisions of the National Electric Safety Codes, PGE standard S-144-10 and Industry specifications and standards except as otherwise specified or shown. The latest edition of the code or standard shall govern.

## 1.4 Submittals

The Contractor shall submit to Substation Engineering, a manufacturer's specification and/or data sheet for all material the Contractor wishes to be considered as a substitute for what the Company has specified. No substitutions are to be made without prior Company approval.

## 2.1 Materials

The cable furnished shall conform to the Cable Specification Sheet(s) included at the end of this section.

The term "Type" used in the circuit list, on the drawings, and in these specifications refers to the letter identification indicated on each Cable Specification Sheet.

**2.2 Coaxial Cable.** Coaxial cable (when specified) used for connection between carrier cabinets and line tuning units shall be 52 ohm RG-8A/U coaxial cable. The cable shall have an 8 mil thick aluminum flat tape water block and an overall chlorinated polyethylene jacket. The cable shall be Belden Catalog No. 9251-A282-BV. This cable is a special run item.

**2.3 Color Coding.** The color code used for Type F, multiconductor, shielded or unshielded control cable shall be in accordance with Tables E-2 of ICEA S-73-532 as indicated on the Specification and Data Sheet(s). All of the wiring diagrams being prepared by the Engineer are based on the color code specified on the Specification and Data Sheet(s). The Tables E-2 color codes are as follows:

| Conducto | Method 1 Table E-2 |
|---|---|
| 1 | Black |
| 2 | Red |
| 3 | Blue |
| 4 | Orange |
| 5 | Yellow |
| 6 | Brown |
| 7 | Red-Black |
| 8 | Blue-Black |
| 9 | Orange-Black |
| 10 | Yellow-Black |
| 11 | Brown-Black |
| 12 | Black-Red |
| 13 | Blue-Red |

| Conducto | Method 1 Table E-2 |
|---|---|
| 14 | Orange-Red |
| 15 | Yellow-Red |

**2.4 Conductor Accessories.** All conductor accessories including connectors, terminations, insulating materials, support grips, markers, and cable ties shall be furnished and installed.

Supplier's installation instructions shall be obtained for cable accessories. These instructions shall be in the possession of the craftsmen while installing the accessories and shall be available to the Project Field Manager for reference.

**2.5 Terminal Connectors for Conductors 8 AWG and Larger.** Terminal connectors for conductors 8 AWG and larger shall be pressure or bolted clamp type, Burndy Qiklug, Varilug, or acceptable equal; or compression type, Burndy Type YAV or YA (long barrel), Panduit Type LCA or LCC, or acceptable equal. Acceptable connectors included with Owner-furnished equipment may be used.

**2.6 Terminal Connectors for Conductors Smaller than 8 AWG.** Terminal connectors for conductors smaller than 8 AWG shall be compression type connectors properly sized for the conductor and the terminal. The connectors shall be constructed of fine grade high conductivity copper in accordance with QQ-C-576 and shall be tin plated in accordance with MIL-T-l0727. The interior surface of the connector wire barrel shall be serrated, and the exterior surface of the connector wire barrel shall be provided with crimp guides.

Noninsulated terminal connectors shall be provided on conductors terminated on devices equipped with individual fitted covers, such as General Electric Type SB-l control switches and General Electric Type HEA lockout relays. Non-insulated ring type terminal connectors shall be used on all current and potential transformer circuits. All other terminal connectors for conductors smaller than 8 AWG shall be non-insulated ring type or preinsulated spade type.

Ring type connectors shall be manufactured by AMP, 3M, Panduit, or acceptable equal. Spade type connectors shall be AMP slotted spring spade, 3M Scotchlok Series 6l snap spade, or Panduit locking fork terminal connectors.

**2.7 Crimping Tools.** Use only ratchet type crimping tools a for all lugs and splices. Crimping tools used to secure conductors in compression type connectors or terminal lugs shall be those made for that purpose and for the

conductor sizes involved. The crimping tools shall accurately crimp the connector barrel and shall accurately crimp the conductor insulation support sleeve where provided. Crimping tools shall be provided with guides to position connectors in the tool, shall be provided with stops to prevent overcrimping, and shall be of a type which prevents the tools from opening until the crimp action is completed. Crimping tools shall be a product of the connector manufacturer or shall be as recommended by the connector manufacturer and acceptable to the Engineer for use with the connectors. The Contractor shall establish and maintain a tool certification program to ensure that crimping tools are kept in accurate operating condition.

**2.8 600 Volt Cable Insulating Materials**. Insulating materials for terminal connectors or compression type connectors shall consist of varnished cambric tape, rubber tape, and vinyl tape. Taping materials shall be as listed below or acceptable equal:

- Varnished Cambric Tape--3M Company Irvington 2520.
- Rubber Tape--3M Company Scotch 130C.
- Vinyl Tape--3M Company Scotch 33+.

**2.9 Support Grips.** Cable support grips shall be either split or closed woven wire type as manufactured by The Kellems Division, Harvey Hubbell Incorporated, Stonington, Connecticut.

**2.10 Wire and Cable Markers.** Markers for wire and cable circuits shall be of an opaque nylon material arranged to include a marker board, nonreleasing holding device, and cable fastening tail. The marker board shall not be less than 3/4 inch wide, 2-1/2 inches long, and 15 mils thick and shall be Panduit Corp. Part No. MP250 marker plates or acceptable equal. One side shall be roughened to hold black nylon marking ink from a fine tip pen similar to Thomas & Betts Company "TY-RAP" marking pen, Catalog No. WTl63M-l, or Panduit Corp. Part No. PFX-0 marking pen. Identification shall be permanent and waterproof. The holding device shall be designed to allow the fastening tail to pass around the cable through the holding device and prevent the removal of the tail without cutting it loose from the marker.

**2.11 Cable Ties.** Lacing materials for field installed cable shall be nonreleasing weather-resistant black nylon ties manufactured by Thomas & Betts Company, Elizabeth, New Jersey; Panduit Corp., Tinley Park, Illinois; 3M Company; or acceptable equal.

**2.12 Cable Shield Bonding Connectors.** Cable shield bonding connectors for use with shielded power, control, and instrumentation cable shall be Scotchlock 4460, manufactured by the 3M Company; Nicopress Shield

Connector B-2974, manufactured by National Telephone Supply Company; Surgegard Shield Bond Connector, manufactured by Brand-Rex Company; or acceptable equal.

Cable shield bonding connectors shall be installed on one end of each shielded power, control, and instrumentation cable listed in the circuit lists.

Concentric neutral of all 15 KV-34 KV power cable, all concentric neutral will be long enough to reach the station ground grid/bus without being spliced

## 3.1 Execution

Conductor installation shall be in accordance with the cable manufacturer's recommendations and the articles which follow.

**3.2 Cable Placement.** All cable described in the circuit lists shall be routed as indicated therein. Routing of other cable shall be as indicated on the drawings.

Cable shall not be handled when the cable temperature is below the minimum temperature recommended by the manufacturer. If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for at least 24 hours. Cable shall be placed the same day it is removed from heated storage.

If at any time during the progress of the work the Contractor finds raceways which appear inadequate to accommodate the assigned cable, he shall notify the Project Field Manager at once and shall discontinue any further work on the questionable raceway until advised by the Project Field Manager as to how he shall proceed.

Immediately prior to the placement of each cable or cable group, the raceway route to be followed shall be inspected and ascertained to be complete in installation and free of all materials detrimental to the cable or its placement. All cable assigned to a particular duct or conduit shall be grouped and pulled in simultaneously using cable grips and acceptable lubricants.

All cable shall be carefully checked both as to size and length before being pulled into conduits or ducts. Cable pulled into the wrong conduit or duct or cut too short to rack, train, and splice as specified herein shall be removed and replaced by and at the expense of the Contractor. Cable removed from one conduit or duct shall not be pulled into another conduit or duct.

**3.3 Cable in Trays**. All cable shall be carefully laid in or pulled through the tray system so that neither the cable nor the trays are damaged. Cable may be laid along the side of the tray system during placement provided it is protected

from dirt, water, oil, or other detrimental materials and from mechanical injury. Cable shall be cut sufficiently long to conform to the contour of the trays, with particular attention paid to vertical inside bends. All excessive slack shall be removed from the cable so that it lies parallel to the sides of the trays. Multiple single conductor cable which constitutes a single power circuit shall be grouped together to minimize magnetic influence on other cable in the area. The cable shall be tied to the trays with nylon ties at l0 foot intervals to hold it in place. Cable clamps designed for holding the cable inside the trays shall be installed at all vertical bends.

**3.4 Cable in Vaults**. Cable shall be supported at all times without short bends or excessive sags and shall not be permitted to lie on the manhole floor. Cable ends must not be submerged. Cable racks or trays shall be provided for permanent support. Temporary support required during placement shall be with rope slings, timbers, or alternate method acceptable to the Project Field Manager.

**3.5 Cable Pulling**. Fishing and pulling shall be done with flexible round metal tape, $CO_2$ propelled polyethylene cord, nylon rope, or manila rope.

Unless specified otherwise or acceptable to the Project Field Manager, cable shall not be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box. Cable shall be pulled out at each manhole and pull box to the length required for termination. Prior to re-pulling of the pulled out cable, the cable shall be thoroughly inspected, cleaned, and relubricated. Damaged cable shall be removed and replaced by and at the expense of the Contractor.

Cable may be pulled in a single pull through two sections of Engineer-designed raceway connected by a manhole or pull box only if it can be determined by calculation to the satisfaction of the Project Field Manager, that the pulling tension will not exceed the maximum tension allowed by the cable manufacturer.

**3.6 Cable Grips**. Factory installed pulling eyes shall be used for pulling cable where they are available. Woven wire cable grips shall be used to pull all single conductor cable 2/0 AWG and larger, where pulling eyes are not available, and all multi-conductor cable. Pulling loops shall be used to pull single conductor cable smaller than 2/0 AWG. All sharp points and edges on the hardware attaching the pulling rope to the cable shall be taped to prevent snagging or damaging the raceway.

When a cable grip or pulling eye is used for pulling, the area of the cable covered by the grip or seal plus 6 inches shall be cut off and discarded when the pull is completed. When pulling loops are used, the entire loop shall be cut off and discarded when the pull is completed.

As soon as the cable is pulled into place, the pulling eyes, cable grips, or pulling loops shall be removed and any cable which was sealed shall be resealed.

**3.7 Swivels**. A reliable nonfreezing type of swivel, or swivel connection, shall be inserted between the pulling rope and the cable pulling eye, grip, or loop to prevent twisting under strain.

**3.8 Feeding Tubes**. A 4 inch or larger flexible feeding tube, with a removable nozzle sized to fit the ducts, shall be used in pulling all underground cable. The feeding tube shall be long enough to extend from the duct entrance to the outside of the manhole and shall be so arranged that it will be impossible for the cable to drag across the edge of the manhole ring or any other damaging surface. The bending radius of the tube shall not be less than the minimum bending radius of the cable specified in this section under the article titled Cable Bends.

**3.9 Pulling Lubricants**. Only lubricants recommended by the cable manufacturer and acceptable to the Project Field Manager shall be used. Lubricants shall be applied liberally and continuously during the pull.

**3.10 Inspection**. The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced by and at the expense of the Contractor.

**3.11 Pulling Tension**. The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by the Contractor shall have the rated capacity in tons clearly marked on the mechanism. Whenever the capacity of the pulling mechanism exceeds the recommended pulling tension of the cable as given by the cable manufacturer, a dynamometer shall be used to show the tension on the cable and the indicator shall be constantly watched. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.

**3.12 Sidewall Pressure**. To avoid insulation damage from excessive sidewall pressure at bends, the pulling tension in pounds at a bend shall not exceed 300 times the radius of the bend in feet.

**3.13 Cable Bends**. Tape shielded, flat tape armored, and wire armored cable shall not be bent to a radius of less than 12 times the overall cable diameter. Nonshielded conductors shall not be bent to a radius of less than eight times

the cable diameter.

**3.14 Supports**. All cable supports and securing devices shall have bearing surfaces located parallel to the surfaces of the cable sheath and shall be installed to provide adequate support without deformation of the cable jackets or insulation.

Adequate cable end lengths shall be provided and properly placed in junction boxes and manholes to avoid longitudinal strains and distorting pressures on the cable at conduit bushings and duct end bells.

Final inspection shall be made after all cable is in place and, where supports or raceway fittings deform the cable jacket, additional supports shall be provided as directed by the Project Field Manager. Additional cable protection such as a wrapping of light rubber belting, friction tape, or similar material shall be provided where required.

Cable in vertical runs shall be supported by woven wire grips in accordance with the NEC requirements, except that the distance between supports shall conform to the following:

| | **Vertical Cable Support Spacing** | |
|---|---|---|
| **Conductor Size** | **Aluminum Conductor** | **Copper Conductor** |
| 1/0 AWG and smaller | 100 feet | 100 feet |
| 2/0 AWG thru 500 Mcm | 120 feet | 50 feet |
| Larger than 500 Mcm | 85 feet | 35 feet |

**3.15 Cable Racks**. Where cable trays are not specified in man-holes, cable racks shall be furnished and installed according to the drawings and as required to provide the proper cable support. Cable racks shall be installed on spacings of not greater than 36 inches and shall be bolt secured to permanent wall surfaces with self-drilling anchors or continuous slot concrete inserts.

**3.16 Spare Conductors.** All spare conductors of a multi-conductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable. Each spare conductor shall be neatly coiled and then taped to the conductors being used.

**3.17 Lacing**. Nylon ties shall be used to neatly lace together conductors entering switchboards and similar locations after the conductors have emerged from

their supporting raceway and before they are attached to terminals.

**3.18 Cable Identification**. The Contractor shall identify the ends of all circuits listed in the circuit lists. Use PGE standard S-144-10 and its addendum.

Each marker shall bear the number of the circuit according to the circuit lists and drawings.

At terminations, the Contractor shall identify each conductor of power circuits, each multi-conductor cable, and each conductor of circuits consisting of multiple single conductors where the conductors are not otherwise identified. Markers shall be attached where the first individual conductor is routed away from the assembly. Each phase of multiphase power circuits shall be individually identified.

One end of each marker board shall remain free of the fastening tail, and the entire marker shall be so attached that it is readily visible for circuit identification.

**3.19 Moisture Seals**. Each cable with an aluminum conductor shall be kept sealed except when termination and splicing work is being performed.

The ends of all cables shall be sealed with heat shrinkable caps. Cap sizes shall be as recommended by the cap manufacturer for the cable OD and insulation. Caps shall contain sufficient adhesive that shrinkage of the cap during application results in formation of a positive water-tight seal capable of withstanding complete immersion or total exposure without permitting the entrance of moisture. Heat shrinkable caps shall be "Thermofit" as manufactured by Raychem Corporation or acceptable equal.

Before and after pulling, the leading end seal of each length of cable shall be examined and repaired if necessary. All cut cable ends shall be promptly sealed after cutting except those to be spliced or terminated immediately.

**3.20 Splices.** No splices shall be made in conductors for instrument circuits or control circuits. Shields may be spliced where necessary to permit connection to the station ground.

Power cable circuits may be spliced only by methods and at locations acceptable to the Project Field Manager.

**3.21 Terminations.** Cable shall be terminated in accordance with the following requirements:

Train cable in place and cut squarely to required length. Avoid sharp bends.

Remove necessary amount of cable jacket and insulation without damage to the conductor.

Install terminals or terminal connectors as required, ensuring a firm metal-to-metal contact.

Insulate each connection of cable to an insulated conductor (whether cable, bus, or equipment bushing). The insulation shall cover all exposed surfaces of the conductors; the insulation voltage level of the completed termination shall be not less than the insulation voltage level of the connected conductors.

**3.22 Insulation of 600 Volt Cable Connections**. Where connections of cable rated 600 volts or less require insulation, all exposed conductor and connector surfaces shall be covered with tape in accordance with the following:

One half-lapped layer of varnished cambric tape.

A minimum of three half-lapped layers of rubber tape, elongated not more than 20 percent, applied over the varnished cambric tape.

A minimum of three half-lapped layers of vinyl tape applied over the rubber tape. The vinyl tape shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the insulation of the conductor to which the cable is connected.

**4.1 Tests after Placement**

All insulated conductors shall be electrically tested after placement.

All circuits, including lighting circuits, shall be tested with the circuit complete except for connections to equipment. All splices, stress cones on shielded cable, and terminal connector attachments shall be complete prior to testing.

In addition to the tests performed after cable placement is complete, continuity tests and insulation tests shall be performed on all supervisory and communication cable before and after each splice is made.

Any circuit failing to test satisfactorily shall be replaced or repaired and then retested.

All equipment and labor required for testing shall be furnished by the Contractor.

**4.2 Continuity and Identification Tests**. All insulated conductors shall be tested for continuity and conductor identification.

- **Continuity tests**. Continuity tests shall include all tests necessary to confirm that each conductor is continuous throughout its entire length.

- **Identification tests**. Identification tests shall include all tests necessary to confirm that the conductor being investigated originates and terminates at the locations designated in the circuit lists or indicated on the drawings.

- Contractor shall supply Owner with yellow-lined schematic and wiring diagrams verify circuit testing and verification.

**4.3 Insulation Tests**. Resistance from ground provided by the insulation on all field installed insulated conductors shall be measured.

- **Cable rated 600 volts and below**. All insulated conductors except supervisory and communication cable, rated 600 volts and below shall be tested with a 1000 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and ground and between each conductor and all other conductors of the same circuit. Minimum acceptable resistance values shall be approximately 100 megohms.

- **Supervisory and communication cable**. All insulated conductors of supervisory and communication cable shall be tested with a 500 volt megger or an equivalent testing device. Insulation resistance measurements shall be made between each conductor and the cable shielding tape and between the two conductors in each pair. Minimum acceptable resistance values shall be 2 megohms.

## 5.1 Fiber-Optic Duct Cable

Fiber-optic duct cable (FODC) and accessories shall be furnished in accordance with the requirements of this section of these specifications. FODC cable and accessories shall be furnished in quantities sufficient for a complete installation as indicated in these specifications.

Contractor will provide the fiber optic cable per the cable schedule and lists of materials. Fiber requirements for the communications rack will be provided by PGE. DTS fiber that will be pulled with the 34.5kV power cable will be supplied by PGE.

Cable reels shall be stored and handled in a manner which will prevent physical damage to the cable. Cable reels shall be stored on a hard surface to prevent contact between cable insulation and earth due to sinking of the reel. Impact damage between reels shall be prevented by aligning reels

flange to flange or by using guards across flanges.

Cable ends, whether exposed or concealed, shall be sealed to prevent moisture penetration. Cap sizes shall be as recommended by the cap manufacturer for the cable. Caps shall contain sufficient adhesive so that the cap provides a watertight seal capable of withstanding complete immersion or totally exposed storage over a period of several months without permitting the entrance of moisture.

**5.2 Attenuation Measurements.** Attenuation measurements shall be performed on all fibers of each reel of FODC at both 1310 nm and 1550 nm. An optical time domain reflectometer (OTDR) shall be used for all attenuation measurements. The measurements shall be made from both directions and the results shall be averaged. The optical loss measured at any stage of manufacturing shall not exceed the allowable attenuation as specified in the Cable Specification Sheet included at the end of this section. The attenuation specified is the maximum allowable attenuation for each reel of FODC, not the average attenuation of all reels for each path.

**5.3 Innerduct.** All fiber shall be installed in innerduct. Innerducts shall be high density polyvinylchloride corrugated innduct as manufactured by Phillips Drisco Pipe, Carton, Endot or Dura-Line. The innerduct shall be 1 inch or 1-1/4 inch inside diameter, or as indicated on the drawings, and shall contain 1/4 inch polyproplene stranded rope for use in pulling the cable or other pulling line. Interduct shall be orange and labeled "Fiber-Optic" at 10 feet intervals.

## END OF SECTION

# SECTION 6050 PRE-CAST CABLE TRENCH & VAULTS

## 1.1 General

## 1.2 Scope

The work covered by this specification includes furnishing of all labor, equipment and materials required for the purchase and installation of pre-cast cable trenches and vault, and fiberglass covers as shown on the drawings and specified herein.

## 2.1 Materials

## 2.2 Contractor Supplied Materials

A. Contractor shall furnish a trench and vault system consisting of precast concrete support brackets, sidewalls and removable fiberglass covers to form a completely enclosed trench, except with an open earth bottom.

B. The manufacturers shall be specified on the drawings or bill of material.

C. The trench system (with the exception of the road rated trench sections) shall be designed to support at least 200-psf live load.

D. Road rated trench sections and vaults identified on the drawings shall be designed to carry HS-20 (32,000#) axle loading. The clear interior cross section shall be the same as the connecting trench.

E. Typical trench width, depth and cross sections are shown on the drawings.

F. Typical vault width, depth and cross sections are shown on the drawings. Conduit duct terminator locations and size will be

G. Backfill used for trench installation shall be road rock as specified in Road Finish Rock section, unless noted otherwise.

H. Contractor shall supply sand for cable bedding.

I. Concrete materials used in fabrication of the trench components shall be in accordance with ACI 318. Reinforcing shall be in accordance with ASTM 615 grade 60. Miscellaneous steel, bars,

and plate shall be in accordance with ASTM A36.

J. Concrete mixing and placement shall be in accordance with ACI 304. Concrete strength shall be designed for durability, have a minimum compressive strength of 4,000 psi and contain 6% (plus or minus 1%) entrained air.

K. Reinforcement will be sized and located by the manufacturer. Placement shall be in accordance with ACI 315 and ACI 318.

L. Precast concrete sections shall be inspected when delivered to the site. Cracked or otherwise visibly defective units shall be rejected and removed from the site.

## 3.1 Execution

Precast concrete sections shall be lifted by suitable lifting devices at points provided by the precast supplier and installed in accordance with the precast supplier's recommendations. Joints between precast sections shall be sealed with a rubber gasket.

Where masonry is required to close the conduit openings in the precast sections, mortar shall be used within 40 minutes after mixing. Mortar that begins to set shall be discarded. Outside surfaces of brick and block masonry shall be plastered with mortar.

Contractor shall install the trench system and vaults at a depth ensure that all conduits and trench interfacing with the vault are at the appropriate depth. The fiberglass lid shall be easily removed and replaced

## 3.2 Trench System

Contractor shall install the trench components and covers in accordance with the manufactures instructions and drawings.

Contractor shall install a 4" deep layer of loose bedding of sand the entire length of the trench including road crossings.

After cables have been laid all road crossing and pedestrian covers shall be in place.

All trench road crossings within the station must remain open to traffic. Removal of covers is allowed but they must be returned at the end of each workday unless provision is made for an alternate route or temporary road plates are used.

Throughout construction all open trenches shall be marked with non-conductive safety tape when not actively worked.

Two bare copper ground conductors, equal in size to the ground grid conductors, shall be routed with each trench route as indicated on the drawings. The trench ground conductors shall be connected to the substation ground grid.

### 3.3 Vaults

Contractor shall install the vault components and covers in accordance with the manufactures instructions and drawings.

## END OF SECTION

# SECTION 6060 CONDUITS AND DUCT BANKS

## 1.1 General

## 1.2 Scope

The work covered by this specification includes the furnishing of all labor, tools, and equipment necessary to install the control/power cable conduit system in the substation / switchyard as shown on the drawings and as specified herein.

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## 1.3 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern:

NESC Section 32: Underground Conduit Systems

IEEE Standard 525 - IEEE guide for the Design and Installation of Cable Systems in Substations

NEMA Standard Publication #OS 1 Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA Standard Publication #OS 2 Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

## 2.1 Materials

Electrical conduit and associated materials shall conform with the requirements of the articles which follow.

**2.2 Rigid Aluminum Conduit**. Aluminum conduit and couplings shall be rigid type conforming to ANSI C80.5 and shall bear the Underwriters' Laboratories label.

**2.3 Rigid Steel Conduit**. Steel conduit, couplings, and elbows shall be hot-dip galvanized rigid mild steel in accordance with ANSI C80.l and UL 6. The conduit interior and exterior surfaces shall have a continuous zinc coating with a transparent organic polymer topcoat. The transparent organic polylmer topcoat shall be chromate free. Rigid steel conduit shall be as manufactured by Triangle PWC, Incorporated or acceptable equal.

**2.4 Plastic Conduit**. Plastic conduit shall be Schedule 40, high impact, polyvinyl

chloride and shall be used with plastic conduit fittings. Each length of conduit shall be furnished with one standard coupling. Joints shall be made with solvent cement. All additional conduit couplings, factory bends, plastic-to-steel conduit adapters, solvent cement, and special fittings for the complete conduit system shall be included. Couplings shall have a center stop to ensure proper seating.

All 6 inch and larger PVC elbows shall have a radius of 36" (thirty-six inches); with 5 inch and smaller PVC elbows adhering to recognized standards and procedures. All PVC conduit joints shall be solvent welded in accordance with the recommendation of the cement manufacturer.

All 6” PVC elbows into switchgear shall be backfilled with slurry backfill to prevent conduit from coming loose when power cables are pulled in.

**2.5 Couplings and Thread Protectors**. Each length of threaded conduit shall be complete with a coupling on one end and a thread protector on the other. The thread protector shall have sufficient mechanical strength to protect the threads during normal handling and storage.

**2.6 Flexible Conduit**. All flexible conduit shall be plastic jacketed, liquidtight, galvanized steel, Sealtite Type EF for general service areas or Type HC for high temperature locations.

**2.7 Metal Conduit Fittings**. All metal conduit fittings shall conform to the requirements of ANSI/NEMA FB1 and UL 5l4 where these standards apply. Galvanized iron or galvanized steel fittings shall be used with steel conduit. All fittings for aluminum conduit shall be copper free aluminum or aluminum alloy.

**2.8 Flexible Conduit Fittings**. All flexible conduit fittings shall be liquidtight, galvanized steel, Appleton Type STN, STB, or acceptable equal, and shall bear the UL label.

**2.9 Special Fittings**. Conduit sealing, explosion proof, dustproof, and other types of special fittings shall be provided as required by the drawings and these specifications, and shall be consistent with the area and equipment with which they are associated. Fittings installed outdoors or in damp locations shall be sealed and gasketed. Outdoor fittings shall be of heavy cast construction.

**2.10 Bushings**. Insulated bushings with insulating inserts in metal housings shall be provided for the termination of all conduit not terminated in hubs and couplings. Grounding type insulated bushings shall be provided for all conduit containing power circuits. Standard bushings shall be galvanized.

**2.11 Locknuts**. One interior and one exterior locknut shall be provided for all

conduit terminations not provided with threaded hubs and couplings. Locknuts shall be designed to securely bond the conduit to the box when tightened. Locknuts shall be so constructed that they will not be loosened by vibration.

**2.12 Unions**. Conduit unions shall be acceptable to the Project Field Manager. Watertight conduit unions shall be Crouse-Hinds Type UNF or acceptable equal.

**2.13 Raintight Conduit Hubs**. Raintight conduit terminating hubs, where indicated on the drawings or required by these specifications, shall be Efcor "Water-Tite" rigid conduit hubs or acceptable equal. Malleable iron hubs shall be used for steel conduit.

**3.1 Execution**

Conduit installation shall be as indicated on the drawings and as described in these specifications.

**3.2 Routing**. Except as otherwise specified or indicated on the drawings, all conduit shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns made of symmetrical bends or fittings. Conduit shall not be installed on the outside face of exposed columns, but shall be routed on the web or on the inside of a flange of the column. Except where prevented by the location of other work, a single conduit or a conduit group shall be centered on structural members.

All conduit field routing shall be acceptable to the Project Field Manager. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

**3.3 Moisture Pockets**. Moisture pockets shall be eliminated from conduits. If water cannot drain to the natural opening in the conduit system, a hole shall be drilled in the bottom of a pull box or a "C-type" conduit fitting provided in the low point of the conduit run.

**3.4 Couplings and Unions**. Metal conduit shall be joined by threaded conduit couplings with the conduit ends butted. The use of running threads will not be permitted.

Where metal conduit cannot be joined by standard threaded couplings, conduit unions or split couplings may be used if their location is acceptable to the Project Field Manager. Only ground seat type watertight unions shall be used outdoors or where the union may be submerged.

Where couplings or unions which do not have ground seats are used in vertical or inclined conduit runs, the coupling nut shall be installed uppermost to prevent the entrance of water into the union.

**3.5 Bends and Offsets**. A run of conduit shall not contain more than the equivalent of four quarter bends, including those immediately at outlets or fittings. Bends in conduit shall be made without reducing the internal diameter of the conduit. The use of a pipe tee or vise for bending conduit will not be permitted. The inside radius of conduit bends shall be not less than six times the inside diameter of the conduit. Conduits deformed or crushed in any way shall be removed from the jobsite.

**3.6 Cutting and Threading**. The plane of all conduit ends shall be square with the center line. Where threads are required, they shall be cut and cleaned prior to conduit reaming. The ends of all conduit shall be reamed to remove all rough edges and burrs.

A cutting oil shall be used in threading operations. The dies shall be kept sharp and provisions shall be made for chip clearance.

All steel conduit, after threading, shall be regalvanized with "Galvanizing Powder M-32l" as manufactured by the American Solder and Flux Company of Philadelphia, Pennsylvania; with "Zincilate 8l0" as manufactured by Industrial Metal Protectives, Inc., of Dayton, Ohio; with "Zinc Rich" coating as manufactured by ZRC Chemical Products Company, Quincy, Massachusetts; or acceptable equal. The Contractor shall supply this protective material and shall apply it in the field.

**3.7 Connections to Boxes and Cabinets**. Conduit shall be securely fastened to all boxes and cabinets. Threads on metallic conduit shall project through the wall of the box to allow the bushing to butt against the end of the conduit. The locknuts both inside and outside shall then be tightened sufficiently to bond the conduit securely to the box.

All conduit entering enclosures outdoors or in wet areas shall enter through watertight hubs or threaded openings.

**3.8 Cleaning**. Precautions shall be taken to prevent the accumulation of water, dirt, or concrete in the conduit. Conduit in which water or other foreign materials have been permitted to accumulate shall be thoroughly cleaned or, where such accumulation cannot be removed by methods acceptable to the Project Field Manager, the conduit shall be replaced.

**3.9 Flexible Conduit**. Flexible conduit inserts not greater than 30 inches in length shall be installed at the locations specified in this article.

Flexible conduit inserts shall be installed in all conduit runs which are supported by both building steel and by structures subject to vibration or thermal expansion.

Flexible conduit shall be installed in conduit runs which cross expansion joints or which connect to building supported independent structures.

Flexible conduit inserts should be considered in all long conduit runs where differential expansion problems may be expected.

**3.10 Plastic Conduit**. Except as specified in the following paragraphs, polyvinyl chloride conduit shall be installed in accordance with the installation requirements previously specified for metallic conduit. Expansion joints for exposed conduit or buried conduit which will be exposed to temperature variations shall be provided as recommended by the manufacturer.

Joints shall be unthreaded solvent cement type as recommended by the conduit manufacturer. The contact surfaces of the conduit and fitting socket shall be cleaned with Stoddard solvent, methyl ethyl ketone, or acetone, liberally coated with solvent cement, promptly and fully engaged, and either conduit or fitting rotated approximately l/4 turn to dispel air and evenly distribute solvent cement over contact surfaces. For proper connection, total elapsed time between the start of the cement application to the surfaces being joined and final assembly of the joint should not exceed 60 seconds. The initial strength of the joint will permit continuous conduit installation; however, additional stress at the joint shall be avoided for at least 24 hours after joining.

Bends shall be made from straight conduit lengths or shall be factory fabricated. Bend radii shall be in accordance with NEC.

The conduit length for field bending shall be heated to approximately 275 F by radiant heat, hot air, or hot liquid immersion. Open flame heating will not be permitted. Special mandrels or forms shall be used to provide a smooth bend without reduction of the conduit diameter. Conduit discolored by prolonged heating will not be acceptable.

Where plastic conduit is required to be buried directly in the earth as indicated on the drawings, the conduit shall be bedded in a graded 3 inch deep soft bedding of sand or finely divided job excavated material free from debris, organic material, and stones. Backfill, to approximately 6 inches above the conduit, shall be the same as bedding material.

**3.11 Below Grade Steel Conduit**. Steel conduit shall not be direct buried in the earth. Below grade steel conduit shall be encased with not less than 3 inches of concrete. Concrete used for conduit encasement shall contain not less than 500 pounds of cement per cubic yard. It shall contain clean and well

graded aggregates and low water content. The slump shall be such that the mixture is stiff and will stand erect when placed. The concrete shall be vibrated to consolidate it around the steel and shall be slow cured for several days to provide strength and prevent shrinkage. Conduit shall be supported for encasement by steel wire hangers attached to temporary supports laid across the conduit trench. After the concrete encasement has hardened, the supports and those parts of the wire hangers not encased in concrete shall be removed.

A minimum separation of 3 inches shall be maintained between multiple conduits enclosed in the same concrete encasement but not assembled as a duct bank.

Concrete used for encasing steel conduit shall contain no additives which contain chlorides. The concrete shall be mixed with pure, clean potable water.

The Contractor shall field route conduit according to the general routing indicated on the drawings and shall coordinate conduit locations with other work. Conduit shall be accurately positioned and securely anchored before the concrete is poured to encase it.

Conduit which will be visible above the finished floor shall be straight and plumb.

Conduit which is stubbed up shall be plugged prior to pouring of concrete and shall remain plugged until the conduit is extended later.

**3.12 Spacing and Attachment of Supports.** Except where buried in concrete, all conduit runs shall be rigidly supported. Each conduit shall be supported within one foot of junction boxes and fittings. Support spacing along conduit runs shall be as follows:

| Conduit Size | Maximum Distance Between Supports |
|---|---|
| 1/2 inch through 1-1/4 inch | 5 feet |
| 1-1/2 inch and larger | 10 feet |

Conduit clamps shall be bolted to building steel using drilled and tapped screw holes. Support channels for three or more conduits shall be welded to building steel or bolted using drilled and tapped screw holes.

**3.13 <u>Inspection</u>:** All conduit work, including all associated trenching and backfill, shall be subject to inspection. This inspection or the waiver of inspection by Company shall not relieve the Contractor from his responsibility for use, supply, and installation of materials, workmanship, and all other liabilities

specified under the contract.

## 4.1 Underground Duct Bank Construction

Duct banks consisting of individually assembled plastic duct, arranged as indicated on the drawings, shall be furnished and installed in accordance with the following specification. The duct banks shall be concrete encased, direct buried with a protective concrete cap, or direct buried as indicated on the drawings.

## 4.2 Material

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

| | |
|---|---|
| Duct | Polyvinyl chloride, Type DB in accordance with NEMA TC-6 for concrete encased duct, Schedule 40 Type TC-2 for direct buried duct. |
| Couplings | Plastic, for use with duct previously specified and "Duct-to-steel" adapters as required, including joint cement. |
| Spacers | Plastic high impact, interlocking, base and intermediate type. |
| Factory bends | PVC, for long radius sweeps. Rigid and sweep galvanized steel (concrete encased) 90 degree bends with 36-inch minimum radius. |
| End bells | Plastic. |
| Plugs | Plastic, high impact, tapered to fit end bell provided. |
| Duct binder | Hemp or sisal twine. |
| Riser termination | Rigid hot-dip galvanized mild couplings steel. |

| | |
|---|---|
| Riser bends | Rigid steel conduit elbows, factory or field made, 36-inch minimum radius, 90 degree, entirely concrete encased below grade; hot-dip galvanized rigid mild steel in accordance with ANSI C80.1 and UL 6; the conduit interior and exterior surfaces having a continuous zinc coating with an overcoat of transparent enamel or transparent lacquer. |
| Duct terminators | Formax type with 3-inch separation as indicated on the drawings. |
| Manhole materials | Shall be as specified and indicated on the drawings. |

## 4.3 Duct Bank Installation

Each duct bank shall be laid to exact grade in the trench and the ends shall enter manholes, switchgear, or buildings as indicated on the drawings. No dips or low points which retain water in any duct will be permitted in ducts between manholes or between buildings or switchgear and manholes. End bells shall be used on individual ducts at the end of duct banks entering manholes or buildings except where another type of termination is specified or detailed on the drawings. All field bends and sweeps shall be fabricated with straight sections of duct, bent to provide the radius indicated on the drawings.

The ends of the individual ducts shall be cleaned and swabbed with joint sealing compound, and the duct shall then be forced tightly into the coupling to make a watertight connection. The individual ducts shall be laid in place, held by standard spacers placed at 5 foot intervals, and bound with hemp or sisal twine. The ends of the ducts in each of the upper layers shall be stepped back approximately 2 feet from the end of the layer immediately below it. The concrete envelope (when indicated on the drawings) shall be poured after the individual ducts are securely tied in place and adequately anchored and/or weighted to completely counteract the buoyancy of the ducts in the fluid concrete. Care shall be taken in pouring the concrete to prevent the empty ducts from being damaged or displaced, either in grade or alignment.

Defective ducts shall not be installed and shall be removed immediately from the site of the work. Particular care shall be taken to keep concrete or other substances from the inside of the individual ducts during construction. All reinforcing materials and other magnetic materials installed in a duct bank shall be parallel to the lengths of the individual ducts, except for ties enclosing all ducts of the duct bank.

In cases where the conduit passes above or below an underground obstruction such as a utility line, a minimum clearance of 12 inches shall be maintained from the conduit to the utility. A minimum of 12 inches of clearance shall be maintained between the concrete encasement and a paralleling utility.

Two cable marking ribbons shall be installed by the Contractor. The cable marking ribbons shall be installed above the concrete encased conduit, the concrete protective cap, or the direct buried ducts. The ribbons shall be placed side-by-side at a depth of 1 foot 6 inches below grade and directly above the conduit.

### 4.4 Testing and Cleaning

After completion of the duct bank or before cable is pulled into existing duct banks, each duct shall be tested and cleaned, and ducts which will not be used immediately shall be plugged at each end. As a clearance test, each duct shall pass a mandrel with a diameter l/4 inch less than the inside diameter of the duct. All foreign material, earth, sand, and gravel shall be removed from the ducts with circular stiff bristled brushes. A 1/4 inch nylon rope shall be installed in all unused ducts.

## END OF SECTION

# SECTION 6070 GROUNDING SYSTEM

## 1.1 General

## 1.2 Scope

This section covers the furnishing and field installation of a grounding system and all components. The grounding system and installation shall be in accordance with the drawings and these specifications.

## 1.3 Codes and Standards

Work performed under these specifications shall be done in accordance with the following codes and standards. Unless otherwise specified, the applicable governing edition and addenda to be used for all references to codes or standards specified herein shall be interpreted to be the jurisdictionally approved edition and addenda. If a code or standard is not jurisdictionally mandated, then the current edition and addenda in effect at the date of this document shall apply.

Grounding systems and components furnished with these specifications shall be manufactured in accordance with applicable standards of the Institute of Electrical and Electronics Engineers, Inc. (IEEE), the National Electrical Manufacturers Association (NEMA), the American Society for Testing and Materials (ASTM), and Underwriters' Laboratories, Inc. (UL). Grounding systems and components shall be installed in accordance with the applicable requirements of the National Electrical Code (NEC) and the Occupational Safety and Health Administration (OSHA) standards.

## 1.4 Submittals

Contractor, under the supervision of the Owner, shall submit to the Owner test results of the completed ground grid area. The results include grid resistance and a current injection continuity check of the ground mat.

All ground resistance measurements shall be made with the Fall of Potential or slope methods as defined in IEEE 81. Some of the acceptable instruments are as follows: Advanced Geosciences, Inc., Sting R1, Mini Sting, Super Sting R1, or Super Sting R8, Iris Instruments, SYSCAL R1 Plus, SYSCAL R2, or SYSCAL Pro AEMC 6472 & 6474 combination

After connection of ground rods to the ground system, the Contractor shall obtain a grid resistance measurement using PGE test procedures with recommended distances. This data shall be obtained, identified, and recorded.

## 2.1 Materials

An electrical grounding system shall be furnished and installed in accordance with the drawings and the following specifications. Grounding components shall include ground rods, ground conductor, ground bus, above and below grade grounding connections, grounding lugs, and hardware required for a complete system.

**2.2** Grounding Materials: Grounding component materials shall be furnished new and undamaged, and shall conform to the requirements of the articles that follow.

**2.3 Ground rods:** Unless otherwise stated, ground rods shall be 5/8 inch diameter, 8 foot long, copper clad, cold drawn carbon steel manufactured in accordance with UL 467. The copper cladding shall be electrically bonded to the steel rod or bonded by a molten welding process. Cold rolled copper cladding will not be acceptable. Ground rods shall have a conical taper on one end to facilitate soil penetration.

**2.4 Below Grade Conductors:** Below grade ground conductors shall be soft drawn, 250 kcmil, 19 or 37 stranded, copper cable conforming to the requirements of ASTM B-8.

**2.5 Ground Stingers:** Ground stingers shall be soft drawn, 19#9 stranded copperweld cable, with 40 percent conductivity.

**2.6 Exothermal connections:** Exothermal connections shall be a standard duty copper molten weld conforming to the requirements of IEEE 837, IEEE 80 Section 11, and UL 467. Molds and powder cartridges used for making exothermal connections shall be furnished by the same manufacturer. Exothermal connections shall be similar to Type CADWELD as manufactured by Erico, or an Engineer acceptable equal.

**2.7 Above Grade Ground lugs:** Ground lugs to structures or equipment shall PGE two hole ground clamp provided by Portland Foundry.

**2.8 Below Grade Ground lugs:** Below grade ground lugs shall be PGE approved DMC grounding connector specified in the bill of materials. Below grade Burndy connections are not acceptable. DMC P/N: GC721B025-025 shall be used for 250-250 MCM CU grounding connector. DMC P/N: GC732B025-562 shall be used for 250 MCM – 5/8” rod connector

**2.9 Hardware:** Clamps, connectors, bolts, washers, nuts, and other hardware used with the grounding system shall be of copper, copper alloy, or stainless steel.

**3.1 Execution**

**3.2 Routing**. Except as otherwise specified or indicated on the drawings, all ground conductors shall be installed in exposed runs parallel or perpendicular to dominant surfaces with right angle turns.

All ground field routing shall be acceptable to the Project Field Manager. Routing not acceptable shall be rerouted and replaced without expense to the Owner.

Any ground wire that runs over concrete more than 12” will require an anchor every 12” to the concrete.

**3.3 Trenching and Backfill.** Except as otherwise specified or indicated on the drawings, refer to trenching and backfill section for fill requirements.

Grounding backfill material shall be either job excavated material or material furnished by the Contractor from offsite sources that is similar to job excavated material. The method of compaction and the equipment used shall be appropriate for the material being compacted and not damage the ground grid. Backfill material obtained from off-site sources shall be free of contamination.

**3.4 Conductors**. Unless noted otherwise, all below grade ground conductors shall be buried 18 inches below finish grade. Ground grid conductors under foundations shall have 6 inches of earth cover between conductor and bottom of foundation.

Conductors routed around 90 degree corners shall be kept in close contact with the perpendicular surfaces and shall not be physically damaged due to an insufficient bending radius.

Below grade ground conductors shall be placed as indicated on the drawings.

Damaged ground system conductors shall be repaired or replaced by the Contractor.

**3.5 Stingers**. All Copperweld ground stingers shall be brought above grade as noted on the design drawings. A 10-foot pigtail shall be coiled and left above grade for future connections to equipment.

Stingers shall not be physically damaged. Any damaged stingers shall be repaired or replaced.

**3.6 Ground Rods**. All ground rods shall be located as indicated on the drawings and installed to the depth indicated. Where the required ground rod length exceeds 10 feet (3 m), ground rod standard sections shall be welded together to provide an extended rod with one true centerline. During welding, the ground rod sections being welded shall be supported by a guide to ensure proper alignment.

**3.7 Connections**. The manufacturer's instructions on the use of exothermal welding materials shall be followed in all details.

All surfaces to be joined by the welds shall be thoroughly cleaned. Powder cartridges and molds shall be kept dry and warm. Worn or damaged molds shall not be used.

All exothermally welded connections shall successfully resist moderate hammer blows. Any connection which fails such test, or which upon inspection indicates a porous or deformed weld, shall be remade.

All exothermal welds shall encompass 100 percent of the ends of the materials being welded. Welds that do not meet this requirement shall be remade.

All bolted and screwed connections shall be securely tightened.

**3.8 Column Grounding**. Structural steel columns shall be grounded as indicated on the drawings. Prior to the installation of the servit post, paint, scale, and other non-conductive substances shall be removed from surfaces of un-galvanized structural steel members by grinding. Galvanized steel surfaces shall be cleaned with emery paper.

**3.9 Conduit Grounding**. All conduit grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug grounding bus with a bare copper conductor. Grounding bushings shall be grounded with conductor sized in accordance with the NEC, but not smaller than 8 AWG.

All grounding bushings on conduit runs which are terminated at tray shall be connected to the tray grounding cable or tray side rail with bare copper conductor as indicated on the drawings.

Where a conduit run is terminated at tray and the conduit carries a separate insulated grounding conductor, this grounding conductor shall be terminated on the tray grounding cable. If the conduit run is terminated with a

grounding bushing and the separate ground conductor it carries is sized in accordance with the requirements of the preceding paragraphs for conduit bushing grounding, the ground conductor in the conduit run may be continued through the conduit bushing ground connection and terminated on the tray grounding cable making unnecessary the installation of a separate conduit bushing grounding cable.

Conduit bushing ground conductors shall be connected to the tray ground cable using split bolt connectors or an Engineer acceptable equal mechanical connector.

Conduit terminated at equipment and device in threaded hubs shall not require additional grounding provisions.

**3.10 Tray Grounding**. A bare copper grounding conductor shall be installed on all power level cable trays containing single conductor power cables. The tray grounding conductor shall be installed on the outside of the tray side rails, along the entire length of the trays, attaching to each tray fitting and to each straight section of tray at 6 foot (1.8 m) maximum intervals. The tray grounding conductor shall be attached to the trays using bolted ground clamps, and shall be connected to the ground grid at locations indicated on the drawings. Splices for the tray grounding conductor shall be made using compression connectors.

Cable trays containing multi-conductor power cables, control, or instrument circuits shall not require a continuous ground conductor installed along the tray. Instead, these tray levels shall be grounded by means of a ground jumper extended from the tray side rail to the continuous ground conductor installed along a power level cable tray, to building steel, or to the ground grid. Grounding intervals shall not exceed 100 feet (30 m).

Grounding jumpers shall be required across all expansion splice plates, dropouts and adjustable splice plates where a continuous ground conductor is not installed along the tray level.

**3.11 Equipment Grounding**. Electrical equipment that requires a ground grid extension stinger shall be connected to the ground grid with copper grounding conductor as indicated on the drawings. The term "electrical equipment," as used in this article, shall include all enclosures containing electrical connections or bare conductors except that individual devices such as solenoids, pressure switches, and limit switches shall be exempt from this requirement unless the device requires grounding for proper operation. Large electrical power distribution equipment such as medium or low voltage switchgear or motor control centers will be furnished with a ground bus which the Contractor shall connect to the ground grid at each end of the ground bus. Other equipment will be furnished with grounding pads and/or ground lugs

which the Contractor shall connect to the ground grid. All ground connection surfaces shall be cleaned immediately prior to connection.

Where ground grid extension stingers are indicated on the drawings to be provided for connection to electrical equipment, the Contractor shall connect the grounding conductor to the equipment ground bus, pad, or lug. In addition to the ground grid extension stingers, a ground conductor shall be provided from the tray ground cable to the incoming line end of the ground bus in each assembly of medium or low voltage switchgear and motor control centers indicated on the drawings.

Where a ground conductor is included with the phase conductors of power circuits, the ground conductor shall be connected to the equipment grounding facilities and to the source ground bus. Where a ground conductor is not included with the phase conductors, the equipment shall be grounded by connecting a separate ground cable to the equipment grounding facilities and to the tray ground cable or source ground bus.
Except where otherwise indicated on the drawings, all equipment ground conductors which are not an integral part of a cable assembly shall be sized in accordance with the requirements of NEC. All ground conductors installed in conduit shall be insulated.

Circuits in the circuit List include an insulated ground conductor to all 6,900 volt, 4,160 volt, 480 volt, and 208 volt loads to satisfy the requirements of the preceding paragraph. This ground conductor is either a separate cable, Type GI, or is contained within the multi-conductor power cable. Power circuits from 120/208 volt power panels contain one additional conductor which is used for grounding smaller devices which require 120-volt power. Additional grounding cables which would duplicate the ground conductors already in the Circuit List are not required.

The Contractor shall design, furnish, and install all equipment grounding cables required in addition to the ground cables contained in the Circuit List. This shall include, but not be limited to, devices which have electrical connections but do not require a power circuit such as junction boxes and control equipment enclosures, any equipment to which the routed ground conductor is not of sufficient size to properly ground the equipment, and any other electrical equipment which is not grounded by means of a conductor in the Circuit List.

Suitable grounding facilities shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure and providing a minimum of joint resistance.

Suitable grounding facilities for electrical equipment not so equipped, but requiring multiple grounding connections, shall include the installation of a bare copper ground bus for the connection of several grounding conductors. This ground bus shall be connected to the equipment frame or enclosure, providing a minimum of joint resistance.

The conduit system is not considered to be a grounding conductor except for itself and for lighting fixtures. No equipment grounding conductor shall be smaller in size than 12 AWG unless it is a part of an acceptable cable assembly.

**3.12 Duct Bank** One bare copper ground conductor, equal in size to the ground grid conductors, shall be routed with each duct bank as indicated on the drawings. The duct bank ground conductors shall be located at the top of the duct bank and physically separated on each side if two are required. The duct bank ground conductors shall be connected to the ground grid and grids at locations where the duct bank crosses the grids as indicated on the drawings.

**3.13 Vault Grounding**. A ground conductor, equal in size to the ground grid conductors, shall be grounded at the vault at one end only as indicated on the drawings.

**3.14 Fence and Gate Grounding**. Use PGE Standard S-140-15 for fence and gate grounding requirements.

**3.15 Barb Wire Grounding.** Use PGE Standard S-140-16 for barb wire grounding requirements.

**3.16 Instrument Transformer Grounding.** Use PGE Standard S-140-24 for instrument transformer grounding requirements

**3.17 Switch Handle and Operator Grounding.** Use PGE Standard S-140-27 for switch handle and operator grounding requirements.

**3.18 Power Transformer Grounding.** Use PGE Standard S-140-31 for power transformer grounding requirements. The neutral connection to the transformer shall be one continuous connection from the X0 bushing to ground. If there is associated switchgear with the transformer the connection shall be continuous from the X0 bushing to the neutral ground connection on the switchgear.

**3.19 Capacitor Bank Grounding.** Use PGE Standard S-140-09 for capacitor bank grounding requirements.

**3.20 Gas Insulated Switchgear (GIS) Grounding.** GIS grounding shall be accordance with drawings and manufacturer's recommendation. Refer to manufacturer GIS grounding information document in the attachment.

## END OF SECTION

# SECTION 6080 YARD LIGHTING

## 1.1 General

## 1.2 Scope

The work covered by this specification includes furnishing of all labor, tools, and equipment necessary to install the yard lighting and convenience receptacles in the substation / switchyard as shown on the drawings and as specified herein.

## 1.3 Codes and Standards

Comply with the provisions of the following codes, specifications and standards, except as otherwise shown or specified. The latest edition of the code or standard shall govern:

NFPA 70 – National Electrical Code

## 2.0 Materials

All materials furnished by the Contractor shall comply with the specifications and drawings and be approved by the Owner.

Miscellaneous materials provided by the Contractor shall meet the following criteria:

| Component | Material |
|---|---|
| Switches | |
| Housing and operating levers | Phenolic compound |
| Device plates | |
| Finished areas (metal) | Type 430 satin stainless steel |
| Unfinished areas | Formed sheet steel coated with zinc of cadmium |
| Weatherproof receptacle and switches | |
| Plates and lift cover | Cast aluminum |
| All other metal parts | Stainless steel or Monel metal |

The following conductor types for use in the lighting and convenience receptacle circuits shall be provided.

| Cable Type | Circuit Use |
|---|---|
| THHN (Type L2) | For 120 volt circuits in heated areas |
| XHHW-2 (Type L1) | All 277 volt circuits and all 120 volt circuits in unheated areas |
| SF-2 (Type SF-2) | For incandescent luminaire connections |

The following raceway and raceway fittings for use in lighting and convenience receptacle circuits shall be provided:

| Raceway Type | Use |
|---|---|
| Electrical metallic tubing (EMT) | Installed in indoor non-hazardous areas |
| Rigid galvanized steel or Rigid aluminum | Outdoors above grade and indoor hazardous areas |
| Flexible metallic tubing | Luminaire taps in finished areas |
| Schedule 40 PVC | Area lighting routed underground |

## 3.0 Execution

3.1 Lighting units, receptacles and boxes shall be installed on structures and in the control house as shown on the drawings. Installation of conduit, conduit fittings and boxes for yard power system is covered in the "Conduits" section (6060). Contractor shall install all lamps and poles as indicated in the drawings.

3.2 **Wiring:** Contractor shall install insulated wire, of type and sizes shown on the drawings, to connect control house, yard lighting, and convenience receptacles.

All splices and joints in wiring shall be carefully and thoroughly soldered, or pressure type solderless connectors may be used. If connections are soldered, they shall be insulated with electrical plastic tape or rubber tape covered with black friction tape. If connectors are used, they shall be properly capped or taped.

Immediately before energizing a lighting or convenience receptacle circuit, the Contractor shall make the following checks:

- The transformer neutral supplying the source panelboard is solidly connected to ground.
- The phase and neutral conductors to be energized are free from grounds.
- Convenience receptacle polarity is verified and tested.
- Ground fault circuit interrupting (GFCI) devices are tested for proper operation.
- All covers are installed on luminaires, wiring devices, pull boxes, junction boxes, and conduit fittings so exposed conductors will not be energized.
- The ground conductor is solidly grounded.

The Contractor under the supervision of the Owner representative shall test all circuits for continuity, grounds and shorts, and shall correct all faulty or improperly connected circuits to the satisfaction of Owner.

3.3 **Inspection**: All electrical wiring work shall be subject to inspection. This inspection or waiver of inspection by Owner shall not relieve the Contractor from entire responsibility for use, supply, and installation of materials, workmanship, and all other liabilities under the contract.

## END OF SECTION

# SECTION 6090 EQUIPMENT TESTING AND ENERGIZATION

## 1.1 General

## 1.2 Scope

This section describes and defines general criteria which pertain to the testing and checkout work covered by these specifications. The scope of work extends to all equipment connected and/or installed under these specifications. This work is in addition to testing activities required in other sections of this specification. The Contractor shall be responsible, as part of the base scope, for all labor and materials required to demonstrate that all equipment has been installed correctly and functions properly.

The Contractor test procedures and plans must meet NETA and IEEE standards for testing. The Contractor shall document all testing and inspections

The Contractor shall supply to the Owner their proposed Electrical and Instrumentation Testing procedures for review.

All checkout and testing shall be performed by a Contractor specializing in this type of work.

The cost of all labor, supervision, materials, equipment, vehicles, supplies, and services necessary to provide field tests and adjustments required to demonstrate that electrical systems are correctly installed, tested, and calibrated shall be included in the base lump sum price.

The Contractor is responsible for all costs associated with correcting deficiencies and retesting in the event of a test failure:

The Contractor shall notify Owner of all Subcontractors that will be used for testing during the bid process.

## 1.3 Work Performed by Contractor

The following activities shall be performed as part of the equipment installation. The Contractor shall perform all mechanical and electrical work required to calibrate, checkout, and make the equipment ready for service as required by these specifications.

- Visual and mechanical inspection of equipment.
- Mechanical adjustment and testing of all electrical equipment, as required, assuring proper mechanical functioning and operation.

- All testing and reconnection necessary to obtain correct operation of the electrical equipment.

- Loop verification of all control and instrumentation circuits, in accordance with the Circuit List, to confirm continuity of conductors and those conductors originate and terminate at the locations designated in the circuit list or on the drawings.

- Contractor shall verify expected relay and SCADA inputs (52a, BFI, control switch inputs to relay, etc.) Interrogating the relays and observing expected inputs. Contractor shall verify and exercise relay outputs contacts with relay commands to ensure proper function of the associated circuits (e.g. trip circuits, close circuits, lockouts, etc.)

- Control wiring shall be confirmed as complete and ready for functional testing prior to starting functional testing.

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

- All equipment labeling shall include type and location information and shall be verified as installed and accurate.

- All mechanical adjustment necessary or recommended by the manufacturer of all Contractor-supplied or Owner-supplied electrical equipment being connected or installed.

- Complete testing of the lighting and receptacle system as applicable.

- All instruments wired and calibrated, even if installed by others.

- The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC)

- Upon acceptance of completion, the Contractor shall provide standby craft labor to correct discrepancies found during initial operation on a time and material basis when requested by the Owner. Such standby craft labor shall not be utilized for completion of Contractor punch list items for work later identified as resulting from Contractor's lack of construction completion or Contractor's warranty work.

## 1.4 Work Performed by PGE

- Protective relaying testing will be performed by Owner.

- Electrical Testing of the transformer will be performed by Owner with assistance provided by the contractor

- Testing of the transformer will be performed as soon as possible after the transformer is fully assembled
- Contractor will provide owner notification 2 weeks in advance of a 3 day window when the owner may test the transformer.

- Owner will provide technicians and the required equipment to complete the electrical testing.
- The Contractor shall provide all other workers required to make adjustments, connect equipment, and correct deficiencies during the testing

## 1.5 Codes and Standards

Testing shall be conducted in accordance with the specified source.

| Tests | In Accordance With | Conducted By |
|---|---|---|
| Acceptance Testing | IEEE, NETA | Contractor |

## 2.0 Materials

The Contractor shall provide all necessary material and equipment required for the functionality testing of all major equipment indicated.

## 3.1 Execution

The Contractor shall inform Owner that specific items, devices, or systems are installed and available for checkout. Documentation of the Inspections and Testing will be done on Testing Checklist for Contractor (TCC). This form will be supplied by Owner.

**3.2 Inspection.** The Contractor shall inspect the installed instrument systems and the installed equipment specified herein prior to starting calibration and checkout and shall report in writing to Owner all deficiencies that could prevent proper checkout of such equipment and systems. Such deficiencies, if caused by or during installation by the Contractor, shall immediately be corrected.

**3.3 Discrepancy Procedure.** The Contractor shall endeavor to promptly discover major discrepancies in equipment, materials, and installation so that corrective procedures can be initiated without delay. When the Contractor discovers equipment with an incorrect rating, damage, not being as specified, or is otherwise unsatisfactory, arrangements will be made for replacement of the equipment. The Contractor shall promptly report to Owner any improper field installations or material usage which the Contractor believes should be corrected. Owner will arrange for corrective action.

**3.4 Calibration in-Place.** All equipment furnished and installed by the Contractor shall be calibrated at the site after installation. The Contractor's technicians performing the calibration shall be experienced in the calibration and

adjustment of mechanical equipment. Technicians shall be experienced in working with the necessary diagrams and documents in accordance with the calibration and checkout work assigned to each technician.

Devices and equipment shall be adjusted and calibrated with the equipment normally installed in place. Exceptions to this procedure will be permitted with the concurrence of the Owner for the specific device categories for which in-place calibration is not practical.

**3.5 Minor Corrections.** Equipment and devices furnished by others may require minor correction to ensure correct operation following calibration and checkout. These minor corrections may include the following:

- Minor assembly operations within instruments.
- Removal of factory shunts or jumpers.
- Minor wiring corrections.

The Contractor shall perform minor corrections as part of the work defined by these specifications. In such cases, the Contractor shall include repair of these discrepancies as part of this work.

**3.6 Contractor-Caused Defects.** The Contractor shall promptly repair at no additional cost to Owner any equipment or devices which are damaged by the Contractor's personnel in the course of performing the work. Such defects shall be promptly reported Owner.

**3.7 Manufacturers' Procedures.** Drawings and installation and operating instructions from manufacturers of the equipment appropriate to the work described in these specifications will be made available to the Contractor as required. The Contractor shall follow the manufacturers' instructions in the performance of this work and perform all required and recommended tests, calibrations, and settings identified in these instructions.

**3.8 Personnel.** The Contractor shall provide all personnel required to complete the work in accordance with the project schedule. The Contractor shall provide sufficient staff so that the project schedule is met.

Owner will have the authority to approve and require changes in the Contractor's actual manpower level, including the number of technicians and craft personnel. The number authorized and required may be above or below the Contractor's planned number.

Personnel not performing efficiently, in the opinion of Owner, shall, upon notification to the Contractor, be immediately removed from the project.

Personnel provided by the Contractor shall include the following classifications.

- **Electrical and Instrumentation Technicians.** The Contractor's technicians shall be experienced in the calibration and adjustment of electrical apparatus, instrumentation, control equipment, and final drive devices. Technicians shall be experienced in working with control electrical schematic and wiring diagrams, electrical one-line diagrams, and electrical three-line diagrams in accordance with the calibration and checkout assignment. The total cost of the technicians shall be included in the base Contract Price.

- **Craft.** Sufficient numbers of craft personnel shall be provided by the Contractor to support completion of the work included under these specifications. The total cost of craft for the level of foreman, journeyman, and apprentice for startup and checkout activities is included in the base Contract Price.

**3.9 Tools and Test Equipment.** The Contractor shall provide all required tools and test equipment to perform the work in accordance with these specifications and the project schedule. The test equipment shall be periodically certified. Any test equipment found out of tolerance during certification shall be replaced or repaired.

The Contractor shall include a list of test equipment provided, including manufacturer and model with the proposal. The Contractor shall provide the Owner with a copy of all certifications for test equipment used on the project including any recertification’s or replacement certifications.

**3.10 Test Instrument Certification.** The Contractor shall provide and maintain an onsite facility to perform periodic certification of test instruments and equipment. Test instruments subject to drift or nonobvious miscalibration shall be certified at least weekly. The Contractor's QA program shall be capable of providing verification that the certification is being performed.

Certification methods shall follow recommendations of the test instrument manufacturers.

The Contractor's personnel performing certification shall be specially trained in the methods and procedures for carrying out these calibration certifications.

**3.11 Calibration or Testing Certification Sticker.** The Contractor shall furnish and affix a self-adhesive label to each device calibrated or adjusted. The label shall indicate the date and the name of the person performing the calibration or adjustment.

**3.12 Checkout and Test Report Forms.** The Contractor shall complete the Testing Checklist for Contractor (TCC) for all instruments, mechanical devices, and electrical devices that are tested or calibrated. A blank form to be used by the Contractor will be furnished by Owner or alternately, the

Contractor's standard forms may be used if accepted in writing by Owner. No increase in contract price will be allowed for not using the Contractor's standard forms. The completed forms shall be submitted to the Owner as part of the turnover package. The forms submitted shall include but not be limited to the Checkout and Test Report Forms listed at the end of this section. Forms shall be submitted within 5 calendar days after completion of the activity covered by the Checkout and Test Report Form.

**3.13 Equipment Checks and Calibration**. Preoperational checks and inspections shall be performed on all equipment as specified herein, and in accordance with the equipment manufacturer's recommendations. A representative of the Contractor shall be present during the equipment checks.

The Contractor shall verify in writing that all work and preoperational checkouts have been completed and, when the services of equipment manufacturers' field service representatives are required, the Contractor shall include verification by such representatives that the equipment is ready for operation.

**3.14 Electrical and Instrumentation Checkout.** This article defines the scope of electrical and all instrumentation devices and equipment which shall be calibrated in-place, adjusted, or checked out by the Contractor as part of the work covered by these specifications.

The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC).

The Contractor shall provide all temporary instrumentation and gauging devices required during testing and checkout of the equipment and systems.

**3.15 Equipment Checks**. Preoperational checks and inspections shall be performed on all equipment as specified herein and in accordance with the equipment manufacturers and owners recommendations. All field tests shall be witnessed by the Owner at the Owner's discretion. The Contractor shall perform all tests described in the TCC.

Preoperational checks shall include, but not necessarily be limited to, the following:

- Safety Equipment. All personnel safety items shall be installed. All bolting shall be securely tightened to the correct torque as recommended by the equipment manufacturer.

- All temporary shipping braces, blocks, or tie rods shall be removed.

- Lighting and Receptacle Checkout. The Contractor shall test, check out, and energize the lights and receptacles furnished and installed under this Contract. Lights shall be energized as soon as circuits are

complete to increase the lighting level for construction and checkout. Immediately before energizing a lighting or receptacle circuit, the Contractor shall make the following checks

- The phase and neutral conductors to be energized are free from grounds.
- All covers are on lighting fixtures, pull boxes, and junction boxes so exposed conductors will not be energized.
- The ground conductor (if required) is solidly grounded.
- All metering, including panel meters and transducers, shall be calibrated to within the manufacturer's accuracy.
- Panel instrumentation indicating lights, switches, and relays shall be adjusted and checked out as part of the checkout of the Contractor-installed electrical equipment. Electric metering for volts, watts, amperes, and other electrical quantity functions shall be checked out as described in this article and the TCC.
- Electrical panel instrumentation shall be calibrated.
- Unless specified otherwise, all meters shall be tested and calibrated with equipment of no more than 50 percent of the manufacturer's stated accuracy instrument being tested.
- All meters shall be visually inspected for damage, and wiring connections shall be verified in accordance with the three-line diagrams.
- Every instrument utilizing a plastic lens or window shall be given a static effect check. The static check shall consist of wiping the lens or window vigorously with a dry cloth of a type recommended by the manufacturer which will not harm the surface. If the needle or pointer holds up-scale or below zero set for more than 15 seconds, the surface of the lens or window shall be treated with a clear antistatic compound recommended by the manufacturer.
- The Contractor shall verify that direct grounds do not exist on any dc or 480 volt powered systems. Should a ground be detected, the Contractor shall locate the ground source and inform the Owner.
- Measurement of resistance to ground shall be made of all switchgear, overhead bus and panelboard bus immediately prior to placing in service. Measurement of resistance will be with a line operated tester. Voltage of testing device shall be in accordance with the following table

or the equipment manufacturer's recommendation, as directed by the Owner:

| Equipment Voltage | Voltage, dc | Test Current, max, mA |
|---|---|---|
| 480 volts | 1000 volts | 3 |
| 4.16 kV | 2 kV | 1 |
| Above 4.16 kV | 5 kV | 1 |

- All 5 kV and above power cable shall be tested (hi-pot, VLF, tan=delta, or partial discharge) in accordance with IEEE and ICEA standards, and in accordance with Startup and Testing Specification.

- Complete check of all field wiring shall be made after installation and connection to verify that field wiring is as indicated on the drawings and schematic wiring diagrams. Equipment jumpers as indicated on the schematics shall be checked.

- Shielded cable ground check should be made after termination is complete using a volt-ohm meter to determine that each is grounded only at the points indicated on the drawings.

- All instrument transformers, including bushing current transformers, shall be tested.

- Ratio and polarity tests shall be performed on all instrument transformers. Current transformer ratio and polarity tests shall be voltage ratio tests using a digital voltmeter or current ratio tests using high current injection test equipment, as directed by the Engineer.

- The external circuit for each current transformer shall be completely tested before the shorting devices are removed from the current transformer secondary terminals. The tests shall include the following:

- Continuity check of the circuit external to the current transformer by application of current.

- Phase check to verify correct phase relationship at each device connected in the current transformer circuit.

- All protective and alarm devices associated with all power transformers with primary voltage of 4160 volts or higher shall be tested for correct operation and adjusted as required according to the manufacturer's recommendations.

- The Contractor shall verify in writing that all work and checkouts have been completed, and when the services of equipment manufacturer's

field service representatives are specified, the Contractor shall include verification by such representatives that the equipment is ready for trial operation.

**3.16 Corrected Drawings**. Owner will furnish three sets of the substation Issued for construction design drawings to the Contractor for markup purposes:

The Contractor shall neatly and legibly mark each set, in duplicate, including all field corrections performed during calibration and checkout. One copy of each drawing shall be submitted to PGE as a part of the completed forms returned at startup. A second set will be turned over to Owner for use by Startup and Operations during commissioning. Submittal of these two sets to Owner shall be concurrent with completion of the startup. The third copy shall be retained by the Contractor until the conclusion of the project. The Contractor's copies shall be turned over to Owner at the conclusion of the project.

The Contractor shall use the following colors on markups: Red – Additions
Green – Removals Blue – Information
Yellow – Quality Assurance Checks

**3.17 Checkout and Test Form .** The Contractor shall perform all tests described in the Testing Checklist for Contractor (TCC) provided with the drawings and documents. The Contractor shall initial and date all tests on this document and turn it over to Owner at the conclusion on the project. Contractor shall use Owner forms where applicable for testing documentation.

## END OF SECTION

**APPENDIX G1**
**ATTACHMENT 05**
**EXHIBIT 04**

# COMMUNICATIONS FACILITIES

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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SECTION 27001 – COMMUNCATIONS FACILITES

PART 1 - GENERAL

1.01 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:

Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications

Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications

The SCADA section in those specifications includes the following:

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

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

B. The proposal shall address three aspects of the telecommunications design.

1. Intra-site Communications - the Network shall primarily be an Ethernet Fiber network to support intra-site data and voice communications needs.
2. Substation Interconnect - Contractor shall incorporate plans for the communications needs required to interconnect the facility to the bulk electric power system. This may include transfer trip and any of special or remedial protection schemes needed for the interconnection of the facility to the bulk electric power system. This design shall meet

any requirements from the interconnecting utility, the Public Utility Commission, and/or the Independent System Operator for SCADA or Metering.

3. PGE Connectivity - to support remote monitoring and operation of the facility. This will include one or more data links back to PGE operations center. This shall include connectivity for both the Primary SCADA link as well as the plant operational data link serving plant operations such as sending operational and maintenance data to a historian, allowing remote access and control, and voice communications to the facility.

1.02 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 three sections (Intra-site Communications, Substation Interconnect, and PGE Connectivity) shall be provided. The proposal price will not be revised if the ultimate solutions remains within these allowances.

1.03 TELECOMUNCATIONS FACILITES

A. The following shall be provided both during and after construction:

1. Communications during construction: The Contractor shall provide a communications network to be used during construction, and specifically communications services to the on-site trailers used during construction. A minimum of 5 Mbps Ethernet link shall be provided to each PGE trailer, along with (2) phone lines per trailer, which may be either VOIP or POTS. The Ethernet link shall only be dedicated to PGE and no other users. In addition each trailer shall be equipped with one 7' tall 19" wide communications rack and 20 A of AC power for PGE IT to install routers/switches used to distribute data connections.

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:
      (1) Shall support the Real-time control for the operation of the plant.
      (2) Shall support remote monitoring for the Owner to gather operational data from microprocessor-controlled equipment.
      (3) Shall support monitoring of weather information.
      (4) Shall allow the Owner to remotely access remotely configurable equipment to make settings changes and firmware upgrades.
      (5) Shall support the use of Voice at each enclosure, desk, conference room, or security control point.
      (6) Shall support the use of Video where required for security and operations of the plant.
      (7) Shall include Wireless Access Points in Office locations.
      (8) 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 SCADA 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:
      (1) Use IP/Ethernet communications over a fiber and copper network.
         (a) 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.
         (b) Category 6 copper shall be used for all connections between switches and equipment within a building.
      (2) Use gigabit Ethernet connections
      (3) Use VLANS for segmentation of traffic
      (4) Use Quality of Service to Prioritize traffic flows
      (5) Use Rapid Spanning Tree or other advanced ring convergence protocols.
      (6) Support POE where phones or wireless access points are installed.
      (7) Use managed equipment that support the following:
         (a) Centralized authentication via RADIUS or TACACS

(b) Centralized logging via Syslog

(8) Use hardened network equipment rated for the environment in which it will be installed.

3. Interconnection to Bulk Electric Power System:
   a. Determine specific equipment required by the Utility/Transmission Owner and the System Operator, specifically relating to SCADA, metering and telemetering due to the interconnection agreement as well as equipment required to complete the indicated control and protection requirements.
   b. Build any fiber, microwave, or leased facilities needed in order to tie facility into bulk electric power system.
   c. Follow Western Electricity Coordinating Council (WECC) teleprotection standards.
4. PGE Communications Circuits:
   a. Contractor shall provide the following communication circuits, each with the respective parameters given. These communications circuits can be delivered over the one or more aggregate leased circuits if possible. These circuits may make use of a private data network or a leased facility from a common carrier. The Contractor's proposal shall include the capital cost for construction, as well as the estimated monthly recurring cost if applicable. The Contractor shall make use of the PGE equipment listed below where such equipment is required:

| Circuit Name | LOC A | LOC Z | Type | Capacity | Latency | Avail. | Circuit Description |
|---|---|---|---|---|---|---|---|
| O&M OPX LINE | O&M | PGE WHQ | OPX | 64 kbps | 100 msec | 99.999% | PHONE LINE |
| O&M CORPORATE NETWORK | O&M | PGE WHQ | ETH | 20 Mbps | 100 msec | 99.99% | CORPORATE NETWORK SERVICE |
| O&M SECURITY ETHERNET | O&M | PGE WHQ | ETH | 1.5 Mbps | 0.5 sec | 99.99% | CORP SECURITY LAN |
| SUB SECURITY ETHERNET | SUBSTATION | O&M | ETH | 1.5 Mbps | 0.5 sec | 99.99% | CORP SECURITY LAN |
| SUB REMOTE ACCESS LAN | SUBSTATION | PGE WHQ | ETH | 1.5 Mbps | 0.5 sec | 99.99% | REMOTE ACCESS LAN FOR PROTECTION & AUTOMATION GROUP |
| SUB COMM TECH LAN | SUBSTATION | PGE WHQ | ETH | 1.5 Mbps | 0.5 sec | 99.99% | REMOTE ACCESS LAN FOR COMM TECHS |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| SUB SCADA | SUBSTATION | PGE WHQ | RS-232 | 64 kbps | 1 sec | 99.99% | SERIAL DNP 3.0 SCADA |
| SUB AGC SCADA | SUBSTATION | PGE WHQ | RS-232 | 64 kbps | 1 sec | 99.99% | SERIAL DNP 3.0 AUTOMATIC GENERATION CONTROL |
| SUB PHONE | SUBSTATION | PGE WHQ | VoIP | 64 kbps | 100 msec | 99.99% | GENERAL USE PHONE FOR CONTROL HOUSE. WILL UTILIZE PSEUDOWIRE. |
| SUB ACCESS CONTROL OPX | SUBSTATION | PGE WHQ | OPX | 64 kbps | 100 msec | 99.999% | PHONE LINE FOR SECURITY ACCESS CONTROL |
| SUB SECURITY OPX | SUBSTATION | PGE WHQ | OPX | 64 kbps | 100 msec | 99.99% | PHONE LINE FOR SECURITY |
| INTERCONNECT METER OPX | SUBSTATION | PGE WHQ | OPX | 64 kbps | 100 msec | 99.99% | PHONE LINE FOR THE INTERCONNECTING UTILITY METER |
| INTERCONNECT PHONE OPX | SUBSTATION | PGE WHQ | OPX | 64 kbps | 100 msec | 99.999% | PHONE LINE FOR THE INTERCONNECTING UTILITY PHONE |

1.04 OTHER COMMUNICATIONS CIRCUITS/SERVICE

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

1.05 TELECOMMUNICATIONS EQUIPMENT

A. In each major facility provide space for (4) adjacent Communications racks. For the Plant and Switchyard/Substation facilities, locate the Communications racks in the same room or adjacent to the relay equipment racks. For the O&M Building or Administration Building, in addition to the Communications racks, provide (4) racks for IT Operations and (2) racks for Corporate Security Operations. Locate the Communications racks in the same room or adjacent to racks dedicated for IT Operations and Corporate Security. Each room to include 4'x8' fire-rate plywood backboard (white).

B. Provide a -48VDC power system capable of supplying the load with an 8-hour reserve time at each major facility.

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

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

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

1. Dual-post Rack – Chatsworth “Clear”, 19” x 84”
2. Ethernet Switch – Cisco
3. VoIP Phone - Cisco
4. Wireless Access Point – Cisco
5. Service Aggregation Node – Nokia 7705-SAR-8 with support cards
6. Fiber Patch Panel – Clearfield FxDS, with SC/UPC Connectors
7. ADSS Fiber Cable – OFS AT-3BE17NT-060-CMEA (60-CNT)
8. OPGW Fiber Cable – AFL DNO-8234 (48-CNT)
9. Splice Cases – Tyco FOSC-450D
10. -48 VDC Fuse Panel – Telect GMT Dual Feed 20/20-position
11. -48 VDC Charger Panel – Valere; CK4D-ANL-VC shelf, min 24 hours battery recharging capability while under load
12. -48 VDC Battery (Plant or Switchyard/Substation) – C&D (flooded) or East Penn Deka Unigy II (VRLA) w/ one-piece base and interlocking cells, min 8 hours carry time
13. -48 VDC Battery (O&M or Admin Building) – C&D (flooded) or East Penn Deka Unigy II (VRLA) w/ one-piece base and interlocking cells, min 8 hours carry time

END OF SECTION 270001

# APPENDIX G2

# WIND TECHNICAL DOCUMENTS

# RENEWABLE ENERGY RESOURCES

# PORTLAND GENERAL ELECTRIC

# 2018

# REQUEST FOR PROPOSAL

**APPENDIX G2**
**ATTACHMENT 01**
**EXHIBIT 01**

# WIND PLANT SPECIFICATIONS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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# 1.0 GENERAL

## 1.1 EXTENT

Contractor is responsible for the engineering, procurement and construction of the Project. It is not the intention of this section or document to specify all details of design and construction of the complete Project. However, the Work shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation meeting all contractual obligations of Contractor including guarantees and warranties in a manner acceptable to Owner.

If there are other or different requirements than are specified in this document or Agreement (including any exhibits thereto) that are necessary in order to provide Owner with a System that: (i) has no Defects, (ii) reflects Prudent Industry Practices; and (iii) is capable of performing on a sustained, fully operational basis to generate the electricity as described in the Agreement, Contractor is to satisfy such requirements as part of the Work.

# 2.0 APPLICABLE STANDARDS

Applicable codes and standards, laws and regulations shall be in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

Where a reference to the above is made in this document the latest edition shall apply. Furthermore, in the event of any discrepancy in the Applicable Codes & Standards, the most stringent standards and requirements shall apply.

Contractor shall be responsible for ensuring that the Work comply with all Applicable Codes & Standards and as these may be amended and revised from time to time.

The Applicable Codes & Standards are in addition to the requirements set forth in the Agreement, this document, including any additional standards, Applicable Permits, and the Specifications.

In the event of any departure from Applicable Codes & Standards the referenced codes and standards must be fully explained in writing and submitted for Owner’s review and approval prior to implementation.

## 2.1 ENGINEER OF RECORD

All engineering shall be performed under the responsible charge of the Engineer of Record, who shall be a registered professional engineer, registered in the corresponding discipline for the reports or drawings produced, and the state(s) in which the Site is located. The registered professional engineer shall have experience and competence in the area of engineering being performed as defined by laws and regulations of the applicable jurisdiction.

Final “Issued for Construction” engineering drawings and reports shall be signed and stamped by the registered professional engineer in responsible charge of the engineering work.

## 3.0 SCOPE OF WORK

### 3.1 GENERAL

The Work supplied by Contractor shall achieve the objective of connecting the Wind Plant to the POI for the purpose of generating electricity into the network and be of a proven, robust and reliable design incorporating protective systems and devices with adequate factors of safety and operability built-in. Work will include, but not be limited to:

1. The engineering, procurement, and construction of the BoP including:
    a. Civil works
        i. Roads
        ii. Wind Turbine crane pads
        iii. Laydown areas
    b. Wind turbine foundations
    c. Electrical balance of plant (EBoP)
        i. Collection system
        ii. Collector substation
        iii. Transmission line
    d. Meteorological masts (supply, delivery, installation and instrumentation)
    e. On site buildings including engineering, procurement, and construction of the O&M Building
2. The supply, delivery, offloading, staging, storage, and installation of the Wind Turbines
3. Provision of a comprehensive training program for Owner personnel in relation to the Work so that they can operate the Wind Plant safely and efficiently upon completion of the Work

The Work shall be carried out in accordance with and meet the requirements of the following:

1. The Agreement including but not limited to this document
2. Applicable Codes & Standards (Appendix G1 Attachment 01 Exhibit 03)
3. Warranty obligations
4. Land lease and easement agreements
5. Wind Turbine Specifications (Appendix G2 Attachment 01 Exhibit 02)
6. The Project geotechnical constructability study
7. The Project grid Interconnection Agreement
8. The Project Power Purchase Agreement, if applicable

Contractor shall be responsible for obtaining all Applicable Permits and authorizations required to undertake the Work.

Contractor shall be responsible for the actions required to enable the engineering, procurement and construction of the Work. Contractor shall accompany Owner on factory visits, as requested, to Major Equipment suppliers to verify equipment is being built and delivered.

Contractor shall be responsible for all reclamation activities as required for all areas disturbed during the Work.

Contractor shall be responsible for the establishment of appropriate O&M procedures, quality management system documentation and warranties for the Work.

Contractor shall plan and execute its own Work to minimize the effect of work by others on its own operations and the effect of its work on the operations of others.

All equipment supplied by Contractor shall be supplied new, complete and operational and shall include all necessary accessories and incorporate all miscellaneous material, minor parts and other such items, whether or not the items are indicated on the drawings or in this document, where it is clearly the intention that they should be supplied or where they are required and necessary to complete and commission the equipment.

## 3.2 PROJECT DESCRIPTION

Owner is requesting proposals for a newly constructed wind power project meeting all requirements of the Agreement including but not limited to those listed in this document.

## 3.3 SITE CONDITIONS

Contractor will ensure that all aspects of the Work are fit for purpose and suitable for the current and reasonably predicted conditions at the Site through inspection, examinations, investigations, explorations, surveys, tests, studies and data collection. All inspections, examinations, investigations, explorations, surveys, tests, studies and data collection will be included in Contractor proposal and thus, Contractor will not be entitled to any scope change based on results included in these investigations.

It is Contractor’s responsibility to ensure that all aspects of the Work are suitable for the existing and predicted conditions of the Site including but not limited to:

1. Climatic (including, but not limited to, both local and regional wind and snow loading as well as potential blade deterioration due to rain)
2. Environmental (including any wildlife/avian habitat protection requirements)
3. Community acceptance and impact
4. Geotechnical
5. Existing rights-of-way or easements,
6. Transmission, and
7. Hydrological conditions

If aerial survey techniques are employed, Contractor will validate aerial survey data with ground based data collection.

## 3.4 DESIGN LIFE

Contractor will design, engineer, procure, and construct the Project according to the following intended design life:

1. Civil Works (including Turbine Foundations): 30 years
2. Electrical Works (including collection system, substation, and communications): 30 years
3. Wind Turbines: 20 years
4. O&M Building: 30 years
5. Transmission Line: 50 years

## 3.5 OPERABILITY, MAINTAINABILITY AND ACCESSIBILITY

Design for accessibility, maintainability, and operability shall be in accordance with Appendix G1 Attachment 01 Exhibit 04 – Access, Maintenance, Operation, and Reliability.

### 3.5.1 Operability

Where redundant (standby) equipment is supplied, the idle component shall be capable of automatic initiation by the plant control system or immediate initiation by the operator upon failure of one or more of the operating components without interruption to critical equipment or systems.

Based on the design and equipment type, necessary instrumentation shall be supplied or installed:

1. That allows safe shutdown of the equipment based on the detection of an impending failure of one or more of the operating components, and
2. That allows assessment of the condition of the equipment so that maintenance can be performed before failure occurs.

The signal from the instrumentation will be available on the plant control system and to PGE’s corporate historian.

### 3.5.2 Accessibility

Convenient and safe access, including sufficient clearance, shall be provided to all instruments and equipment for construction, as well as operation and maintenance.

Equipment that only requires access for maintenance shall be accessible from either a ladder or a platform in compliance with all applicable OSHA requirements.

Contractor shall provide sufficient access around all of the Work, in accordance with good utility design practice and Applicable Standards, to allow effective maintenance and removal of items from service or parts thereof, while maintaining operation of the Work unaffected by maintenance tasks.

### 3.5.3 Maintainability

The Work shall be provided by Contractor to allow maintenance to be performed safely and efficiently without significant dismantling or disruption to other items or parts of the Work or curtailing power generation, unless authorized by Owner.

The Work shall allow maintenance activities that can be performed by a limited crew using mobile plant and operating in remote locations.

## 3.6 FACILITY SAFETY

1. The Work shall be designed and constructed in compliance with all relevant health and safety requirements in accordance with Appendix G1 Attachment 01 Exhibit 06 – Safety, Health, and Environment and as specified herein.

2. The Work designed and provided by Contractor shall ensure satisfactory operation in which safety of personnel and Work and continuity of service are the first considerations, and equally to facilitate inspection, cleaning, maintenance and repairs.

3. The design shall incorporate industry best practices for the safety of all those concerned in the operation and maintenance of the Work and of related works supplied under other contracts.

4. Safe operation shall not rely on the connection of the Wind Turbines to the SCADA system or a remote monitoring center.

5. All equipment (including equipment with remote control functionality) shall be designed and installed to ensure the safe isolation of personnel from energy sources when either routine or invasive maintenance is being performed. Energy sources include but are not limited to:

    a. Electrical
    b. Mechanical
    c. Potential (gravity)
    d. Hydraulic
    e. Pneumatic

6. The design shall include a safe and sufficient means to isolate and test the equipment during startup, and operation for purposes of troubleshooting and maintenance.

7. The design shall include the installation of fall protection equipment on all meteorological masts. Such equipment shall match that specified for wind turbine

fall arrest in accordance with Appendix G2 Attachment 01 Exhibit 02 – Wind Turbine Specifications.

8. Equipment and systems shall be designed and installed to allow for:
    a. Safe dispensation of energy released or created by equipment or system failure;
    b. Safely commissioning and/or troubleshooting equipment while the equipment is operational.
    c. Satisfactory operation under the environmental conditions prevailing at the Project Site and under such variations of load as may be met with under working conditions on the grid including those due to synchronization and electrical faults including short circuit.

9. Prior to any paving, gravel walkways and roads shall be maintained for safe movement of personnel and vehicles to all construction locations in accordance with 29 CFR 1910 Subpart D.

10. Cover temporary holes with metal plates (or other rot-proof material) in accordance OSHA Regulation 29 CFR 1926, Subpart M.

## 3.7 PERMITS

Contractor will obtain and maintain, at its sole cost, all Applicable Permits required to design, engineer, procure, and construct the Project, except those provided by Owner or required to be held by Owner (e.g., site certificate). Such Applicable Permits to be obtained by Contractor shall include but not be limited to 1200c (NPDES and Sediment and Erosion Control) permit, removal/fill permit, septic or WPCF permit.

## 3.8 PROJECT CONTROLS

Project management planning, scheduling, project status reports, risk assessments, and recovery planning shall be in accordance with Appendix G1 Attachment 01 Exhibit 05 – Project Management and Controls.

The project schedule will detail all wind turbine activities, including all BoP, testing, commissioning, and turbine manufacturer down-tower work.

## 3.9 PROJECT MILESTONES

In addition to Project Controls requirements of Section 3.8, Contractor will define milestones with associated completion certificates to include, as a minimum:

1. Construction Storage/Laydown Area Completion
2. Public Road Completion
3. Access Road Completion
4. Individual Wind Turbine Foundation Completion
5. Individual Collection Circuit Completion

6. All Collection Circuits Completion
7. Fiber Optic Network Completion
8. Substation Completion
9. Transmission Line Completion
10. Individual Wind Turbine Mechanical Completion
11. Individual Wind Turbine Final Completion
12. Meteorological Mast Commissioning Completion
13. Wind Plant Substantial Completion
14. Remediation/Restoration Completion
15. Drawings and Documentation Requirements Completion
16. Wind Plant Final Completion

## 3.10 QUALITY CONTROL

Contractor shall operate a quality system equivalent to the ISO 9000 series of standards and as approved by Owner.

Contractor's quality assurance / quality control plan will be adequate to cover all construction operations.

Contractor will submit all quality assurance / quality control documentation to Owner to show compliance with the requirements of this document.

Contractor will meet the requirements of Appendix G1 Attachment 01 Exhibit 08 – Quality Management System.

## 3.11 DESIGN AND ENGINEERING

Contractor will complete design and engineering services and will provide comprehensive drawings and specifications for a complete and fully operational Project that meets the requirements of Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

Contractor will submit 30% (preliminary) design packages for the entirety of the Project for Owner review. Such packages will include, at a minimum, drawings, specifications, and assumptions.

Contractor will submit 60% (issued for review), 90% (issued for permit and procurement), and 100% (issued for construction) design packages for the entirety of the Project for Owner review. Such packages will include, at a minimum, drawings, specifications, design calculations, studies, materials, and assumptions. 100% (issued for construction) design packages shall be issued prior to the commencement of construction.

Unless economically prohibitive, Owner preference is to design all turbine strings such that the turbines within each string are on the same side of the string access road.

## 3.12 DELIVERY, STORAGE, HANDLING, OFFLOADING, AND ERECTION

### 3.12.1 Delivery

Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Agreement. These requirements also apply to any sub-suppliers making direct shipments to the jobsite.

Owner shall, from time to time and at their discretion, supply equipment, spare parts, special tools, and materials to the site. Contractor shall coordinate receipt of such items and shall apply all requirements set forth herein to those items.

Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Agreement by Contractor before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, commissioned, placed in operation and found to comply with all the specified requirements.

All items shall be checked by the Contractor against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay, at no additional cost to Owner when it is Contractor supplied.

Delivery of portions of the equipment in several individual shipments shall be subject to review of Owner before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

Contractor is responsible for ensuring that date and time of arrivals and unloading is recorded, including smaller turbine parts (e.g., bolts, collars, etc.), and all copies of packing lists are delivered to the Owner. Owner representatives may check this information prior to signing the transport control form.

Contractor shall be responsible for any delays by shipping from overseas manufacturing.

### 3.12.2 Storage

Upon delivery, all equipment and materials shall immediately be inspected, stored and protected in accordance with manufacturers' requirements and recommendations (to be provided to Owner prior to delivery) or as specified herein, whichever is more protective, until installed. It is assumed that all materials can be received and stored at the Site. If offsite storage is required, it shall be coordinated by Contractor and approved by Owner. Costs for offsite storage will be the responsibility of the Contractor.

Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground. Galvanized steel with architectural purposes shall be stored with appropriate spacers to protect against galvanic discoloring. Galvanic discoloring is not applicable to ground mount array piles for which some discoloring is acceptable. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe and fittings may be stored outdoors but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight. Wind turbine blades shall be properly anchored/secured per manufacturer requirements and shall not be set such that the broad side is facing the prevailing wind. Wind turbine blades shall not be placed on hay bales in presence of cattle.

Motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F [16°C]. Electrical equipment, controls, and insulation shall be protected against wind, moisture, water damage, or induced electrical energy. Space heaters furnished in equipment shall be connected and operated appropriately to protect equipment from condensation.

Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer.

Contractor shall inspect equipment and material before installation. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work. Where possible, pre-installation testing shall be performed to validate component is acceptable for installation.

When applicable and reasonable, the packaging of spare units and spare parts shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

### 3.12.3 Offloading and Handling

Offloading and handling of Wind Turbine equipment and materials shall be completed in accordance with manufacturer’s requirements, installation manuals, Appendix G2 Attachment 01 Exhibit 02 – Wind Turbine Specifications, and as specified herein.

Contractor shall furnish the necessary hoisting equipment, standard rigging equipment (slings, cables, chokers, etc.) that is not provided by Turbine Supplier as described in their tooling list and associated labor to offload the Wind Turbine equipment.

Stored items shall be laid out to facilitate their retrieval for use in the Work. Care shall be taken when removing the equipment for use to ensure the precise piece of equipment is removed and that it is handled in a manner that does not damage the equipment.

Shipping fixtures and containers shall be returned to avoid demurrage costs, as applicable. Contractor shall note the date of notification for pick-up and ensure parts shipped are all noted on the container packing list.

Equipment shall be cleaned following offloading and prior to erection or installation. Touch-up paint shall be applied, as necessary.

### 3.12.4 Erection

Contractor shall erect the Wind Turbine towers, nacelles, hubs, blades and other equipment in accordance with manufacturer's requirements, installation manuals, Appendix G2 Attachment 01 Exhibit 02 – Wind Turbine Specifications, and as specified herein.

Wind Turbine Supplier shall provide Contractor with technical representatives to assist with erection activities. The technicians shall provide oversight and provide Contractor with any specialized training as necessary to support erection activities.

Contractor shall furnish the necessary hoisting equipment, standard rigging equipment (slings, cables, chokers, etc.) that is not provided by Wind Turbine Supplier as described in their tooling list and associated labor to install the Wind Turbine equipment.

Contractor will develop and coordinate critical lift plans and discuss/review plans with erection crew personnel, crane and transport companies, Owner, etc., prior to and during the erection phase.

Contractor will execute erection using a "reference Wind Turbine" approach as a way to gain buy-in from all applicable parties that the first Wind Turbine is erected correctly. Once complete, the reference Wind Turbine will serve as the standard of finished product for all future Wind Turbines on the Project.

Contractor will actively work to minimize wind days, to the extent possible, by scheduling erection activities at times of day when wind speeds are projected to be lowest.

Wind Turbines shall be erected with tower doors oriented downwind of the prevailing wind direction.

## 3.13 TEMPORARY FACILITIES

### 3.13.1 Office Trailers

Contractor shall provide, at a minimum, two job site office trailers. One trailer shall be dedicated to the Owner, with facilities for full time staff members to perform their necessary onsite duties. The second trailer shall be for the Contractor and any engineering or subcontractor staff that requires such space on Site.

The office trailers shall be double-wide and contain all of the necessary provisions to meet local codes and standards for temporary structures. Each office space shall have access to telephone and high speed internet service, either via hard line or cellular connection.

### 3.13.2 Electric Power

Contractor shall determine the type and amount of power necessary and make arrangements for obtaining temporary electric service, metering, and shall bear the costs for electric power used during the construction period.

### 3.13.3 Lighting

Contractor shall provide lighting to all construction areas during construction including but not limited to all indoor areas and areas around equipment, temporary trailer areas, storage areas, roads, walkways, and parking areas per 29 CFR 1910 Subpart M. This shall include general site lighting provided by high mast lights per OSHA regulation 29 CFR 1926, Subpart D.

### 3.13.4 Water

Contractor shall provide potable water for construction and drinking by construction personnel during construction.

### 3.13.5 Sanitary Facilities

Contractor shall provide and maintain sanitary facilities on Site during construction.

## 3.14 TRAINING

Contractor shall provide comprehensive and adequate training for Owner personnel, including Owner sub-contractors, in relation to the Work so that they can operate the Wind Plant safely and efficiently upon completion of the Work.

Training of Owner and Owner’s staff by the Contractor shall avoid interference with the Contractor’s installation and testing activities and be conducted to enable the personnel to participate, to a practical extent, in the commissioning activities.

Training of Owner’s personnel may be conducted at the Site. However any supplementary training at manufacturers’ works or other similar utilities which is necessary shall be offered by the Contractor.

The Contractor shall ensure that adequate supply of training manuals are made available early enough prior to the commencement of training.

# 4.0 GEOTECHNICAL INVESTIGATION

## 4.1 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 foundation systems supporting Wind Turbines, as well as infrastructure listed in Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.2 DOCUMENT REVIEW

A document review shall be conducted consisting of available geotechnical and geologic documentation, per Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.3 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, per Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.4 GEOTECHNICAL EXPLORATION

For all Wind Turbine locations, geotechnical exploration shall consist of a minimum of one soil boring drilled per turbine foundation, or more as necessary to characterize soil and bedrock conditions within the foundation influence zone. Soil borings shall be located within the turbine foundation footprint, extend to a minimum depth of one foundation diameter below the base of the foundation and capture all soil and bedrock materials that can influence foundation behavior.

The drilling method chosen shall be capable of achieving the minimum exploration depth without encountering refusal. Samples shall be taken at regular intervals to characterize materials within the soil and bedrock profile. Soil sampling shall consist of Standard Penetration Testing (SPT or split spoon) samplers and thin wall tube samplers, and performed at approximately 2.5 ft intervals in shallow depths and 5.0 ft intervals to the total boring depth, or as determined by the geotechnical engineer. Where bedrock is encountered, conventional rock coring techniques shall be utilized to obtain rock samples. If bedrock is encountered at a depth of less than 15 ft below the bottom of the projected foundation depth, rock coring shall extend to a minimum of 10 to 15 ft into the rock formation for confirmation that the encountered material is indeed bedrock and not an obstruction such as a large boulder.

Rock or soil drilling without sampling (percussion, air-track or similar) is not considered suitable for geotechnical exploration without prior owner approval. A boring log shall be prepared for each exploration point that includes all geologic and geotechnical observations, sampling information (sample type, blow counts, etc.), groundwater

observations, and boring completion information. All exploration locations shall also be plotted on a map of the Site.

If groundwater is detected within the foundation influence zone during geotechnical exploration, a standpipe piezometer shall be installed to monitor groundwater fluctuation that could affect foundation stability and bearing capacity.

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

### 4.4.1 Geophysical Testing

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

Geophysical testing, including seismic velocity testing, electrical imaging, or other appropriate methods may also be used by the geotechnical engineer to assist in determining soil properties for turbine foundation design. Geophysical investigations shall be carried out by a licensed professional with specific experience in the geophysical method to be used. Geophysical methods shall only be used to supplement the subsurface exploration program and not be used as the only means of geotechnical exploration.

## 4.5 GROUNDWATER CONSIDERATIONS

Refer to Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.6 GEOTECHNICAL LABORATORY TESTING

Refer to Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.7 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

In addition to the geotechnical analyses and recommendations for ancillary and civil infrastructure indicated in Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements, recommendations specific to wind plants shall be provided in the geotechnical report for the following for incorporation into design of the Project:

1. Turbine foundation bearing capacity
2. Turbine foundation total and differential settlement estimates
3. Soil shear modulus (for wind turbine foundation stiffness calculations)
4. Shear modulus degradation factor
5. Turbine foundation subgrade verifications

6. Ground improvement depths and methods, as applicable

## 5.0 WIND TURBINE FOUNDATIONS

The wind turbine foundations shall meet the requirements of this section and Section 6. Where applicable the requirements of this section modify and/or replace the requirements of Section 6.

## 5.1 GENERAL

The wind turbine foundations shall be designed, built and constructed in accordance with local and international industry standards of care, best practice and guidelines.

## 5.2 DESIGN

Wind turbine foundations shall be designed to support the wind turbine generators for all anticipated loads consistent with the information provided in this document and as determined by Contractor's own geotechnical and site investigations. The foundation designer shall prepare a design basis document to outline all references, design procedures, and software tools to be utilized for the design and analysis of wind turbine foundations. The design shall withstand any seismic loading associated with the site and foundation designer shall make its own assessment of the likely ground accelerations based on the greater return period of: 475-year return period as specified in IEC 61400-1, or as specified in the applicable state and local standards.

The wind turbine foundations shall be designed to consider all relevant design factors, including but not limited to:

1. Ultimate limit state, serviceability limit state, and fatigue limit state loads, as required by the turbine supplier.
2. Required degree of rotational stiffness with respect to:
    a. The site geotechnical conditions, and
    b. The wind turbine specification and turbine supplier's foundation requirements.
3. Allowable stresses for the supporting soils.
4. The overall stability (overturning and sliding) of the foundation.
5. Shear modulus degradation of soils.
6. Flexure and shear in the foundation.
7. Resistance to tower anchorage pullout.
8. Seismic loading.
9. The presence of groundwater (buoyancy effects).
10. Load transfer reinforcement to transfer loads into the foundation.
11. Fatigue in the embedded foundation inset or anchor bolt cage and reinforcement
12. Fatigue in rock anchors (if applicable).
13. Crack control in the reinforced concrete.
14. Accommodation of cable ducts as required by the wind turbine manufacturer.

15. Accommodation of the grounding requirements of the wind turbine manufacturer.
16. Accommodation, where applicable, for the installation of temporary met masts as required for the power performance measurements and site calibration.
17. Positive drainage away from foundations and avoidance of ponding within the foundation influence zone. Foundations shall be above crane pads or engineered to allow water to not drain to foundation in areas where land formations are above the foundation.
18. The density of the backfill over the top and at the sides of the foundation and its control and achievement on site.
19. The need to safely access and construct the foundation at all stages of its construction.

## 5.3 EXCAVATION, PONDING AND BACKFILLING

The excavations shall involve stripping vegetation, topsoil and subsoil, storing each separately and further excavation or piling to a suitable bearing stratum. Elevation of existing (or natural) ground surface and bottom of excavation shall be surveyed and approved by the Owner to confirm that the top of concrete pedestal of the proposed turbine foundation will be consistent with the recommendations from the hydrology study for the Site and provide a sufficient buffer to the flood depths, if necessary.

Following excavation and prior to a lean concrete slab layer (mud mat) the substrate shall be inspected by a suitably qualified geotechnical engineer to verify the findings of any geotechnical studies and specifically as it relates to the wind turbine foundation design. Following excavation to the design foundation base level, a lean concrete slab layer (mud mat) layer shall immediately be poured to prevent softening or drying of the foundation.

After construction of the foundation, the top and sides of the foundation shall be backfilled as appropriate to the design with compacted material at a controlled density. In the event of ponding, the excavation shall be drained before foundation construction commences. A gravel ring shall be included as the final layer of the foundation backfill to provide serviceability access for wind turbine operations and maintenance, as well as to prevent potential erosion of backfill soils which should follow the hydrology study recommendations based on flood depths and flow velocities. Debris, weak, softened or disturbed material shall also be removed and replaced with suitable material, as appropriate.

## 5.4 BLASTING

Owner shall be notified in advance of any blasting work anticipated for the Site. Blasting plans shall be prepared by Contractor for all anticipated blasting work to be conducted for the project, and Contractor shall obtain and provide for all Applicable Permits and licenses required for blasting. Storage of explosives and blasting materials shall be consistent with applicable federal, state and local laws and regulations. All blasting shall be conducted in accordance with Owner-approved blasting plan and Applicable Permits.

Blasting shall only be performed by appropriately licensed and qualified persons experienced in the use of blasting for rock excavation.

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

## 5.5 FORMWORK

Shall meet the requirements of Section 6.2 of this document.

## 5.6 REINFORCEMENT

Shall meet the requirements of Section 6.3, except where the following requirement takes precedence.

No reinforcement in the wind turbine foundation shall be welded.

## 5.7 WELDING

Where welding is necessary for fabrication of any wind turbine foundation component other than foundation concrete reinforcement:

All structural or load bearing welds shall meet the AWS D1.1 Structural Welding Code for steel (current edition at time of bid) and welds shall be identified per the AWS Code and or be clearly marked on a drawing as applicable in accordance with an established procedure. This procedure is intended to be used for identification purposes, as such, shall define in detail how the Contractor controls the identification with the marking of welds. Secondly, how the weld history, NDT results and material placement are recorded. This may be accomplished by marking up drawings or by providing a weld record type form designating which piece or weld has been welded buy a specific welder. Welding Procedure Specifications (WPS) shall be provided to Owner for review and approval and shall meet all requirements of the AWS D1.1 code. The certified welders to be used shall be listed in the WPS. Welding inspection shall be conducted by a certified welding inspector per the AWS D1.1 code, and the certification or qualifications shall be furnished by Contractor. Those welds shall be designated on the drawings for volumetric (RT UT) examination or VT only. Examinations shall be performed in accordance with the AWS D1.1 code, as shown on the drawings meeting the Oregon Building Structural Code requirements, and in accordance with AISI rules adopted by the state. If a third party building codes Special Inspector is required, this does not relieve the contractor from the responsibility of performing those examinations required by the code.

Contractor shall develop and maintain complete, up-to-date records of all inspections, surveys and tests, including failures. Recordkeeping, inspection, and testing procedures

shall be included as part of the WPS. Contractor shall maintain records of continuity logs, weld repair, and rejection rates throughout the Work. Owner reserves the right to conduct regular audits and cross checks on production weld joints to verify the competence of all technicians working to agreed NDT procedures. As a condition of AWS D1.1- “When there is reason to suspect the welder is not capable of producing sound welds”, it is the responsibility of the contractor to evaluate the conditions and re test the welder.

## 5.8 CONCRETE WORKS AND BATCHING PLANTS

Contractor shall meet the requirements of Section 6.4, and the batching plant(s) shall have a production capacity capable of providing concrete to any wind turbine foundation to prevent the occurrence of unplanned cold joints and other discontinuities with the wind turbine foundation concrete.

Contractor shall provide a method statement for forming designed cold joints, as part of Contractors documentation. However, while supply of this method statement is required prior to construction it does not imply that a cold joint shall be accepted by Owner.

## 5.9 CONCRETE AND GROUT STRENGTH

Shall meet the requirements of Section 6.5 of this document.

# 6.0 CIVIL WORKS

## 6.1 GENERAL

The Design shall suit the requirements for construction access for long loads, heavy plant and cranes as well as ongoing access for O&M of the Wind Plant. Roads and tracks shall be designed to minimize cut and fill and cross drainage requirements consistent with property boundaries, drainage paths and other site constraints.

Roads and tracks shall be designed to minimize native vegetation clearance and be in accordance with Applicable Permits.

## 6.2 FORMWORK

Formwork shall be in good condition, capable of supporting all loads applied to it during construction, sufficiently rigid to prevent movement or deflection and provide a standard quality surface finish to the concrete. Gaps and joints shall be adequately sealed to prevent seepage of concrete. Prior to pouring concrete, formwork shall be clean with release agents applied as appropriate. Formwork shall be removed with care and any damage shall be repaired.

## 6.3 REINFORCEMENT

Reinforcement, including post-tensioning strand, shall comply with all applicable state and local standards including ACI 318, ASTM A615, ASTM A706. Reinforcement shall be cut and bent in accordance with ACI 318. Acceptable manufacturers and processors of steel reinforcement shall hold a valid certificate of approval. Evidence of compliance with this Section shall be obtained when contract bids are received and approval from Owner shall be obtained in writing prior to procurement.

Contractor shall nominate the items in which each individual batch of reinforcing steel is to be used and shall also state the country, mill of origin and the specification to which the steel for that Work item is produced, and clearly demonstrate how it is equivalent to that specified. Certificates from a laboratory of chemical composition and physical properties of all reinforcing steel shall be required. All testing shall comply with Applicable Standards, including frequency of sampling and testing. (Refer to Level B Construction Documentation requirement, Section 11).

Steel shall not be ordered or placed before written approval has been obtained from Owner. Once such approval has been obtained, the materials shall be cut and bent in accordance with ACI 318. Reinforcement shall be free from loose rust, dirt, oil and any material that may impair the bond with the concrete. Spacers and support bars shall be of a type that shall adequately support the reinforcement and resist deflection. Tying wire shall be annealed wire of adequate size for the purpose required. Sufficient ties shall be used to ensure stability of the reinforcement. Reinforcement shall be supported on plastic or concrete bar chairs. If concrete bar chairs are adopted, they shall be fabricated from the same grade of concrete as that which they are to be cast into.

Welding of any grade of steel concrete reinforcement is not permitted.

## 6.4 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.

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 Applicable Permits that are required for the associated batching plant(s)

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). Sufficient concrete delivery trucks shall be mobilized to provide continuous concrete supply without significant lapses from the batch plant to the construction site.

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. 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 Site temperatures.

## 6.5 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 Engineer of Record (i.e., 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<br>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 |

| Material | Requirement |
|---|---|
| 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 or Natural Pozzolans | ASTM C618 |

Grout materials shall be non-shrink cementitious (ASTM C1107) or epoxy material. The concrete 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, and ASTM C231. Sampling and testing of grout material shall be in accordance with ASTM C579. Sampling and testing concrete and grout is to be carried out by an accredited materials testing laboratory. Testing shall also conform to Appendix G2 Attachment 01 Exhibit 03 – Wind Pre-Operational Startup and Testing.

## 6.6 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 Wind Plant, including, but not limited to:
    a. Wind turbine components, and
    b. Cranes for the installation of the wind turbines.

Contractor, with respect to the Work, shall be responsible for obtaining any relevant encroachment permits or other Applicable 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.

## 6.7 SITE ENTRANCE AND ACCESS ROADS

Contractor, with respect to the Work, shall be responsible for obtaining any Applicable Permits or authorizations and reaching any relevant agreements required with Government Authorities and third parties in relation to access, except in the following cases:

1. Where it is explicitly agreed as being within Owner’s scope

2. 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. Survey verifications shall also be responsibility of the Contractor and provided to the Owner for approval.

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 Wind Turbine components in accordance with the turbine manufacturer's requirements.
2. Crane access for the installation of the Wind Turbines.
3. Two-way traffic for construction access
4. All-weather emergency vehicle access to work areas and Wind Turbine locations

Roads shall be built with minimal cutting into banks and other land formations to the maximum extent possible.

Access road geometry shall conform to the Turbine Supplier requirements, permit requirements, and the following criteria:

1. Road width shall be a minimum of 16 feet
2. If the design road width is less than 32 feet, passing areas shall be provided every 1500 feet. Passing areas shall be a minimum of 16 feet wide in addition to the road width, and a minimum of 200 feet long.
3. Road cross-fall gradient shall be between 1 and 4 percent
4. Maximum road longitudinal gradient shall be 10 percent
5. Turn radii shall be as specified by the turbine supplier

The Site entrance and access roads shall be designed to facilitate access, including crane access, for the ongoing operation and maintenance of the Project. Site entrance and access roads shall be designed following the recommendations provided in the hydrology study to control storm water runoff and prevent road deterioration (see Section 6.12). Land forms that allow snow drifts and water drainage to concentrate on the road shall be removed to the maximum extent possible.

Contractor shall repair the Site roads and access roads to the required standard 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

## 6.8 LAYDOWN AREAS

Contractor shall construct appropriately sized/designed equipment laydown areas nearby each Wind Turbine foundation pad in accordance with Wind Turbine Supplier requirements.

Contractor shall construct a permanent laydown/storage area adjacent to the designed O&M building location (per Section 10 herein) to accommodate:

1. Vehicle parking
2. Storage of Owner-supplied equipment, materials, parts, etc.
3. O&M building
4. Spare parts not planned to be stored within the O&M building
5. Security fencing and vehicle entrance gates

Outside of the above-specified laydown areas, additional laydown areas may be constructed, as needed, to accommodate:

1. Storage of Owner-supplied equipment, materials, parts, etc.
2. Equipment, parts, materials, etc., not stored at the Wind Turbine pads or permanent laydown area, in accordance with supplier requirements
3. Office/construction trailers and temporary facilities (per Section 3.13 herein), if
4. Additional vehicle parking

All laydown areas shall:

1. Be appropriately sized/designed for anticipated construction traffic
2. Be constructed of aggregate surfacing following the recommendations from the civil or geotechnical Engineer of Record
3. Be secured with fencing or other approved means to prevent equipment vandalism, theft, damage, etc.
4. Remain suitable for use in all weather conditions

Except for the permanent laydown/storage area, all laydown areas shall be restored (per Section 6.15 herein) after the laydown area is no longer needed.

## 6.9 CRANE PAD/HARDSTANDS

Each wind turbine shall have a crane pad layout designed, constructed and maintained to be suitable for the installation, operation and maintenance of the Wind Turbine, in accordance with the turbine manufacturer's requirements, following the recommendations from the civil or geotechnical Engineer of Record, and able of remaining for future operational requirements.

Crane pads are assumed to be left in place at the end of construction, unless specified otherwise by the Owner or permit authorities.

## 6.10 FENCES, GATES, ENTRANCES, CATTLE GRIDS

All fences and entrances shall be in accordance with Applicable Standards and Applicable Permits, unless otherwise specified. All fences, gates, entrances, and cattle grids 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.

## 6.11 SIGNAGE

Each Wind Turbine shall have a unique identification number, which shall be clearly and indelibly displayed inside and outside the lower tower access door.

For all signage, capitalized block numbers/letters shall be used, black in color, and 8 to 12 inches tall.

## 6.12 DRAINAGE

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. The design assumptions and criteria of the Wind Turbine foundations, and other elements of the Civil Infrastructure
4. The absolute requirement to maintain adequate soil cover over the Wind Turbine foundation
5. Pollutant discharge and other environmental permitting restrictions on construction and the finished Project
6. 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 25-year return period flood event for the road and drainage infrastructure, and
2. A 100-year return period flood with sufficient freeboard for the Wind Turbine tower and turbine components, substation and permanent buildings.

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 turbine access roads. Water pooling under the wind turbine 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.

## 6.13 WASTE MANAGEMENT

Contractor shall provide a Hazardous Materials Management Plan (HMMP) that includes spill and recovery procedures and a Solid Waste Recycling/Recovery Plan. Contractor shall be responsible for controlling, labeling, using, handling, storing, transporting, and arranging for disposal and disposing of all Hazardous Materials brought to the Project Site. At Contractor's sole cost and expense, remove all Hazardous Materials brought to the Project Site

All Applicable Permits and authorizations required for the temporary storage of waste on site shall be obtained by Contractor. No litter or construction related waste is to be left on the Site.

Excess soil and excavated materials meeting standards for clean fill may be left on-site (at locations approved by Owner) 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 the HMMP and federal, state and local laws and regulations. If immediate removal is impractical, the wastes are to be temporarily stored in accordance with applicable laws and regulations.

## 6.14 DUST CONTROL

Contractor shall comply with all federal, state, and local ambient air quality standards surrounding the work areas, as applicable.

All practical dust control measures and erosion prevention BMPs for the prevention and suppression of fugitive dust shall be used as normal practice including, but not limited to:

1. minimizing potential for dust by wetting down bare and disturbed soils, on construction routes subject to surface dust movement, and where off-site damage may occur if dust is not controlled;
2. minimizing free fall of soil/aggregate materials and eliminating excessive drop heights during material transfer; covering soil/aggregate stockpiles;
3. limiting the size of open excavations or the duration an excavation is open;
4. controlling vehicle speeds and designating construction traffic patterns;
5. installing construction entrances and stabilizing construction haul roads with crushed rock;
6. installing temporary or permanent surface stabilization measures immediately after completing land grading; and

Contractor shall maintain dust control measures through dry periods until all disturbed areas have been stabilized.

## 6.15 RESTORATION

Contractor shall restore all areas that have been disturbed during the Work by replanting and seeding in conformance with the requirements of any Applicable Permits, Project Agreements, and revegetation plans. The seed mix and plant species are to be approved by Owner prior to re-seeding. Restoration shall be in accordance with the Applicable Permits and planning and environmental constraints on the Project. Restoration seeding must occur during the first optimum seeding window for the location and before the Final Completion of all construction activities. Contractor is responsible for monitoring and maintaining site vegetation for one year after construction, including re-seeding of any areas where the initial seeding is unsuccessful.

# 7.0 ELECTRICAL BALANCE OF PLANT

The Electrical Balance of Plant (EBoP) shall keep all Wind Turbines electrically energized (except under fault conditions or for maintenance) and collect the output of the Wind Turbines and transfer it to the Point of Interconnection (POI).

The design of the EBoP by Contractor shall:

1. Be for high reliability and efficiency;
2. Be compliant with Interconnection Agreement and Power Purchase Agreement (if applicable) requirements; and
3. Allow safe operation and maintenance.

## 7.1 GENERAL

The Wind Plant shall integrate seamlessly with and be fully compatible with the Transmission Service Provider (TSP) interconnection facilities at the POI, including any required communications links.

The POI will be defined in the Interconnection Agreement.

## 7.2 TRANSMISSION SERVICE PROVIDER (TSP) AND INTERCONNECTION AGREEMENT

Contractor shall ensure that the EBoP and components supplied under the EBoP comply with all Interconnection Agreement (IA) requirements. If IA is not executed, refer to interconnection studies for requirements. If interconnection requirements are still uncertain, such as reactive power/power factor control, Contractor may exclude or provide allowance for reactive compensation equipment, with final requirements to be subject to change order if required.

Contractor shall undertake studies, prepare a modelling package, information and technical reports that confirm compliance with all Interconnection Agreement requirements.

## 7.3 ENVIRONMENTAL CONDITIONS

The EBoP, including equipment selection, design and installation, shall be suitable for all environmental conditions expected at the Site, including those as defined in Section 3.3 and, without limitation:

1. Normal and abnormal voltages and currents, and
2. Lightning.

It shall remain Contractor's responsibility to satisfy themselves of the appropriate environmental conditions and to supply equipment that is suitable for operation under those conditions.

## 7.4 MATERIALS AND SUPPLIERS

The EBoP shall consist only of new, un-used equipment made from the highest quality materials and components.

All electrical plant materials shall be sourced from reputable suppliers, consistent with Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers, that are accredited to recognized manufacturing quality systems.

## 7.5 ELECTRICAL EQUIPMENT RATINGS

All electrical equipment within the Work shall be adequately rated, including with respect to thermal ratings, fault ratings and insulation ratings.

### 7.5.1 Thermal Ratings

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

### 7.5.2 Fault Ratings

1. Fault ratings of all electrical equipment shall be such that it shall pass, without damage, the maximum expected fault currents for a period no shorter than the backup protection clearing time and considering the maximum expected future fault level at the POI to the TSP network within the Design Life.

### 7.5.3 Insulation Ratings

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

## 7.6 SAFETY AND WIND TURBINE ISOLATION

It shall be possible to locally isolate, de-energize, lockout and earth each Wind Turbine transformer without de-energizing others.

Transformers shall have loadbreak disconnect switches operable from outside any arc-flash hazard.

Each down tower transformer shall have ball studs installed for capability to hang grounds on the tower or low voltage side.

## 7.7 ECONOMIC OPTIMIZATION

All components of the EBoP shall be designed by Contractor to minimize electrical losses, as far as is economically advantageous. Specifically, collection system cable losses/sizing shall be optimized by comparison of net present value of losses versus cost of up-sizing cable using a base cost of $40/MWh.

Wherever applicable, cable sizes shall be determined in accordance with IEC 60287-3-2 Economic Optimization of Power Cable Size and within the constraints imposed by other limitations such as voltage drop, fault ratings, thermal ratings, and common conductor sizes or insulation types already in use by the Owner.

Notwithstanding the above, the EBoP shall be designed to ensure that electrical losses are minimized as far as economically advantageous and that as a proportion of the total Wind Plant annual electrical energy generation, over an average year and measured between the Wind Plant POI and the sum of the outputs of all the Wind Turbines, shall be less than 2.5%. The electrical energy loss calculation shall be completed based on IFC plans and specifications and Project-specific wind speed distribution; the calculation shall be repeated following construction and updated for any material change in the as-built EBoP compared to the IFC plans and specifications.

## 7.8 RELIABILITY

The EBoP between the POI with the TSP and the Wind Turbine terminals shall be designed to achieve availability in excess of 99.0% on an annual basis, after considering planned outages.

The availability calculation shall take into account the expected mean time between failures (MTBF) and the mean time to repair (MTTR) of the components of the electrical system, and the proportion of the Wind Plant (number of Wind Turbines affected by the failure divided by the total number of Wind Turbines) affected by the failure of the component, however Owner acknowledges that such a calculation is a design intent and not a warranty.

## 7.9 PROJECT SUBSTATION

Project substation shall be in accordance with Appendix G1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.

## 7.10 COLLECTION SYSTEM

### 7.10.1 General

1. The Project electrical collection system shall be buried. Overhead circuits may be permitted with Owner approval.
2. The electrical collection system will include power and communications cabling in the same trench.

3. Cable tagging shall be in accordance with Owner-supplied requirements.
    a. The ends of all underground and overhead cables must be tagged by Contractor with information designating their unique name, phase and location of the other end.
    b. All cables and lines shall be given a unique name (preapproved by the Owner via a submittal) and appropriately marked.
    c. All enclosed cables are to be tagged with Burndy UNIRAP identification cable ties, or approved other, supplied by the Contractor. Marking shall be done by neat and clear hand printing using an indelible marking pen, Burndy type MP-1 or equivalent
    d. Cables that are exposed on riser poles shall be marked with a 3” diameter brass tag, attached to pole near the terminators in a manner acceptable to the Owner. The tag shall be embossed using a stamping set to create letters and numbers at least 3/16” high. All tags, tie wires, and the required embossing stamp are to be supplied by Contractor.
    e. All tags shall be marked in with the type and identification of the equipment at the other end of the cable. The following abbreviations should be used:
        i. T-xx Turbine step-up transformer for tower xx, or turbine downtower
        ii. switch for tower xx
        iii. GT-xx Grounding transformer xx
        iv. JB-xx Primary junction cabinet JB-xx
        v. RP-x Primary riser pole RP-x
        vi. F-xx Substation switchgear, feeder cubicle xx
4. Junction boxes shall be kept close to property lines, access roads or otherwise accessible locations to minimize encroachment and other long term impacts to local landowners.
5. All cable and communication terminations or above-ground junctions shall be along the road-side.
6. The layout of the electrical collection system will follow existing or new roads wherever possible, but not in contradiction to economic optimization as described in Section 7.7.
7. Trenches will be free of water, firm throughout, and of a minimum dimension to facilitate cable installation
8. Backfill will be compacted to 90 percent (90%) of standard proctor density, unless alternatively specified.
9. Blasting for the collection system trenching is not permitted without authorization from Owner.
10. Studies to be completed as part of Project electrical collection system design will be in accordance with Appendix G1 Attachment 04 Exhibit 01 – General Electrical Study Requirements.

### 7.10.2 Power cabling

1. MV cable
    a. Collection system 34.5 kV cable shall be rated 35 kV, direct buried aluminum conductor with copper concentric neutral. Insulation shall be

tree retardant, water blocked, cross-linked polyethylene insulation (TRXPL) or ethylene-propylene rubber insulation (EPR) 345 mils thick, 100% insulation level (provide cost alternative for 133%), that meets or exceeds all requirements of applicable AEIC, IEEE, ICEA, NEMA, and UL standards.

i. Copper conductor may be proposed versus aluminum, if conditions require, if cost effective and compliant with all requirements. Options for aluminum or copper conductors shall be presented to the Owner for final approval.

b. Cable sizes to be utilized are (as required):
   i. 1/0 AWG AL (full neutral)
   ii. 3/0 AWG AL (full neutral)
   iii. 750 kcmil AL (1/3 neutral)
   iv. 1000 kcmil AL (1/6 neutral)
   v. 1250 kcmil AL (1/6 neutral)
   vi. Other cable sizes shall not be used without Owner approval.
c. All central conductors shall be Class B stranded. No more than one (1) conductor per cable shall be allowed. Conductor material shall be aluminum or copper.
d. All 34.5kV collector circuits shall include a bare copper ground cable. The size shall be determined by included studies but be no smaller than 1/0 bare soft-drawn cable. Copper weld trench ground cable may be proposed provided it is compliant with all requirements and modeled in applicable studies.

2. LV cable – between turbine and pad-mount transformer
   a. Options for aluminum or copper conductors shall presented to the Owner for final approval.

### 7.10.3 Cable installation

1. Underground cable runs, including SCADA communication cables and earth conductors, shall be located at an appropriate depth to meet Applicable Standards, Owner's requirements as set forth in the Agreement and this document, and industry best practices.
2. Cables shall be installed in accordance with Applicable Standards including requirements for mechanical protection, warning and locating tape, and depths of burial.
3. Where appropriate, cables or cable conduits shall be laid during access road construction in order to avoid disturbing reinstated ground.
4. Cables shall be installed in conduit where they cross roads.
5. Possible surface reduction from future road maintenance shall be considered when selecting the cable burial depth at road crossings.
6. Use of plow type installation equipment is not allowed unless confirmed appropriate for soil type and approved by Owner.

7. Mechanized, all-in-one wheel or chain trenching-laying equipment is allowed, and open trench method is allowed. Directional drilling bores are allowed for crossings.
8. Cable trefoil configuration shall be maintained by use of zip ties or suitable tape in accordance with manufacturer recommendations and Owner approval, placed at 10 foot maximum intervals.
9. Native material excavated from the trench shall be used for the bedding/cover material as much as practicable, subject to the requirements listed below, local ordinances, and the need to ensure thermal stability.
10. Bedding: Approximately 6 inches of < ¼ inch native bedding (or thermal backfill if required), and twelve (12) inches of < ¼ inch native (or thermal backfill if required) soils shall cover the collector fiber optic and cable bundle and shall be screened/visually inspected for materials in excess of two (2) inches. Bedding material shall be free of sharp stone, debris, roots, or other deleterious material unsuitable for use within the cable trench.
11. A continuous metallic cable marking tape shall be laid in the trench a minimum of thirty (30) inches below grade along the length of all buried cable, and at least twelve (12) inches above cable bundle in all cultivated areas.
12. Electrical marker balls shall be installed in the trench every 300 feet, at all crossings and at every turn. The markers shall be programmed with the feeder number as per the substation breaker identification number.
13. An appropriate cable locating device shall be provided to enable the location of underground cables and electronic markers.
14. All trenches are to be backfilled and compacted upon completion and original ground levels restored to a minimum level of compaction and tested as specified by the geotechnical Engineer of Record.
15. Trenches shall be surveyed prior to backfilling (cable route and depth shall be indicated on the as-built Record Drawings).
16. Compaction: Backfill above the first lift shall be placed in maximum 6-inch lifts and tamped or compacted between lifts. Minimum compaction shall be 95% testing every 500 feet at start of job, increasing to 1000 feet upon approval by engineer (assume 90% compaction in ampacity studies to provide margin).
17. Ditch dams, consisting of sand bags or soil cement berms placed over the conductors at a 30 degree angle, shall be placed at intervals in all cable runs which traverse slopes greater than 3 per cent. Spacing shall vary, depending on the steepness of the grade, at from 100 ft. to 300 ft.
18. All collector trenches shall be laid out and pre-graded to assure correct burial during final grading. Changes of grade between trenching and final profiles shall be accounted for in confirming burial depth.
19. Final depth of collectors shall be verified following final grading and adjusted to meet the specified minimum requirements.
20. 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.
21. Parallel collector circuit bundles shall maintain a minimum separation of 8-feet, in order to provide physical and thermal separation. Closer spacing where

necessary shall be evaluated for thermal effects or shall require de-rating of the buried conductors.

22. Sufficient slack shall be provided at termination points to allow two future terminations. Establishing slack via coil under the pad-mount transformer or junction box, in a plenum or vault, is required.
23. A sufficient amount of cable slack shall be provided to allow installation of elbows and termination of the cables to the appropriate junction box and/or Turbine switchgear terminal and permit ready disconnection of the elbows and mounting on the parking stands. For the avoidance of doubt, such slack shall allow for the installation/service disconnection of connectors, dead breaks, and other similar devices.
24. Cable bending radius shall not be less than NEC and cable manufacturer requirements, whichever is larger. Contractor shall ensure vault size and depth allows for bending radius. For largest cable sizes e.g. 1250 kcmil, that prevent coiling within vault, cable slack may be provided by s-bends at external approach to junction box or pad-mount transformer.
25. 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.
26. 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, utility, fence, and waterway crossing. The markers shall include cable voltage details and telephone numbers of both the asset Owner and the appropriate dig-safe agency. Landowners shall also be provided with these phone numbers and the as-built cable route details and drawings
27. Directional fault current indicators (DFCI) at all key feed through points, branch points, load-break Circuit Switches, and junction boxes. Each DFCI shall include a fiber optic indicator-extension, with lenses mounted through the enclosure. All fiber optic indicator extensions shall be of such length as to allow normal unimpeded opening of the enclosure, and normal operation of its contents. All DFCIs shall be installed and phase orientations displayed uniformly, and be representative of the phase orientation within the enclosure.
28. Collection system conductor shall be rated for a maximum temperature of 250°C (short-circuit current rating).
29. Collection system components shall be rated for a basic impulse level (BIL) of 200 kV.
30. Cable Splices/Terminations/Connections
    a. Direct burial splices are not allowed.
    b. Splices shall be made in above ground metal or fiberglass splice cabinets, over underground vaults or plenums. Splice-points shall include a capacitive test point and allow means of establishing a ground point with hot-stick applicable accessories. Any splice-point terminations rated over 200A, shall also employ integrated 200A bushing with dust cap, accessible for grounding. All splices and terminations at junctions, pad-mount transformers are to be made by experienced personnel, with

manufacturer refresher training on site at beginning of job, with training certificates made part of QA/QC job books.

31. 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.
32. 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.
33. All trenched fiber optic cables shall be protected against rodent damage by use of PVC conduit, Pest Duct or armored fiber optic installation as chosen by the contractor and approved by Owner. A combination of the following methods shall be used:
    a. Non-armored fiber-optic cable in Pest Duct
    b. Non-armored fiber-optic cable installed in a minimum of 4" schedule 40 PVC or HDPE innerduct
    c. Armored fiber optic cable
    d. Any concreted encased duct bank or metallic conduit
    e. Any owner approved substitution that achieves equal protection from rodent damage
34. Met tower power supply: If a pad-mount transformer feeds a Met Tower, one additional Met Tower power and one additional communication conduit or duct getaway shall be provided. The length of this duct shall be sufficient to exit the transformer vault footprint.

### 7.10.4 Sectionalizing junction boxes and above ground splice JBs (2-way)

1. Contractor shall install and connect each junction box/cabinet in accordance with the appropriate drawings and specifications.
2. Concentric neutral tails are to be connected to the ground bus supplied with the cabinet, with sufficient slack to allow free movement of the terminations for maintenance or replacement. The cable jacket shall be carefully sealed against moisture ingress at all jacket openings.
3. Sufficient slack cable shall be installed such that the cables can be re-terminated after the project is commissioned per applicable section. If the cable size permits this to be achieved by coiling in the ground sleeve/basement, such cable shall be trained neatly in the ground sleeve area, with a minimum amount of crossovers and buried in sand to prevent damage to the cable from failures in the cable riser section.
4. Fault indicators with externally visible/monitored indicators shall be installed in each junction box.
5. Infrared windows shall be installed in the junction box lid such that the Owner can monitor all the bushing and elbow temperatures using an infrared camera without opening the junction box.
6. Bollards shall be installed around the junction boxes to prevent damage from wheeled and tracked equipment. If the junction box is installed in area used for raising livestock an appropriate system, to be agreed with the Owner, shall be installed to prevent the livestock from rubbing on the junction box. Bollard color shall be red.

### 7.10.5 Pad-mount transformers

1. Pad-mount transformers shall be installed on vaults; fiberglass box pads will not be used.
2. Spare pad-mount transformers will be supplied at a ratio of 1:40 (one spare per 40 installed) by Contractor
    - One spare ground reference transformers by Contractor
3. Transformers shall be K-1 rated, unless higher factor required due to turbine type (e.g. Type IV full converter) or per turbine supplier requirements.
4. Transformer tanks shall be rated to withstand 10psi internal pressure and a full vacuum.
5. Each pad mount transformer shall be equipped with an exterior fill valve, drain valve, external oil sample port, oil level gauge, temperature gauge, and nitrogen bleed valve, under lockable covers separate from the HV or LV cabinets.
6. Each pad-mount transformer shall be equipped with an Oil Switch. The operating handle shall be accessible from the side of the transformer, outside the HV or LV cabinet under a lockable cover under a lockable cover.
7. HV and LV cabinet doors shall operate independently, each with own locking handle.
8. Each pad-mount transformer will have at least one 3” diameter or larger infrared viewing port installed on both primary and secondary sides, such that the viewing angle of an IR camera does not exceed 30° from perpendicular.

9. For each Wind Turbine type and size, each transformer in the Wind Farm shall be of the same type and shall be directly interchangeable with any other.
10. It shall be possible to completely replace any transformer without removing any Wind Turbine or Wind Turbine tower.
11. Any switching, protection or isolation functionality provided as part of the Wind Turbine transformers shall facilitate safe switching and operation to the maximum extent afforded by modern electrical equipment in accordance with the Applicable Standards.
12. If required due to proximity to waterway, oil-filled pad-mount transformers will be supplied with a bund adequate for the purpose of containing oil. A vault, in which the transformer is mounted upon, may be configured to serve this purpose.
    - A minimum bund capacity of 110% of the transformer's maximum oil volume is required and the bund shall be shielded to prevent the accumulation of rainwater.
13. Ball studs shall be installed on all LV paddles of the transformer for ease of grounding. In so doing, the ball studs shall be directed outward toward the LV door. Further, the pad-mount transformer cabinet clearances shall anticipate this additional length.
14. Pad-mount transformer LV bushings shall be provided in a staggered arrangement, in accordance with Figure 8 in IEEE Std C57.12.34-2015
15. X0 bonding jumper shall be external to the tank (inside the LV cabinet) and separable.
16. Transformer mounting flanges shall be flush with the vault surface to prevent rodent ingress
17. Concentric neutral tails are to be connected to the ground bus supplied with the vault, with sufficient slack to allow free movement of the terminations for maintenance or replacement. The cable jacket shall be carefully sealed against moisture ingress at all jacket openings.
18. Sufficient slack cable shall be installed such that the cables can be re-terminated after the project is commissioned per Section 1 and 2. If the cable size permits this to be achieved by coiling in the vault, such cable shall be trained neatly in the vault, with a minimum amount of crossovers and buried in sand to prevent damage to the cable from failures in the cable riser section.
19. Bollards shall be installed around the pad-mount transformer to prevent damage from wheeled and tracked equipment. If the pad-mount transformer is installed in area used for raising livestock an appropriate system, to be agreed with the Owner, shall be installed to prevent the livestock from rubbing on the pad-mount transformer. Bollard color shall be red.

### 7.10.6 Wind Turbine tower foundation electrical work

**MV Cable**

1. Sufficient slack will be provided at termination points to allow two future terminations. Establishing slack via coil under the padmount transformer or junction box, in a plenum or vault, is preferred.

**LV Cable**

1. Conduit – at least two spare power conduits are required between the pad-mount transformer and Wind Turbine tower

**Grounding**

1. Driven ground rods shall be installed for each Wind Turbine transformer, and bonded to the turbine foundation ground grid and rebar cage. Turbine foundation ground system ground rods shall be copper-clad, 5/8-inch diameter, 8-foot-long rods at a minimum.
2. Pad-mount transformers shall be ground bonded to the Wind Turbine foundation ground ring via Eufer ground, at a minimum of two places.
3. Ground rings shall be bonded to the Wind Turbine foundation large diameter, full length reinforcing bar by suitable mechanical clamps.
4. Ground resistance shall comply with turbine supplier maximum resistance requirements.
5. Ground grid resistance shall be tested at each Wind Turbine foundation prior to connection to (isolated from) trench ground.
6. Underground ground connections are to be exothermic weld.
7. Ten (10) feet wide "beauty ring" crushed, high impedance rock shall be placed around the tower foundation pedestal and transformer pad if required
8. All Wind Turbine foundation ground above are subject to grounding study results including step and touch analysis results, as specified in the General Electrical Study Requirements and to Turbine Supplier grounding requirements.
9. All turbine manufacturers, local requirements, NESC and IEEE shall be adhered to in the grounding design and construction. Grounding design shall consider recommendations of the geotechnical report, grounding study (personnel safety for step-and-touch potentials), and lightning and surge protection.

### 7.10.7 Overhead installation

The following general specifications apply to the Project overhead collection system if applicable:

1. Overhead collection system shall be designed and installed in accordance with Appendix G1 Attachment 05 Exhibit 01 – Transmission Line Design Specification and Appendix G1 Attachment 05 Exhibit 02 – Transmission Line Construction Specification.
2. Collection system shall be in full compliance with the applicable requirements of the Oregon [or applicable state/jurisdiction] Avian Power Line Interaction Committee.
3. Double circuit construction is allowed but with prior approval of Owner considering impact of outages.
4. Portions of the 34.5 kV overhead collection system may be installed as underbuild on higher voltage (e.g. 230 kV) transmission line only where terrain or other construction factors absolutely dictate.
5. Conductor type shall be approved Owner standard transmission line conductor size, with OPGW shield required per Owner direction.

### 7.10.8 Surge arrestors

1. Surge arrestors shall be fully shielded, submersible, dead-front devices rated at 35-kV class, 600A, 30kV/24.4MCOV and meeting the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation. Specify and supply with 600A interface to ensure compatible with 600A bushings and no requirement for bushing extenders.

### 7.10.9 Conduit

1. Conduit size shall be in accordance with ANSI / NFPA 70, at a minimum. Conduit material shall be Schedule 40 PVC, with smooth interior surface and suitable pulling lubricant used to prevent cable damage while pulling cable into duct.
2. All conduit shall have collars (bell ends) installed to protect cable while pulling.
3. The location of all conduits shall be surveyed and recorded within the as-built drawings.
4. All above-ground power and communications cabling shall be installed in conduit.
5. All below grade crossings, including road, utility, and wetland crossings (if required), shall be installed in conduit. Directional bores may be used in accordance with Owner requirements.
6. Directional bores
    a) Conduit installed in directional boring operations shall be polyethylene electrical plastic duct, with wall thickness as specified. All polyethylene conduits pulled in to a single bore shall be one continuous length without joints or couplings or by welding method approved by Owner.
    b) Conduits under roadways or pipelines and certain other locations shown on the drawings shall be placed by directional boring techniques with conduit installed in the bored hole. Contractor is responsible for supplying and installing conduit as specified. In addition, Contractor may elect to install additional cable by directional boring techniques.
7. LV cable from turbine to pad-mount transformer (if any) shall be installed in conduit.
8. Fiber optic 1-1/4” innerduct shall be installed in a minimum 3” conduit.
9. Conduits shall be filled with stainless steel brillo and sealant to prevent rodent entry into tower and smoke from being drafted up tower from the pad-mount transformer.

### 7.10.10 Connectors and fittings

1. Connectors and fittings shall be of the proper size and design to assure permanent, secure, and low-resistance connections.
2. Suitable connectors and fittings to be used where appropriate include:
3. Belleville washers for all pad connections
4. Stainless steel bolts for copper to aluminum connections
5. Bi-metallic pads shall be used for any or all copper-aluminum connections – conductive paste is not to be used.

6. Stud-to-pad and cable-to-pad connectors for stranded aluminum conductors
7. Tubular compression fittings for stranded aluminum conductors
8. Four bolts or two “U” bolts for copper bus work joints
9. Shield wire dead ends, splices, and taps shall incorporate fittings that are compression type with bolted jumper connections, with compressions sleeves of at least 90% shield wire strength.
10. Disconnect switch terminal pad connectors will be NEMA four (4) bolt terminal pad connectors.

## 8.0 PLANT SCADA

The Plant SCADA system shall be a proven system, suitable for performing the operation, maintenance and monitoring functions associated with the Wind Plant.

Other features that include modules for managing O&M may be offered as an option. These may include maintenance scheduling, spare part records, service records and maintenance records.

The Plant SCADA system includes and integrates both the Wind Turbine SCADA system supplied as part of Wind Turbine scope of supply, and the substation SCADA system provided separately as part of the collector substation scope of supply.

### 8.1 GENERAL

The central Wind Turbine SCADA computer and substation SCADA system shall be installed in the substation and shall be suitably protected against all reasonably foreseeable environmental conditions.

The Plant SCADA system shall record and report all necessary operational details and allow central and remote, automatic and manual control. The software provided shall also be capable of undertaking the warranty calculations and providing daily/monthly/yearly operations and management reports to an agreed format. The Plant SCADA system will be able to generate nonstandard reports, points and Owner will have the ability to create new reports/points without vendor assistance. Owner will be given access to all points via a standard communication protocol.

The Plant SCADA system shall be capable of meeting the TSP Interconnection Agreement requirements, for monitoring and control of the Wind Plant. This shall include the provision of real time data required by the Interconnection Agreement via the TSP remote terminal unit (RTU).

The Plant SCADA system shall be equipped with an on-site database back-up facility that shall allow Owner to obtain and process all Owner data and to customize and configure reports for the purpose of undertaking the warranty calculations (as well as any other calculations desired by the owner) and providing daily/monthly/yearly operations and management data, by employing suitable industry standard database software (e.g. MS SQL Server).

The Plant SCADA system shall be capable of routine interrogation from a remote site at an acceptable speed.

The Plant SCADA system shall be connected to all the Wind Turbines and the central SCADA control via industry standard data communication hardware and software. It shall also be possible to connect other signals including utility meters and other Wind Turbine signals as required by the design and supply of the Wind Plant. It shall be possible to access the Plant SCADA system from any of the Wind Turbines using a portable PC, giving full access to the system. The Plant SCADA system will also support the addition of nonstandard instrumentation to include, but not be limited to, SODAR, LIDAR, cameras, and other meteorological instrumentation.

Should the central SCADA control or communication connection fail the individual Wind Turbines and electrical systems shall continue in operation and shall be operated safely by the individual Wind Turbine control system.

It shall be possible to store at least one (1) year of data from the Wind Plant without archiving it from the system. It shall be possible to remotely download raw 10-minute average SCADA data by means of an online database facility for further analysis. All raw data shall be available to owner via an on-site data link.

Upgrades to the SCADA software and any necessary hardware keys shall be provided free from charge throughout the warranty period. Contractor shall provide additional upgrades, additional hardware keys and support on reasonable terms over the Design Life.

The Plant SCADA system shall be traceable and transparent in operation. It shall be structured in such a way as to provide maximum data integrity. Data sampling rates shall be sufficient to meet the requirements of the warranty and testing contracts and external parties as specified in this document.

It shall be possible to download configuration settings, parameter settings, and control logic from the Wind Turbine controllers and record them on the Plant SCADA system.

The substation SCADA system will be accessible and independent of the Wind Turbine SCADA system. The substation SCADA system will be scalable and able to integrate with other variable energy assets.

The Owner shall prepare and provide the following substation SCADA documents and drawings to the Contractor in accordance with Owner’s substation design standards:

a) SCADA Division of Responsibility

b) SCADA Scope Designation Drawing

c) SCADA Typical Points List

d) SCADA architecture diagram

e) Network drawing

f) SCADA system equipment final bill of materials

g) Panel layout drawing

h) Vendor style SCADA schematic drawings

These drawings shall be incorporated into the Contractors substation design package. Specifically the “Panel Layout Drawing” shall be incorporated/modified such that the Owner’s Engineer specified equipment is mounted in a panel similar to the panels housing all other protection and control equipment. Only the equipment placement shown in the Owner’s Engineer provided drawing shall be maintained. The “SCADA Schematic Drawings” provided by the Owner’s Engineer shall be a “Vendor” style drawing showing all interconnect wiring for the SCADA equipment with “customer connect” locations called out for the connection of power or digital I/O points. These drawings will be provided in CAD format and it is left to the Contractor’s discretion to either redraw these drawings or merely update the “customer connect” connections to incorporate the provided drawings into their drawing package.

The following entities are involved with providing the SCADA and communications system:

1. Turbine Vendor

The Turbine Vendor supplies the SCADA system for the turbines.

2. Owner:

PGE’s Operations division will specify and configure an OPC Server based overlay system for use as a comprehensive project SCADA system. This system provides status, remote operation, and reporting for the turbines and substation.

3. EPC Contractor

The Contractor will purchase and install the SCADA system equipment for the substation, referred to hereafter as the Substation SCADA System. The equipment will be specified by the owner and vendor style drawings will be provided for the SCADA panel for use by the Contractor in overall substation design. The Contractor is also responsible for the fiber optic network, telephone, and communication network infrastructure for the project.

4. Owner’s SCADA Engineer

The Owner contracted engineer(s) will design the SCADA system, specify the SCADA equipment, prepare the Owner supplied documentation and develop the configuration files as described later in this document. They will also provide the commissioning of the substation SCADA system at site. Owners SCADA

engineer will perform other technical and coordination functions as requested by the Owner.

## 8.2 MAIN SCADA COMPONENTS

The Plant SCADA system shall comprise as a minimum:

1. Main SCADA server(s), viewing and operation station (may be combined with server) in the PlantO&M building WCC
2. SCADA panels/cabinets
3. Communications links connecting all Wind Turbines, Met Masts, buildings and electrical equipment within the Wind Plant
4. Interface to Wind Turbine controllers
5. Interface to external systems including the TSP's RTU and PGE's corporate historian
6. Interfacing and connections between components as required
7. The Plant SCADA system will have a local user interface at the physical location of the Plant SCADA system. The system will be accessible to Owner employees 24/7. Owner employees will be able to control the plant in the event of communication failure externally.

The Plant SCADA system will be fully accessible to Owner engineering and compliance group. Owner will be able to designate which SCADA points will be archived in Owner's PI system through the OPC server.

## 8.3 SCADA DEVICE REQUIREMENTS

### 8.3.1 Servers

1. General
    a. Each server shall be an independent Microsoft Windows based computer capable of stand-alone operation.
    b. Server shall meet the recommended system configuration of all SCADA software installed
    c. Servers shall connect to SCADA system through an Ethernet NIC
    d. Rack mountable
    e. Servers shall be configured for redundancy complete functionality shall be available with the loss of any server
2. Operating System
    a. Microsoft Windows Server 2016 or as recommended by SCADA Vendor
    b. Must not predate Windows Server 2012
3. Network Interface cards
    a. Minimum 2 NICs
    b. Each virtual server must have a dedicated NIC
4. Power: hot pluggable redundant power supplies
5. Virtualization: no more than 4 virtual machines per physical host

6. Video Interface: 1080p DVI video outputs as needed
7. KVM: Contractor will provide an IP-based KVM for accessing all servers

### 8.3.2 View Nodes/Workstations

1. General
    a. SCADA viewing and operation workstations shall allow full viewing, analysis, reporting, fault diagnosis, resetting of faults and control of Wind Turbines consistent with its deployment as the primary SCADA terminal located on the Site.
    b. Each workstation shall be an independent Microsoft Windows based computer capable of stand-alone operation.
    c. Workstations shall connect to the Plant SCADA system through an Ethernet NIC
    d. Rack mountable hardware
    e. Equipped with a printer suitable for printing reports from the Plant SCADA system
2. Operating System: Microsoft Windows 10, 64 bit
3. Video Interface: 1080p DVI outputs as needed
4. KVM: Contractor will provide IP-based KVM for accessing all View Nodes/Workstations

## 8.4 INTERFACES

The main SCADA server(s) shall comply with the requirements of the TSP as required by the Interconnection Agreement. The communication protocol and medium for this interface shall be agreed with Owner. This interface shall provide AGC control of the entire plant.

The main SCADA server(s) shall interface with any substation capacitors, SVC or other reactive plant comprising part of the Work as necessary for their control and monitoring. This interface shall be suitable for the purpose of:

1. Voltage, VAR or power factor control as necessary to achieve compliance with the Interconnection Agreement and TSP requirements, Wind Turbine requirements and plant insulation ratings
2. Controlling voltage at the Wind Turbines' terminals to maximize uptime and energy production and minimizing electrical losses as reasonable
3. Viewing the status and monitoring the condition of any reactive plant as necessary
    a. The main SCADA server(s) shall interface with the substation equipment. This interface shall be suitable for the purpose of:
        i. Viewing status of circuit breakers and switches at the substation
        ii. Obtaining voltage, current, active and reactive power, and relay data at feeders and the point of interconnection with the TSP

iii. Receiving equipment alarms
iv. Tripping feeder circuit breakers

The main SCADA server(s) shall interface with Owner's PI data collection and historical system via Owner's standard interface. All plant I/O control points will be available at the interface to historized in owner's PI system.

All SCADA devices shall interface with Owner's security system to receive security updates, send logs, as well as any other security requirement documented in Section 8.6.

### 8.4.1 Fiber Optic Network Design

a) Design Requirements

Contractor shall prepare fiber optic overview design drawings; which include transitions from OPGW to underground cable (as applicable) and the connections to the substation, O&M building, and interconnecting utility/transmission facilities.

b) Fiber Optic Network Drawings

(1) The BOP Contractor shall prepare detailed fiber optic network drawings showing the fiber loop connections to the turbines and MET towers. This design shall be based on that supplied by the Turbine Vendor and shall be reviewed and approved by the Turbine Vendor and Owner.

(2) Contractor shall prepare fiber optic drawings as required for substation connections.

(3) The Contractor shall submit for Owner's review a complete set of project Fiber Optic Network Drawings.

c) Fiber Optic Splice and Distribution Panel Details

(1) Contractor shall prepare drawings detailing the splicing/connections required at all OPGW to underground transitions (as applicable), and the substation fiber optic distribution panel,.

(2) Expected deliverables include: Fiber Optic Splicing Drawings, Fiber Optic Distribution Panel Drawings.

### 8.4.2 Fiber Optic Installation

(1) The BOP Contractor shall furnish and install fiber optic cable interconnecting the WTG units, MET tower(s), and the Project Substation to the O&M building and other locations as required. The BOP contractor shall provide an additional five meters of cable at each end. All cables shall be appropriately labelled with a permanently attached label.

(2) The Contractor shall provide conduits as required for any fiber entry into the substation control building including that associated with any transmission lines (e.g. OPGW). Conduit shall have a pull string for pulling the cable. Fiber optic cables may be routed through substation control cable trenches with other control wiring (subject to Applicable Laws, codes, and regulations) provided that a high-visibility colored innerduct is used for identification and protection of the fiber optic cables.

(3) Contractor shall furnish and install fiber optic splice and distribution panels as required, including, over head to underground transitions and the project substation. All distribution panels shall be neatly labelled with source and destination information for each fiber pair. Fiber optic distribution panels in the WTGs shall be provided and installed by Contactor unless supplied and installed by the Turbine Vendor.

(4) Contractor shall furnish and install above ground communications cable junction boxes as required.

### 8.4.3 Fiber Terminations and Testing

(1) The BOP Contractor shall terminate all fiber optic cable utilized in the collection system, substation, and O&M building. The cables shall be terminated with SC or ST connectors as required and shall be in compliance with the Turbine Supplier's and/or the Owner's specifications. Connectors, break-out kits, and other miscellaneous materials required for terminating shall be provided by the BOP Contractor. Each fiber pair shall be labelled with a permanently attached label. All fibers (used or unused) in the cables shall be terminated and tested.

(2) Contractor shall perform OTDR testing on all OPGW fiber cables and provide tests to Owner for review two weeks prior to energization of the associated equipment. Fiber, splice, and connector losses shall not exceed industry standards and any detected cable damage shall be repaired prior to acceptance of the work.

(3) Expected deliverables include: Terminated fiber optic cables, Test reports. Fiber patch cables from the fiber distribution panels to end devices shall be provided by others. For single mode fiber no field terminations will be accepted only field splicing of single mode fiber is allowed.

## 8.5 AVAILABILITY AND RELIABILITY

The Plant SCADA system, inclusive of all elements including and between the Wind Turbine controllers and the main SCADA server shall be designed and implemented for an availability of 8760 hours per year minus hours for planned outages and 100% reliability. Redundancy shall be designed into the system to meet the required availability and reliability.

Redundancy shall be provided for all critical elements that are prone to failure, including electromechanical hard drives and computer power supplies.

In case of a grid failure or other loss of power, an uninterrupted power supply (UPS) shall prevent data stored on the main SCADA server(s) from being lost after loss of supply. When normal conditions are resumed, the main SCADA server(s) shall re-start automatically.

## 8.6 CYBER SECURITY

Cyber security of the SCADA system shall be in accordance with Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

## 8.7 VIEWING AND DISPLAY

The Plant SCADA system shall display an “easy-to-read” summary of the Wind Plant status and performance at any time and shall also be able to display more detailed information about individual machines. The monitoring system shall be able to process the data and to sort the data necessary for the presentation.

The user shall be able to monitor the Wind Plant current status through either a GUI showing a map based representation of the Wind Plant or a series of tables summarizing Wind Turbine, meteorological station and grid station status.

The GUI shall provide a top-level view of the Wind Plant with facilities to link to particular groups or units. Units shall be represented by icons identifying the unit type and name and conveying the equipment status as the user scans the Wind Plant.

Commands shall be instantly available on selecting a unit or group of units from the map.

Direct links shall be available from the GUI icons to the corresponding tabular summary screens.

A single top level tabular screen shall show the complete site status at a glance. Clearly defined areas of the screen shall show Wind Turbines, meteorological stations, grid stations and current events. The Wind Turbine status shall show Wind Turbines on line, faulted, stopped, power and energy outputs. The meteorological status shall show the site mean wind speed, direction, temperature, and pressure. The grid status shall show the grid active and reactive power, voltage and current at the interconnection point with the TSP.

Current Site events shall be clearly shown with event code, event description, response status and times.

There shall be easy access to detailed information screens on individual Wind Turbines, meteorological stations and grid stations.

SCADA points lists

The Owner's Engineer shall provide to the Contractor a data points list showing all data points required to be provided to the SCADA system by the Contractor from the substation. All digital points shall be provided by "dry contacts" when not coming from an IED and wired to the Owner's Engineer specified digital I/O module. Digital point wetting voltage shall be 125 VDC. Wires from metering systems, and for communication, shall be twisted shielded pairs, and the shields shall be grounded in the Project Substation SCADA panel only.

The Plant SCADA system shall display, at a minimum:

1. Single Wind Turbine data, e.g. status, power, voltages, currents, temperatures, energy, faults, vibration, and wind speed
2. Actual power for the whole Wind Plant calculated as a sum of the Wind Turbine outputs from the Wind Turbine SCADA system
3. Meter values from Check Meters including at a minimum:
    a. MW
    b. MVAr
    c. Power factor
    d. MWh
    e. MVArh
4. Actual line conditions at the substation including, voltage, current, active power, reactive power, power factor and average values for each Wind Plant and Reactive plant feeder
5. Actual status of major substation equipment
6. Clock time synchronized to an external source
7. Data collection and storage
    a. Data shall be recorded from the Wind Turbines and Met Masts. Provision shall be made for additional sensory data from transformers, meters, noise monitoring stations, cameras, condition monitoring systems, safety and access control equipment as required.
    b. Data recorded shall be both regular time series data (e.g. wind speed, power, temperature etc.) and event data (faults, warnings, errors, changes of state, operator initiated changes, etc.).
    c. Time series data shall be recorded with an averaging period of 10 minutes. Mean, min, max and standard deviation are required for wind speed and Wind Turbine active power. Other time series data may be recorded as mean only.
    d. Data sampling rates for time series data shall be independent of the Site communications network and depend only on the speed of communication with the Wind Turbine controller. Sampling rates shall be 0.5 Hz or higher for time series data at the Wind Turbines and Meteorological Stations.
    e. Processed data shall be stored locally in a queue so that no data are lost if the Site communications network is temporarily unavailable. When the network is available, the queue shall be downloaded to the SCADA computer.

f. If any Wind Turbine is switched off, the data processing shall continue and communication with any other Wind Turbines shall not be interrupted.
g. Ten-minute averaged performance data and all event data shall be stored in an industry standard relational database. The data shall be time stamped. The database shall be capable of being searched with a range of data access query functions provided. Ideally these shall be implemented as SQL commands. It shall also be possible to store specific query functions for later use.
h. The returned data shall be capable of graphical or tabular presentation. It shall also be capable of being exported to external analysis programs in appropriate formats, e.g. CSV, Excel etc.
i. It shall also be possible to store at least 50,000 events on the system and to download data to third party software (e.g. Excel) for further analysis.
j. The Plant SCADA system shall be equipped with full facilities to back up all critical operating data; all operational data from the Wind Turbines, Meteorological Stations, and other monitored signals; and all other non-regenerable data.
k. Backups shall be written to standard media using an open, non-proprietary file format. The backup facilities shall allow all backups to be verified once they are written.

## 8.8 CONTROL REQUIREMENTS

The Plant SCADA system shall include local and remote control of the individual Wind Turbines, groups of Wind Turbines and substation switchgear.

The Plant SCADA system shall include the capability to apply a wind sector management program if necessary.

Remote control shall be capable from a remote computer connected to the Plant SCADA system via the Owner's internal network or Owner-managed VPN. System configuration shall allow for any number of user-defined groups of Wind Turbines. The following commands shall be included as a minimum:

1. Reset Wind Turbine
2. Stop Wind Turbine
3. Start Wind Turbine
4. Stop group of Wind Turbines
5. Start group of Wind Turbines
6. Selection of fixed voltage / reactive power / power factor mode
7. Limit Wind Plant output to a configurable value

Remote control function shall be protected by a locally, Owner-managed, authenticated multi-factor authentication system

Adequate provision shall be made for interlocks to prevent unsafe operation of the Wind Turbines while Site personnel are working on them and a switch shall be provided at the Wind Turbines to allow maintenance staff to disable remote access.

Any SCADA system commands shall be ignored if there is a crew at the Wind Turbine. Any commands issued locally at a Wind Turbine shall override the Plant SCADA system if there is a crew present. If there is no crew present, commands from the Plant SCADA system shall override the current Wind Turbine setting.

The Plant SCADA system shall implement auto control of the Wind Turbines. This shall allow automatic implementation of any constraints on Wind Plant operation (e.g. network restrictions, noise restrictions, time of day restrictions).

The Plant SCADA system shall provide remote access to the Wind Turbines to aid in the remote analysis and repair of Wind Turbine faults. The Plant SCADA system shall be optimized to allow remote interrogation and resetting of as many errors as possible consistent with industry standards for safety and machine integrity.

## 8.9 REPORTING

The user shall be able to view and interrogate the 10-minute data and events database and show the events for any unit for any time period. The more common selections shall be catered for in drop down menus such as:

1. View Wind Turbine and Wind Plant event data with options to, select Wind Turbine or group of Wind Turbines, include events from grid station, meteorological stations and servers, select time range and list all events or filter on type of event
2. Scroll through 10-minute data records for a selected Wind Turbine, meteorological station or grid station
3. Compare time series data for up to 10 selected Wind Turbine signals
4. Trend any selected signal from Wind Turbines, metering stations and meteorological masts

Summary analysis reports for daily/monthly/yearly or other defined time periods shall be produced to an agreed format. They shall be produced on demand by the system. They shall provide extensive analysis and viewing functions for statistical and event data. Reporting based on data that has been archived from the system is not required.

Power curves shall be created for any user-selectable date range and choice of binned or scatter data.

Meteorological data shall be able to be analyzed according to wind speeds, wind direction, turbulence, temperature, pressure, and other data from any installed sensors. This includes frequency distributions, and analysis of mean, maximum and minimum data. Wind speed and wind direction distributions shall be created over any user selectable date range. It shall be possible to generate them from any meteorological station.

The energy production for individual Wind Turbines, groups of Wind Turbines or the whole Wind Plant for any time period to date shall be available.

Additional information that shall be available shall include, but not be limited to:

1. Faults on a per Wind Turbine and whole Wind Plant basis
2. Availability reports
3. A record of software updates downloaded to the main SCADA server(s) and other machines comprising the Plant SCADA system
4. Control system control variables and calculated points for:
5. Nacelle yaw
6. Rotor blade pitch
7. Tower Cut in/Cut Out
8. Operation mode

## 8.10 SUPPORT FOR WARRANTY CALCULATIONS

The Plant SCADA system shall be capable of producing reports for evaluation of availability and performance as required for warranty and other agreements.

## 8.11 REMOTE ALERTS

It shall be possible to configure the Plant SCADA system to alert operations staff via mobile phone (SMS) or email if any part of the Wind Plant requires attention. There shall be a choice to configure this function to operate continuously for unmanned sites or only during certain times of day as required.

## 8.12 TIME BASE AND DATE FORMATS

Separate GPS satellite receivers and antennae shall be installed at the O&M building and substation. The devices shall provide time synchronization signals for the Plant SCADA system main SCADA server(s). All other clocks shall automatically be synchronized to the central computer clock. GPS protocol to be modulated IRIG-B over RG58 coax as required for PGE standard AGC RTU.

Time and date formats shall be chosen to eliminate confusion arising from different time zones, summer/winter changes and different country display formats.

All time stamps on time series data shall apply to the end of the averaging period.

All time stamps shall be stored as UTC, regardless of local time setting used.

# 9.0 METEOROLOGICAL MASTS

## 9.1 GENERAL

All meteorological mast (Met Mast) structures shall be designed and installed to Revision G (or later) of the ANSI/TIA 222 standard.

A geotechnical investigation shall be performed at the final Met Mast locations prior to the design phase.

Design and construction shall take into account and not interfere with the requirements for construction access for long loads, heavy plant and cranes for the construction of the entire Wind Plant as well as ongoing access for operation and maintenance of the Wind Plant.

All meteorological stations shall include a free-standing lattice mast of height such that wind speed measurements may be made at the hub height of the Wind Turbines, and not higher.

The Met Mast(s) shall be suitable for support of the specified meteorological instruments, any autonomous power supply systems and any marking or aviation lighting as required by Applicable Permits, and in masts without an H-frame, the Met Mast shall be suitable for support of data logging and communications equipment. Details regarding the Met Mast instrumentation and mounting hardware shall be reviewed by the manufacturer and incorporated into the design with a minimum of 3kW service for all equipment, plus auxiliary 120VAC provisions and a 20A/120VAC GFCI outlet for service work.

When installed, safe access shall be possible for maintenance to the mast itself and to all instrumentation.

Each Met Mast shall be safely climbable and shall support two persons at any one time. Each Met Mast shall include a suitable wire or rail free fall-arrest system in accordance with ANSI A14.3 Safety Requirements for Fixed Ladders and identical to the fall-arrest system used in the wind turbines.

The design of the mast(s), while suitable for use in the Site climate, shall minimize interference to the air flow at the anemometers and wind vanes. The instrumentation arrangements shall comply with relevant IEC and MEASNET standards, including but not limited to:

1. IEC 61400-12-1 Ed. 1.0 Wind Turbines - Part 12-1: Power performance measurements of electricity producing Wind Turbines.

Contractor shall be responsible for ensuring and demonstrating that the meteorological stations are fit for purpose and that the design and construction are in accordance with all Applicable Standards.

Contractor shall be responsible for obtaining an instrumentation design for each Met Mast using a third party technical consultant specialized in the wind industry.

## 9.2 POWER PERFORMANCE TESTING MET MASTS

The Permanent and Temporary Met Masts for the purpose of Power Performance Testing and site calibration, respectively, shall be designed and instrumented in accordance with the requirements of:

1. The instrumentation requirements specified in the power performance warranty agreement issued by the Wind Turbine OEM
2. IEC 61400-12-1 Ed. 1.0 Wind Turbines - Part 12-1: Power performance measurements of electricity producing Wind Turbines, and
3. MEASNET standards.

## 9.3 PERMANENT MET MASTS

The number and locations of Permanent Met Masts shall be such that at all times there shall be at least one (1) Met Mast within free-stream, non-wake-affected wind, effectively covering wind speed and direction measurement at hub height for all wind directions (360°).

The Permanent Met Masts shall be at least two (2) rotor diameters from the nearest Wind Turbine.

Met Masts shall be sited in accordance with IEC 61400-12-1.

Permanent meteorological masts shall be designed to be Class II or better.

All permanent meteorological masts shall include the construction of an H-frame located on the South-facing side of the mast. The H-frame shall be suitable for support of data logging equipment, communications equipment and any marking as required by relevant permit. The H-frame shall have a minimum separation of 10’ between support posts and engineered per to withstand expected local environmental conditions. Unistrut shall be used to support any equipment on the H-Frame.

Annex A of the standard IEC 61400-12-1, shall be used to determine non-wake-affected sectors for each Permanent Met Mast.

### 9.3.1 Security and fencing

1. The Permanent Met Mast installations shall include suitable security/anti-climb fencing to prevent unauthorized access to the Met Mast of at least 3 strands of barbwire on the upper atop the fence.
2. The fencing shall be 6’ tall chain link. The compound size shall be 40’x40’ with 3” of gravel with weed barrier and include a lockable 15’ gate.

### 9.3.2 Lighting and marking

1. The Met Masts shall be marked in compliance with FAA recommendations found in Advisory Circular 70/7460-1L.
2. Temporary or guyed Met Masts may be required to have marker balls, bird diverters, and anchor guy guards installed. The marker balls shall be placed such that they do not interfere with the air flow at the anemometers and wind vanes.

### 9.3.3 Power supply

1. The Permanent Met Masts shall be permanently connected to a 120VAC power supply and be equipped with a transfer switch to allow connection to a portable generator when the tower is not powered
2. Power supply is to be firm against interruption by all environmental and electrical grid conditions for a period of twenty-four (24) hours.

### 9.3.4 SCADA connection and monitoring

1. The instrumentation installed shall be connected to the Plant SCADA system as well as be capable of feeding real time data to forecast vendors such that it can record, with an averaging period of the more stringent requirement of ten (10) minutes or the data sampling rate requirements below:
    a. Mean, standard deviation and three-second gust wind speed from each anemometer
    b. Mean and standard deviation of direction from each wind vane
    c. Mean temperature from each temperature sensor
    d. Mean barometric pressure
2. Data sampling and sampling rates shall be sufficient to meet, where applicable, the requirements of:
    a. Warranty and testing arrangements
3. Calibrations shall be undertaken prior to installation in accordance with IEC 61400-12-1 Ed 1.0 (or later) and provided to Owner
4. The integration to the Plant SCADA system shall be such that the instrument calibrations can be traced on the configuration of the data logger equipment on the H-frame.

### 9.3.5 Anemometers

1. All anemometers shall be high quality calibrated, Class 1, cup anemometers meeting all the requirements specified by IEC 61400-12-1
2. All calibrations shall be carried out in a MEASNET accredited wind tunnel.
3. All mounting of anemometers shall comply with IEC 61400-12-1 recommendations for minimization of mast and boom interference to air flow.
4. The primary anemometer shall be placed at hub height as recommended in Section G.2 of IEC 61400-12-1.
5. A secondary (control) anemometer shall be installed as recommended in Section G.5 of IEC 61400-12-1.

6. A tertiary anemometer shall be installed at the lowest blade tip height.
7. Additional anemometers, including heated anemometers, may be required for testing purposes.

### 9.3.6 Wind vanes and direction measurement

1. All direction measurements shall be made by high quality wind vanes meeting all requirements specified by in IEC 61400-12-1.
2. All mounting of wind vanes shall comply with IEC 61400-12-1 recommendations for minimization of mast and boom interference to air flow.
3. The primary wind vane shall be installed as recommended in IEC 61400-12-1.
4. A secondary wind vane shall be installed as recommended in IEC 61400-12-1.

Other climatic measurement sensors shall be installed to make accurate measurements of:

1. Air temperature
2. Barometric pressure
3. Humidity
4. Rainfall

Sensor specifications and mounting arrangements shall meet requirements of IEC 61400-12 -1 Ed 1.0.

## 9.4 TEMPORARY MET MASTS

Temporary Met Masts shall be installed in number and at locations as required by IEC 61400-12-1

### 9.4.1 Anemometers

1. All anemometers shall be high quality, calibrated, Class 1, cup anemometers meeting all the requirements specified by IEC 61400-12-1.
2. All calibrations shall be carried out in a MEASNET accredited wind tunnel.
3. All mounting of anemometers shall comply with IEC 61400-12-1 recommendations for minimization of mast and boom interference to air flow.
4. The primary anemometer shall be placed at hub height as recommended in Section G.2 of IEC 61400-12-1.
5. A secondary (control) anemometer shall be installed as recommended in Section G.5 of IEC 61400-12-1.

### 9.4.2 Wind vanes and direction measurement

1. All direction measurements shall be made by high quality wind vanes meeting all requirements specified by in IEC 61400-12-1.
2. All mounting of wind vanes shall comply with IEC 61400-12-1 recommendations for minimization of mast and boom interference to air flow.

3. The primary wind vane shall be installed underneath the secondary (control) anemometer as recommended in IEC 61400-12-1

## 9.5 FOUNDATIONS

The foundation shall be capable of accepting all loads to be imposed upon it during its temporary installation period or the Design Life, where applicable. Each foundation shall be designed and installed to Revision G of the ANSI/EIA/TIA 222 standard.

Particular care shall be taken with respect to the height of the ground on which Temporary Met Masts are installed.

1. Ideally Temporary Met Masts shall be installed on the Wind Turbine foundation, or if not, another suitable foundation at the Turbine location shall be installed, such that all requirements of IEC 61400-12-1 are adhered to. Meaning, it shall be ensured that the relationship between the Temporary Masts sensors and the final installed height of the Wind Turbine is in line with the requirements of the Power Performance Testing measurements standard or warranty requirements specified by the wind turbine OEM.
2. Any excavation and/or build up at the site that shall be required for the final Wind Turbine foundation shall be taken into account to ensure the Temporary Met Mast measurements are applicable for the final installed Wind Turbine foundation.

## 9.6 INSTRUMENT CALIBRATIONS

MEASNET calibrations shall be undertaken prior to the installation of instrumentation.

## 9.7 ENCLOSURES AND CABLING

Other than the sensors, all local Met Mast system equipment shall be installed at or above the base of the Met Mast in an enclosure that meets or exceeds an IP 66 rating.

All cables between enclosures on the equipment rack shall be in protective conduit.

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

The location of the junction box shall not affect the measurements of the Met Mast sensors.

Sensor cable tails shall have suitable plugs at each end, and shall pass within the booms and risers as recommended in IEC61400-12-1 Ed 1.0.

## 9.8 GROUNDING AND LIGHTNING PROTECTION

The Met Masts and H-Frames shall be grounded and protected from lightning strikes in accordance with Revision G of the ANSI/TIA 222 standard.

All instrumentation on the Temporary and Permanent Met Masts shall be protected from lightning and grounded in accordance with industry best practice.

Where the instrumentation on a Met Mast is connected to an LV supply from a Wind Turbine or from another fixed source, the connection shall be equipped with overvoltage protection designed to limit the effects of a lightning strike to the Met Mast on the LV supply to which it is connected.

Lightning protection shall be installed in accordance with the recommendations of IEC 61400-12-1.

A separate, multi-stranded copper cable shall connect the mast top lightning finial to the buried grounding system. The tower structure itself can be used as a conductor.

All copper connections shall be used to join the lightning protection components.

The final placement of the mast top lightning finial shall not interfere with the instrumentation, operation and correct functioning of the instrumentation in the dominant wind directions sectors.

## 9.9 UNINTERRUPTIBLE POWER SUPPLY

Met Masts shall have local UPS or equivalent supply, capable of lasting a minimum of eight hours.

## 9.10 MET MAST COMMISSIONING

The commissioning of all permanent and temporary Met Masts for the purpose of power performance testing shall be performed by a third party technical consultant specialized in the wind industry to ensure that the instrumentation, hardware and configuration meet the required standards set forth in this document.

## 9.11 DEVELOPMENT MET MASTS DECOMMISSIONING

All Development Met Masts at the Site shall be decommissioned by Contractor in line with directions by Owner.

No Development Met Masts shall be decommissioned without Owner’s consent, which shall follow satisfactory correlation of site measurements between the Development Masts and the new Permanent Met Masts. Such data correlation shall occur prior to energization of any Wind Turbines at the Site.

# 10.0 ON SITE BUILDINGS

## 10.1 GENERAL

All permanent buildings shall be designed and installed in accordance with Appendix G1 Attachment 02 Exhibit 02 – General Onsite Buildings, Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance, and as specified herein.

The final design(s) of all buildings shall be approved by Owner prior to building procurement.

All buildings 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

## 10.2 OPERATIONS AND MAINTENANCE BUILDING

The O&M building and surrounding area shall incorporate sufficient road infrastructure, parking lot and outdoor facilities suitable for the operation and maintenance of the Wind Plant and the operational staff requirements during its Design Life during all anticipated weather conditions.

The O&M building shall consist of the minimum indoor and outdoor storage and working areas corresponding to the Wind Turbine Supplier and/or Maintenance Provider's requirements, in addition to office and meeting space for Owner's staff, bathroom and kitchen facilities as well as network and SCADA control facilities to support wind Plant operations.

Structural design for the building shall be conducted in accordance with building code standard regulations for the local jurisdiction and subject to Owner's approval. The structural design shall utilize the parameters obtained from the Geotechnical Investigation Report (Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements).

The building should be minimum 10,000 sq. ft. (or as approved by Owner) including:

1. Office space, minimum 3,000 sq. ft. including 2nd story/mezzanine office space (or as approved by Owner)

2. Separate warehouse area, approximately 65 sq. ft. per turbine and a minimum of 7,000 sq. ft., whichever is greater (or as approved by Owner)

The building shall be of steel construction, site-specific design, and shall be at least 20 ft. high with a roof having minimum 5-degrees slope. Building and surrounding plot must be elevated by one foot above the surrounding ground level for positive drainage away from building environs.

The indoor warehouse/workshop/storage area shall be smooth hardened concrete, while the outdoor storage/laydown area shall be covered with compacted gravel.

The building shall include, at a minimum:

1. Restrooms
    a. One male restroom including:
        i. two sinks/hand washing facilities
        ii. two showers
        iii. two urinals
        iv. two stalls/toilets
        v. locker area with lockers and benches
    b. One female restroom including:
        i. two sinks/hand washing facilities
        ii. one shower
        iii. two stalls/toilets
        iv. locker area with lockers and benches
    c. One unisex restroom including:
        i. one sink/hand washing facilities
        ii. one toilet
2. Reception area with sufficient room for a desk/workstation, copier and printer
3. Office area of adequate size to accommodate 6 working stations (minimum 6 ft x 6 ft each) and a library area with ample shelving for storage of manuals
4. Conference room with built-in monitor and seating 120V power and Ethernet receptacles to be installed in center of room for video/audio conferencing equipment
5. Two private offices with doors – one minimum 250 sq. ft. and one minimum 150 sq. ft.
6. Owner Work Control Center (WCC) area/room
    a. capable of being qualified NERC Critical Infrastructure Protection (CIP) compliant
    b. coordinated with plant controls and other pertinent systems to safely and reliably operate the plant, as specified herein
    c. interacts with all telecommunications and SCADA equipment and systems, as specified herein
7. Office supplies room
8. Utility room equipped with washer, dryer, and large utility sink
9. A kitchen equipped with refrigerator, oven, dishwasher, microwave, countertop space, cabinets, and space for a kitchen table(s) to accommodate 10 people
10. Server room approximately 240 sq. ft., climate controlled for temperature and humidity, with separate, redundant air-conditioning system

11. Separate room for OEM technicians, fully equipped with office area, workstations, area for OEM WCC, restroom(s), kitchenette, etc., as required by OEM and as approved by Owner
12. Warehouse with:
    a. Workshop area with 480V weld receptacles, 120V outlets, equipment hoist, HVAC, weld venting, machine equipment, storage racks, washup/parts cleaner, work order material staging area
    b. Consumables storage area
    c. Oil storage area with spill containment
    d. Exterior doors (minimum of 2)
    e. Rollup doors, sized accordingly to allow tractor trailer delivery
13. The following systems, in accordance with applicable codes and standards:
    a. Potable drinking water system
    b. Waste water disposal system via on-site means or connection to a public sanitary sewer system
    c. HVAC system
    d. Lightning protection and grounding
    e. LED overhead lighting throughout
    f. Power
        i. THHN wire in EMT for homeruns inside the building
        ii. MC cable from homerun junction box to loads
        iii. thermoset wire for outdoor raceway
        iv. 120V receptacles throughout
        v. Power shall be supplied in accordance with Appendix G1 Attachment 02 Exhibit 02 – General Onsite Buildings
    g. Ethernet
        i. CAT6 wiring
        ii. receptacles in all office/work station areas
    h. Coaxial (for IRIG-B signal)
        i. RG58 wiring
    i. All exposed cable/wiring runs in conduit (EMT)
    j. Communications link to local internet service provider (ISP) for:
        i. Turbine OEM remote access if required
        ii. dedicated analog POTS telephone service for backup telephone upon loss of IT equipment
        iii. 911 caller ID recognition
        iv. Contractor to provide raceway and coordination with ISP
    k. Key card reader for secure access to entry gate, O&M building, warehouse, server room, and WCC
    l. Transformer/panelboard
    m. Flex conduit for connection to transformers

The O&M outside area/yard shall include, at a minimum:

1. Open area of 1000 sq. ft. per 10 turbines and a minimum of 10,000 sq. ft., whichever is greater or as approved by Owner, for equipment, parts, and

materials storage/laydown (see Section 6.8 for additional laydown area requirements)

2. Drive area of sufficient size/space to accommodate tractor trailer deliveries and turn-around or building drive-around
3. Bollards protecting all building and drive entryway corners
4. Parking area
    a. with sufficient space to accommodate 2 vehicles per 10 turbines with a minimum of 20, including parking for Contractor and Owner
    b. handicap parking spaces to comply with applicable laws and regulations
    c. paved with either Portland cement concrete or asphaltic concrete in accordance with local standards

## 11.0 REQUIRED DOCUMENTATION

An up-to-date printable index listing all previously issued Contractor drawings and specifications by number and title, showing the revision status of each drawing, shall be maintained and shall be available to Owner at all times.

Contractor shall develop a design package, associated documents, and reports for the Project at the appropriate time during the project, as applicable. The documentation requirements are not intended to be exhaustive and all the requirements of this document relevant to the document submission item shall be considered by Contractor when preparing a submission. Documentation and submittals as well as requirements shall follow Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

**APPENDIX G2**
**ATTACHMENT 01**
**EXHIBIT 02**

# WIND TURBINE SPECIFICATIONS

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 14Dec17 | Issued for Implementation | DNV -GL | DS | JMR | Jim Riehl |
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# 1.0 WIND TURBINE EQUIPMENT

## 1.1 GENERAL

The Wind Turbines shall be fully described within Contractor's Specifications, including specific hub height, tip height and any specific packages offered as optional equipment.

The Wind Turbines shall meet the following minimum requirements:

1. The Wind Turbines shall be three bladed, horizontal axis, upwind type
2. The Wind Turbines shall be mounted on a tubular tower
3. The Wind Turbines shall provide suitable marking and lighting (i.e. aviation related obstacle marking) in accordance with the Applicable Standards and Applicable Permits
4. The Wind Turbine components shall be fully interchangeable between different units
5. The Wind Turbines shall be designed to operate and perform acceptably without manual intervention during normal operation

The Wind Turbines shall be part of a well-developed product range, as further defined below.

The Wind Turbines shall be commercial units with substantial fault-free operational experience, such that the model meets "Qualified Status," at minimum, or "Proven Status," per the following definitions:

A turbine model achieves Proven Status when:

1. The manufacturer is capable of performing all contractual and commercial obligations in North America.
2. The manufacturer can demonstrate the ability to support warranty, O&M, and supply chain obligations in North America.
3. The version of the turbine that will be supplied to North America carries a valid Design Statement of Compliance (SoC) to IEC 61400-1 standards issued by an accredited certification agency.
4. The turbine model has at least 100 turbine-years of experience in the North American market, and turbine supplier can demonstrate it has been operating at 96% fleet turbine availability or greater.

A turbine model achieves Qualified Status when:

1. The manufacturer is capable of performing all contractual and commercial obligations in North America.
2. The manufacturer can demonstrate the ability to support warranty, O&M, and supply chain obligations in North America.

3. The version of the turbine that will be supplied to North America is in the process of obtaining a Design SoC to IEC 61400-1 standards issued through an accredited certification agency.
4. The turbine model is an evolutionary variant of turbines already considered Proven in North America. Examples include rotor diameter changes for new wind classes, cold weather packages, or other modifications sufficient to require a new IEC certification but not a fundamental re-design.
5. The turbine model is considered Proven in its home market but is new to North America.
6. The turbine model has at least 25 turbine-years of experience in the North American market, and turbine supplier can demonstrate it has been operating at 96% fleet turbine availability or greater.

A list of approved turbine suppliers is provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

Applicable codes and standards, laws and regulations, and engineer of record shall be in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

Provision of spare parts will be included as part of operations and maintenance of the Project, covered under separate agreement. As such, Contractor shall not include spare parts as part of the turbine supply agreement.

## 1.2 SITE SUITABILITY ASSESSMENT

Contractor shall warrant that the Wind Turbine is fit for the purpose of generating electricity in line with Owner's requirements as set forth in the Agreement and this document, Contractors Specifications are within the range of climatic conditions expected at the project site and based upon the final Site Layout for the Wind Plant, therefore including, but not limited to, consideration of Wind Turbine spacing, obstructions (e.g. forestry) and site topography.

In the case a cold-weather package is required the site-specific loads analysis must state that it explicitly considers the planned operating temperature range. Regardless of cold-weather package, turbines operating outside of the standard IEC temperature range must undergo loads analysis specific to site conditions as defined in Site Conditions Table.

Contractor shall provide a definitive statement confirming that the Wind Turbines are fit for purpose at the site in the final locations for a minimum of 20 years. Any operational modifications required to assure the Wind Turbines are fit for purpose shall be clearly stated in Contractor's Specification.

Contractor shall provide a summary of the applicable site conditions in Site Conditions Table and the output of Contractor's assessment shall be provided with Contractor's Specification.

## 1.3 CERTIFICATION AND STANDARDS

All Wind Turbine components shall be capable of withstanding all mechanical, aerodynamic and electrical induced loads during a 20-year operating life.

The Wind Turbine design shall be in compliance with the latest edition of IEC 61400-1 Ed. 3.0 Wind Turbines - Part 1: Design requirements.

Contractor shall provide a Wind Turbine with a valid Type Certificate for the Climatic Conditions expected at the Site. The Type Certificate shall be in accordance with latest edition of IEC 61400-22. In the absence of a Type Certificate, a Design Evaluation Conformity statement according to "-22" section 8.3 plus completion of associated testing is acceptable Associated testing shall include at minimum:

1. Safety and Function testing per "-22", section 8.4.2
2. Blade testing in accordance with "-22", section 8.4.5
3. Power performance testing per "-22" section 8.4.3
4. Loads measurement per "-22", section 8.4.4.
5. Test reports for the above shall conform to the requirement of "-22" section 8.4.7

The Wind Turbines and Wind Turbine towers shall carry a current and valid Design Evaluation Conformity Statement from a recognized Certification Body or other accredited party acceptable to Owner.

The Certification shall be provided within Contractor's Specifications and shall state:

1. Standards to which the design was certified against
2. Climatic assumptions
3. Cold weather package specifications if applicable
4. Description of the scope of the assessment
5. Description of the Wind Turbine and Wind Turbine tower design assessed

Contractor shall make the Certification reports available in electronic format.

Contractor shall provide additional documentary evidence of the suitability of the Wind Turbine for the Site if:

1. Any of the equivalent climatic conditions at the Site are more onerous than the assumptions in the Design SoC
2. Additional characteristics of the Site prevent the Design SoC serving as evidence of the suitability of the Wind Turbine and Wind Turbine tower
3. There are deviations in the design of the Wind Turbine or Wind Turbine tower from that assessed in the Design SoC

## 1.4 DESIGN WORKING LIFE

The design working life of the turbine equipment shall be a minimum of 20 years.

## 1.5 POWER PERFORMANCE

An independently performed power curve measurement test of the Wind Turbine model shall be performed in accordance with the IEC 61400-12-1 Ed. 1.0 Wind Turbines - Part 12-1: Power performance measurements of electricity producing Wind Turbines on at least two wind turbine generators. The report on such shall be provided within Contractor's Specifications.

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

Any modifications or deviations on the turbine manufacturer warranty document from IEC 61400-12-1 Ed. 1.0 must be reviewed and approved by an independent party prior to contract execution.

## 1.6 NOISE

The Wind Turbine shall not have a sound power level in excess of that defined within this document and as required in all Applicable Permits, including planning, environmental and local noise ordinance.

The Wind Turbine shall have had its acoustic noise emission assessed at the Wind Plant site according to IEC 61400-11 Ed. 3.0 and any additional local compliance requirements.

The Wind Turbine shall produce no audible tones under any normal operating conditions, when assessed at the Wind Plant site according to IEC 61400-11 Ed. 3.0. Acoustic measurements shall include instances of the turbine yawing during power production and yawing below cut-in wind speeds to assure tone prominence meets stated requirements for all operating and non-operating conditions.

Contractor shall specify the maximum warranted A-weighted (LwA) sound power level emissions for the Wind Turbine.

## 1.7 ELECTRICAL CHARACTERISTICS

Contractor is responsible for ensuring the requirements as defined in IEC 61400-21 are met, including power quality issues.

This shall include carrying out all tests, and production of all documentation, simulations, test results and other information required, including average standby consumption data including a cold weather package.

The Agreement shall provide documentation of power quality measurements to IEC 61400-21 within Contractor's Specifications.

The Wind Turbines shall be manufactured and configured to be compatible with the North American bulk power system, including operation at 60 Hertz (Hz) nominal, and with electrical fixtures and fittings meeting applicable U.S. standards and parameters.

## 1.8 VISUAL APPEARANCE

The visual appearance of the Wind Turbines shall be in accordance with Applicable Permits.

Unless otherwise instructed by Owner or required by Applicable Permits, the Wind Turbine color shall be of a white or dull light grey color or similar and all external visible components shall be of an identical color and finish, and free of branding or other markings, where not otherwise required.

## 1.9 HEALTH AND SAFETY

The Wind Turbine shall comply with all relevant health and safety regulations including OSHA standards and as detailed in the Applicable Permits.

The Wind Turbine shall be designed to include provisions that respect the health and safety of the general public, operators, maintainers, land owners and any other personnel who may have an interest in the Wind Plant throughout the Wind Turbine's lifetime. These provisions shall include for:

1. Fire prevention and fire fighting
2. Emergency stop
3. Emergency evacuation
4. Evacuation of injured personnel including from the nacelle and hub
5. Rotating machinery guards, where required by applicable standards
6. Electrical isolation of systems and components
7. Mechanical protection against hazards
8. Mechanical isolation of systems and components including, but not limited to the rotor lockout system
9. Lightning protection
10. Protection against electric shock and arc flash hazards
11. Lighting of tower and nacelle for normal operation and maintenance
12. Emergency lighting upon loss of external power
13. Unauthorized access and climb prevention

### 1.9.1 Working at height features

1. A fall arrest system shall be incorporated on the tower ladder, Lad-Safe or Owner approved equivalent.
2. Secure attachment points and safety rails for lanyards shall be provided at all locations inside or outside the Wind Turbine where maintenance personnel may require access and Working at Height hazards apply as per all Applicable Standards.
3. Appropriate markings and signs shall indicate hazards, attachment points, include brief instructions, load ratings and maintenance requirements and as required by Applicable Standards.

### 1.9.2 Confined spaces

1. If any part of the Wind Turbine can be classified as a confined space in accordance with Applicable Standards, appropriate safety and risk control measures shall be implemented to conform to the relevant Applicable Standards.
2. Safety measures shall include but not be limited to the implementation and use of relevant safety processes, procedures, personnel training, signage and equipment.

### 1.9.3 Rotating equipment

1. Robust guards shall be fitted around rotating machinery in line with Applicable Standards to prevent any part of an operator or their clothing coming into contact with moving parts. Signs warning of rotating machinery shall be clearly displayed.

## 1.10 WIND TURBINE PROTECTION

### 1.10.1 General

1. The Wind Turbine shall have a safety and control system that conforms to all requirements of IEC 61400-1 Wind Turbines - Part 1: Design requirements.
2. In addition to this Section further Wind Turbine earthing requirements are identified in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications.
3. During power outages of any nature, the Wind Turbine shall have the ability to power down, feather blades properly, and orient appropriately to prevent damage by high winds.

### 1.10.2 Lightning protection

1. The Wind Turbine shall have sufficient lightning protection to protect the Wind Turbine components and its support structure, and shall meet the requirements of IEC 61400-24.
2. Details of the lightning protection system shall be given within Contractor’s Specifications.

### 1.10.3 Electrical protection

1. The electrical protection scheme shall disconnect faulted electrical plant within the Wind Turbine and be designed to adequately protect the electrical components of the Wind Turbine for the maximum design fault currents at the Site and any other electrical conditions passed through to the Wind Turbines from the utility system or created by the Wind Plant electrical system.

### 1.10.4 Corrosion Protection

1. All ferrous materials shall have coating systems adequate to protect from corrosion for the design life (minimum 20 years) of the Wind Turbines considering the project site location and conditions.

### 1.10.5 Fire Protection

1. Fire suppression equipment for the Wind Turbine should be included as an option.

### 1.10.6 Security protection

The Wind Turbine towers shall include security features including heavy duty lockable tower door, concealed hinges and other features designed, such as door alarm in SCADA, to prevent theft and vandalism.

### 1.10.7 Pest and biological protection

The Wind Turbines and towers shall include design features to prevent and minimize incursion by pests and animals.

## 1.11 MARKINGS AND LIGHTING

External Wind Turbine marking and lighting, including but not limited to aviation related obstacle marking and lighting shall be in accordance with any requirements identified or implied by the Agreement and the relevant Permits.

Obstruction lighting shall be LED FAA Type L-864 (single, red, flashing configuration) and flashing of lights shall be synchronized.

Obstruction lighting equipment shall be designed for continuous operation. Obstruction lighting shall incorporate an uninterruptible power supply capable of supplying backup power for at least one hour.

Safety signs shall be displayed in the English language at suitable locations of the Wind Turbine.

Nameplates shall be fixed to the tower base and major components showing; manufacturer name, serial number, part number, manufacturing batch number.

In addition to this Section, further Wind Turbine signage and marking requirements are identified in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications.

## 1.12 WIND TURBINE SYSTEMS AND COMPONENTS

### 1.12.1 Rotor and blades

1. The blades shall be fitted with an adequate lightning protection system with sufficient receptors and down conductors to protect the complete length of the blade in accordance with IEC 61400-24.
2. Blade bearings shall be fitted with automatic lubrication and grease catchers to prevent egress of excess grease.
3. Blades leading edge will be treated with erosion protection prior to rotor assembly, preferably at blade factory, or prior to affixing to main bearing assembly.

### 1.12.2 Nacelle

1. The nacelle shall be designed to allow personnel safe and easy access to and from the tower ladder, and a safe working environment within the nacelle.
2. Nacelle interior lighting shall allow visibility for service tasks within the nacelle during any hour of the day meeting OSHA requirements for working environments.
3. Nacelle interior lighting shall be equipped with emergency battery backup system and supply at least one hour of illumination.

### 1.12.3 Gearbox

1. Gearbox shall be certified to the IEC 61400-4 standard.
2. Replacement gearboxes and components shall be made available by the turbine manufacturer for procurement through the design life of the gearbox.
3. A failure modes and effects analysis shall be provided by the gearbox manufacturer to demonstrate that failure modes have been identified and that the design mitigates or eliminates the identified failure modes.
4. A summary of the test plan, workshop testing, field testing, loads verification, robustness testing, design reviews, and reliability test results summary from the gearbox manufacturer which validate the long term drive train assembly reliability shall be provided by Contractor. These results shall account for system assembly dynamics, grid events, non-torque loading, and other unique operational characteristics specific to the wind industry.
5. The gearbox shall be designed to operate without major intervention requiring an offsite crane for a minimum of 20 years.
6. All pressurized lubrication lines shall be filtered.
7. Gearbox shall be fitted with an off-line oil filtration (3 µm or as approved by the lubricant supplier), in addition to the in-line filter, and a desiccating breather.
8. Gearbox shall be fitted with a Gram and Juhl, turbine condition monitoring (TCM), or Owner approved equivalent, online and continuous vibration monitoring

system capable of detecting all low and high speed faults. The data shall be property of Owner and integrated into the turbines' SCADA system and Owner's data historian system. Accelerometers will be threaded into the gearbox housing using integral, threaded holes.

9. A list of gearbox faults which are being monitored for and the associated alarm conditions and fault thresholds shall be provided by Contractor to permit Owner auditing and continuous improvement.
10. Kinematic data for each gearbox model supplied shall be provided by Contractor.
11. A bill of material defining the type, make, model, and serial number (if available) of the bearings shall be provided for each gearbox. The BOM shall be provided in MS Excel format.
12. The gearbox full load acceptance test report with evidence of run-in, water content in the oil < 500 ppm, and final oil cleanliness of 17/15/12 (or less), and a manufacturing non-conformance summary for each gearbox shall be provided by Contractor.
13. The gearbox dimensional outline, lubrication, cooling and heating, and section drawings from the gearbox manufacturer shall be provided by Contractor. Third-party component manuals for cooling fans, lubrication pumps, etc. shall also be provided by Contractor.
14. The gearbox specification, transportation, installation, operation, and maintenance manual from the gearbox manufacturer, in addition to the wind turbine installation and maintenance manual, shall be provided by Contractor.
15. Routine and planned overhaul or major maintenance, including oil and filter changes, shall be identified in Contractor's maintenance schedule. The maintenance schedule shall be provided in MS Excel or MS Word format. Changes to the maintenance schedule or maintenance requirements are not allowed without prior review and approval by Owner.
16. The design may be subject to third-party expert review if required by Owner and Contractor's gearbox manufacturer shall co-operate with such reviews.
17. Gearbox manufacturer storage, handling, and assembly requirements shall be followed and documented by Contractor whose associated quality assurance records can be made available to Owner upon request.
18. Final fill oil to be added during turbine erection shall be tested and verified to be the correct lubricant, cleaner than 16/14/11, and water content <300 ppm before installation. Oil outside of these parameters shall be filtered and dried prior to installation.

### 1.12.4 Main bearing

1. The main bearing(s) shall be designed to operate without major intervention requiring a crane for a minimum of 20 years.
2. Main bearing(s) manufacturer storage, handling, and assembly requirements shall be followed and documented by Contractor whose associated quality assurance records can be made available to Owner upon request.
3. The main bearing(s) shall be fitted with an automatic centralized lubrication system. Lubrication operation shall be able to be initiated by both SCADA and an integral meter (time).

4. Main bearing(s) shall be fitted with borescope access plugs to permit in-situ visual inspection.
5. Main bearing(s) shall be fitted with online continuous temperature monitoring.
6. The main bearing shall be fitted with a Gram & Juhl turbine condition monitoring (TCM), or Owner approved equivalent, online and continuous vibration monitoring system capable of detecting all low and high speed faults. The data shall be property of Owner and integrated into the turbines' SCADA system and Owner's data historian system. Accelerometers will be threaded into the bearing housing using integral, threaded holes.
7. A list of the main bearing(s) and housing make, model, and serial number shall be provided.
8. The main bearing shaft assembly drawing, lubrication, and component drawings and manuals shall be provided.
9. Grease analysis sampling procedure and test limits (such as ICP iron, wear debris concentration, etc.) shall be provided by Contractor.
10. Test plan and test result summary shall be provided.
11. Test results and/or design calculation summary which verify that a 20-year operational life without major intervention is achievable given certain design limitations (namely, a low axial/radial load ratio) in three point-mounted drive train configurations with a spherical roller main bearing.
12. Routine and planned maintenance or major maintenance shall be identified in Contractor's maintenance schedule. The maintenance schedule shall be provided in MS Excel or MS Word format. Changes to the maintenance schedule or maintenance requirements are not allowed without prior review and approval by Owner.

### 1.12.5 Generator

1. The generator shall be suitable for operation in the full range of climatic conditions which it is expected to experience.
2. The generator shall be designed to operate without major intervention requiring a crane for at least 20 years.
3. The generator shall be supplied from a reputable manufacturer and be within a standard product range. The passage of lightning through the generator shall be protected against in accordance with IEC 61400-24.
4. The generator bearings shall be fitted with automatic centralized lubrication. Lubrication operation shall be capable of initiation by both SCADA and an integral meter (time).
5. The generator bearings shall be fitted with a Gram & Juhl turbine condition monitoring (TCM), or Owner approved equivalent, online and continuous vibration monitoring system capable of detecting all low and high speed faults. The data shall be property of Owner and integrated into the turbines' SCADA system and Owner's data historian system. Accelerometers will be threaded into the bearing housing using integral, threaded holes.
6. The generator cooling system, if air-cooled, shall utilize a closed loop heat rejection system to ensure airborne particulate are not entrained in the generator.

7. There shall be a 10 degrees C temperature margin between the generator insulation class temperature rating and the maximum measured generator “hot spot” temperature under all operating and climatic conditions to ensure that any degradation of the generator insulation over 20 years of operation does not lead to failure. A minimum of class F insulation shall be required in any instance.
8. Routine and planned maintenance or major maintenance shall be identified in Contractor’s maintenance schedule. This will include initial guidance on generator alignment tolerance levels. The maintenance schedule shall be provided in MS Excel or MS Word format. Changes to the maintenance schedule or maintenance requirements are not allowed without prior review and approval by Owner.

### 1.12.6 Transformer

1. Contractor shall provide a single, suitably rated Wind Turbine main power transformer for each Wind Turbine to step up from the generation voltage to the Collector System voltage for connection to the Wind Plant Electrical System. The transformer, if not supplied as part of the Wind Turbine scope of supply, is typically ground mounted, oil filled, and specified in conjunction with the detail electrical balance of plant design, incorporating Wind Turbine supplier requirements.
2. The transformer may instead be installed in the nacelle or tower, and supplied as part of the Wind Turbine scope of supply. In this case the Wind Turbine transformer is to be specified for site specific electrical grid requirements, and in accordance with standards applicable to the Wind Turbine.
3. In addition to this Section further transformer requirements are identified in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications.

### 1.12.7 Hydraulic power unit

1. Third-party supplier installation, O&M manuals, process and instrumentation diagram shall be provided.
2. On-line filter alarms, oil pressure, and oil temperature monitoring shall be provided.
3. Sump shall be equipped with a desiccating breather.
4. Oil analysis sampling procedure and limits shall be supplied.
5. Hydraulic oil to be filled during turbine erection shall be tested and verified to be the correct lubricant, cleaner than 15/13/10, and water content <100 ppm before installation. Oil outside of these parameters shall be filtered and dried prior to installation.
6. Routine and planned maintenance, including oil and filter exchanges valve testing, shall be identified in Contractor’s maintenance schedule. The maintenance schedule shall be provided in MS Excel or MS Word format. Changes to the maintenance schedule or maintenance requirements are not allowed without prior review and approval by Owner.

### 1.12.8 Yaw system

1. The yaw bearing shall be fitted with automatic centralized lubrication. Lubrication operation shall be capable of initiation through an integral meter (time).
2. The yaw system of each wind turbine shall be programed and normalized to the same 0-degree (true north) reference.

### 1.12.9 Service crane

1. The nacelle shall be fitted with a service crane capable of lifting tools and consumables required for scheduled maintenance directly into the nacelle from the ground level.
2. The crane shall comply with relevant Permits and Applicable Standards.
3. Contractor shall provide details of the service crane, including largest component able to lifted, as part of Contractor's Specifications.

### 1.12.10 Wind turbine tower

1. The tower shall be of tubular steel construction.
2. The tower shall be fitted with an internal ladder, Lad-Saf (or Owner approved equivalent) fall arrest systems, rest platforms and lighting (including safety lighting which shall work during grid and internal power failure).
3. The tower paint system shall at minimum conform to a "C3" environmental protection classification for the tower interior and "C4" for the tower exterior according to ISO 12944. The tower exterior paint color shall be approved by Owner prior to tower fabrication.
4. The tower access door shall be of sufficient size to allow removal of the largest sub-assemblies of major components housed within the tower enclosure.
5. The tower access door shall be fitted with a mechanism to lock the access door in an open position and include features to ensure safe personnel egress should the tower door be inadvertently locked from the outside.
6. Tower interior lighting shall allow visibility within the tower during any hour of the day.
7. Tower interior lighting shall be equipped with emergency battery backup system and supply at least one hour of illumination.

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### 1.12.11 Cabling

1. All cables shall be mechanically protected against effects of bending, abrasions, impact, abnormal heating, rubbing, movement and vibration and supported at suitable locations.

• Terminations and joints shall be installed in a manner consistent with Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications. If not specified, terminations and joints shall be installed per turbine supplier requirements.

### 1.12.12 Service ladder

1. The service ladder in the tower shall comply with the relevant Applicable Standards including where applicable, requirements of the current IBC, State and Local standards.
2. The clearance between the ladder and tower wall shall comply with the OSHA CFR 1910.27 Standard.
3. All turbine ladders shall be equipped with a deflector plate at tower section junctions.
4. Turbines not fitted with a Service Lift shall be fitted with an Ibex Power Climber, or Owner approved equivalent installed on the climbing ladder to assist climbers. Owner shall pre-approve the climb assist make and model.

### 1.12.13 Remote control and monitoring

Remote control and monitoring capabilities of the Wind Turbines shall be sufficient to fulfill the requirements of:

1. Authorized and unauthorized access monitoring
2. Applicable Standards and Applicable Permits including but not limited to the Interconnection Agreement between Owner and the TSP
3. Base SCADA system shall have all data stored locally in an SQL data base fully accessible to Owner.
4. All WTG SCADA data points need to be processed and stored locally and provided to PGE via OPC.
5. In addition to this Section further compliance and security requirements are identified in Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.
6. In addition to this Section further SCADA and communication requirements are identified in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications and Appendix G1 Attachment 05 Exhibit 04 – Communication Facilities.

### 1.12.14 Low voltage supplies

1. All low voltage and auxiliary electrical equipment installations shall comply with Applicable Standards and the requirements of Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications.

### 1.12.15 Medium-voltage switchgear

1. All medium voltage equipment installations shall comply with Applicable Standards and the requirements of Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications and Appendix G1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.

### 1.12.16 Control system and converter (if applicable)

Contractor shall provide:

1. Control System and converter [power electronics AC/DC/AC converter used to converter variable frequency generator output to 60 Hz output (depending on turbine model: full converter or partial converter for DFIG turbines)] bill of material defining the type, make, model, and serial number.
2. One hand held terminal per 10 turbines for tower troubleshooting, control and software downloading. Software updates per the period of warranty coverage.
3. High speed wind extended cut-out options
4. Grid code compliance documentation including applicable SCADA system function/options
    a. Frequency range
    b. Voltage range
    c. Harmonics
    d. Voltage unbalance
    e. Voltage flicker
    f. Reactive power capability
    g. Voltage control
    h. Frequency control/primary frequency response
    i. Power control
    j. Fault ride-through
    k. Sub-synchronous resonance – protection, mitigation
    l. Short circuit contribution
    m. Short circuit MVA and ratio

### 1.12.17 Condition Monitoring System

Condition monitoring system will be designed for the purpose of establishing predictive maintenance activities and proactively monitoring component issues. Vibration sensors and diagnostics shall be carried out, at a minimum, on the following:

1. Main bearing
2. Gearbox
3. Generator

A baseline for vibration data shall be established on every Wind Turbine using no less than three (3) months of data at the start of operations.

## 1.13 FOUNDATION LOADS

Contractor shall supply Owner, and as required the foundation designer and certifier, with foundation loads, performance criteria and interface details prepared by the Turbine Manufacturer in accordance with the relevant certification.

The foundation loads shall be compatible with the relevant Certification and Site Suitability Assessment.

Foundation loads are to be calculated in accordance with the all Applicable Standards including, but not limited to:

- International Building Code and applicable state and local amendments
- ASCE 7 (current edition) Minimum Design Loads for Buildings and other structures
- IEC 61400-1 Wind Turbines - Part 1: Design requirements
- DNV GL Standard DNV GL-ST-0126: Support Structures for Wind Turbines, Edition April 2016 (supersedes DNV/Riso Guidelines for Design of Wind Turbines, Second Edition)

Fatigue loads shall be provided in a Markov Matrix format for the specified Design Life.

## 1.14 OPTIONS AND OTHER FEATURES

Contractor shall advise of any special packages that may be supplied as ‘Options’, including but not limited to:

1. Advanced grid control
2. Special SCADA features (see Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications and Appendix G1 Attachment 05 Exhibit 04 – Communication Facilities)
3. Vibration and Condition monitoring
4. Cold Weather Package
5. Meteorological Instrumentation
6. Fire suppression system

Should any options be selected by Owner, they shall be included in the definition of the Wind Turbine.

The following specifications relate to the noted optional item:

### 1.14.1 Climb Assist

The climb assist shall be compatible with the standard tower ladder.

The climb assist shall provide a reduced carrying weight of at least 75 pounds.

The climb assist shall meet all OSHA standard requirements for safety and construction.

### 1.14.2 Service Lift

The service lift shall be an electrically-driven man-lift capable of lifting two workers and light parts from the base of the tower to the nacelle.

The service lift shall have a minimum lift capacity of 500 pounds.

The service lift shall meet, at a minimum, the requirements of ASME A17.1, ASME A120.1, and OSHA standard requirements for safety and construction.

The service lift shall have interior lights.

The service lift shall include external controls at the base of the tower to enable movement of the lift without an operator inside.

**APPENDIX G2**
**ATTACHMENT 01**
**EXHIBIT 03**

# WIND PRE-OPERATIONAL STARTUP AND TESTING

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

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# 1.0 INSTALLATION, COMMISSIONING, AND TESTING

## 1.1 GENERAL

Contractor shall provide all necessary labor, equipment and tools for erection, installation, commissioning, and testing activities, and shall be entirely responsible for efficient and correct procedures and operations associated with transportation of all components associated with the Wind Plant.

Contractor shall adhere to the requirements of this document and the installation, commissioning, and testing requirements set forth in the specifications for the item of work as obtained from the item's original manufacturer.

Contractor will maintain comprehensive records of the installation, commissioning, and testing work and provide Owner with a copy of these records and the as-built drawings at the completion of the work.

Contractor shall collaborate with turbine manufacture representatives and ensure that appropriate wind turbine technical advisors are available during each phase of turbine completion, including but not limited to, inspection, erection, and mechanical completion.

The tests on the Work are categorized as follows:

1. Factory acceptance tests
2. Equipment receiving and inspection checks
3. Mechanical completion
4. Commissioning tests
5. Performance tests for the purpose of achieving Project substantial completion

Applicable codes and standards, laws and regulations, and engineer of record shall be in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

## 1.2 INSTALLATION RECORDS

The installation records shall include as a minimum:

1. Final location of each structure
2. Serial numbers of all equipment and components with a serial number
3. Electrical test records
4. Bolt tightening records or certificates (At a minimum, these shall be included for base bolts, tower section bolts, blade bolts, nacelle bolts)
5. Foundation excavation records
6. Concrete and steel records

7. Records of remedial works required to foundation excavations
8. Quality records throughout the foundation construction
9. Photographs of the works at relevant hold points
10. Wind Turbine erection records

## 1.3 COMMISSIONING ACTIVITIES

Contractor shall carry out all testing and commissioning activities, which shall be monitored by Owner.

Contractor shall draw up a general commissioning procedure, which shall cover all activities from mechanical completion of the facilities to Project substantial completion, including all commissioning tests and acceptance tests.

The testing and commissioning phase shall be planned as part of the overall project planning.

Daily and weekly meetings shall be held during the testing and commissioning period to coordinate activities.

Contractor shall be responsible for liaison with third parties, including the grid interconnection provider, to ensure the efficient and timely commissioning of the Work, and provision of all test results and data required by the grid interconnection provider.

## 1.4 OWNER'S RIGHT TO WITNESS TESTS

Owner reserves the right to attend and witness all onsite and offsite tests in relation to the Work. Contractor shall comply with the following test requirements:

1. Owner shall be offered an invitation two months prior to all factory acceptance testing for right to attend.

2. Owner shall be notified of onsite testing schedules and testing procedures at least 30 days in advance of such testing.

3. Owner shall be notified at least ten (10) business days prior to the actual commencement of any onsite inspections and/or tests in this Protocol or the Commissioning Test Manual.

## 1.5 FACTORY ACCEPTANCE TESTS

Contractor is responsible for the provision of FAT documentation for all components, including any components manufactured by a third party.

FATs shall be performed in accordance with the relevant manufacturer's established procedures, its approved quality assurance scheme and as identified in Contractors quality plan.

## 1.6 COMMISSIONING TESTS

### 1.6.1 General

Contractor shall demonstrate by suitable tests that the BOP and Wind Turbines will operate satisfactorily and safely.

Commissioning tests shall be based on Contractor's standard commissioning procedures, Wind Turbine supplier commissioning and testing procedures, and shall include, but not be limited to, the tests included in this section.

No tests shall threaten the safety of the Project or personnel. Contractor will report any such test to Owner should this be the case, along with details on measures to be implemented to mitigate any such risk.

Following satisfactory completion of each commissioning test Contractor will issue a certificate to that effect, supported by Contractor's test report.

Owner may reject the commissioning certificate, providing written reasons for this rejection within 5 business days of submission of the commissioning certificate.

### 1.6.2 Wind turbines

Commissioning of individual Wind Turbines is completed upon issue of turbine completion certificates and all punchlist items related to the Wind Turbines are addressed, demonstrating the Wind Turbines can be operated satisfactorily and safely.

Commissioning tests for each Wind Turbine will follow the technical specifications provided by the turbine supplier in accordance with industry practices and will include, at a minimum, a run test of 168 continuous hours error free duration with operational data recorded by the SCADA.

### 1.6.3 Wind turbine foundations

Commissioning tests shall include but not be limited to the following:

1. Certificate from a qualified geotechnical engineer confirming conditions in the base of the excavation were in-line with expectations prior to pouring the foundation.
2. Third-party Registered Professional Engineer's Report (or certificate) confirming the suitability of the WTG foundation(s) design.
3. Pre-pour inspection approval from the foundation design engineer. Rebar installation inspection shall be included in the pre-pour inspection.
4. Concrete production tested in accordance with ACI 301 Specification and supply of concrete and ACI 318, ASTM C172, ASTM C31, ASTM C39, ASTM C172 and ASTM C231:
    a. Slump tests

   b. Four (4) concrete test cylinders to be taken every batch, for compressive strength testing at 7 days and 28 days as follows:
   c. One (1) specimen tested at 7 days cure
   d. Two (2) specimens tested at 28 days cure
   e. One (1) specimen to be kept as a permanent record and/or for additional testing
   f. Drying shrinkage shall be tested at each foundation on the basis of three (3) specimens for each foundation
5. Grout production tests (for WTG foundation-to-tower base flange connection and/or rock anchors) in accordance with ASTM C579, including:
   a. A minimum of three (3) specimens (1 set) to be taken for each turbine foundation site for compressive strength testing as follows:
      i. One (1) specimen tested from each set at 3-7 days cure
      ii. Two (2) specimens tested from each set at 28 days cure
   b. Specimens shall be taken at commencement, during and near completion of grouting.
   c. If grout production is not continuous then additional sample sets and testing shall be required.
6. Testing of concrete and grout samples shall be carried out by an accredited laboratory

### 1.6.4 Substation and electrical works

Commissioning tests related to the Project electrical systems will include the following, as applicable, as a minimum:

1. Check mechanical state and earth connections.
2. Check satisfactory equipment labelling and warning signs. Phase labeling shall be updated to reflect phase test results.
3. Check substation tap selector switch in correct position.
4. Ratio and vector group checks on all transformers (unless already checked in the FAT). Rotation checks on all transformers (regardless if previously checked in the FAT).
5. Check oil levels and oil cleanliness.
6. Transformer winding resistance measurement on highest, lowest and nominal tap settings.
7. Transformer power factor and dissipation factor on all windings and bushings.
8. Insulation resistance between all windings, and each winding to earth.
9. Insulation resistance tests.
10. Transformer field tests including oil sample tests prior to HV applied tests and energization, including breakdown strength, moisture content, dissolved-gas content, and leak tests in accordance with manufacturer’s procedures. This applies to all switchyard transformers, pad-mount transformers, ground reference transformers and site-owned oil-filled service transformers, regardless of purpose.
11. Perform visual inspections and resistance tests on all earth connections for substation equipment.

12. Check all control, alarms, fans and pumps for correct operation and voltage.
13. Routine tests and dielectric withstand tests prior to energization.
14. Visual check for damage to insulation, and satisfactory identification of cores.
15. Perform AC/DC voltage withstand tests (“pressure test”) or otherwise as recommended by cable manufacturer.
16. Test all cables during and after installation prior to connecting to substation equipment in accordance with IEEE Standards.
17. Perform functional test (trip/close) of switchgear, including remote operation and indications if applicable.
18. Perform voltage withstand tests (“hi-pot”) of substation buses and breakers (to earth, between phases, and across open switch contacts).
19. Perform conductivity tests across switch contacts (including earth switches) and across busbar joints (if applicable)
20. Tests on the Wind Plant earthing system shall be of sufficient type and number as necessary to fully verify the safety of the Site and to justify any assumptions made in respect of the Wind Plant earthing system.
21. Contractor will measure resistance to earth of each Wind Turbine earthing system (isolated from balance of earth system). The results are required to satisfy statutory requirements and requirements of Wind Turbine manufacturer.
22. Check that direct grounds do not exist on any floating DC systems; Contractor to locate and correct grounds.
23. Perform ground grid testing (fall-of-potential or equivalent) and confirm results agree with specifications and assumptions from grounding studies with respect to step and touch potentials. Contractor shall take corrective action acceptable to Owner.
24. After the installation of all joints and terminations and before energization of the circuit, Contractor shall conduct an insulation resistance (IR) test between each phase and earth/neutral, between the cable screen and earth, and between phases.
25. Commissioning tests shall be undertaken to confirm compliance with the requirements of the network service provider, grid interconnection agreements, and IEEE Standards (as applicable).
26. High voltage breaker and disconnect testing
27. Capacitor bank or reactor bank testing, if applicable
28. Substation relay/meter/SCADA/communication inspection by PGE. Contractor to perform point-to-point checkout on relay panels prior to PGE inspection. Contractor to coordinate scheduling of inspection with Owner.
29. CT’s and PT’s
30. Batteries and battery chargers and UPS
31. Motors (HVAC)
32. Panelboards and molded case circuit breakers
33. Lighting
34. Fiber optics

### 1.6.5 Meteorological Stations

Commissioning of the permanent meteorological station(s) (met mast) is completed upon issue of met mast completion certificate, demonstrating the met mast can be operated satisfactorily and safely.

Commissioning tests for each met mast will follow the technical specifications provided by the met mast supplier in accordance with industry practices and will include, at a minimum, evidence of data from each installed instrument and recorded by the SCADA.

The results of all test results will be provided to owner in pdf.

### 1.6.6 Communications network and SCADA system

Commissioning tests shall include the following as a minimum:

1. Attenuation measurements on all optical fibers.
2. Redundant loops tested and operational on all optical fiber loops.
3. Contractor's standard commissioning tests for the SCADA System.
4. Tests to demonstrate that the system is able to send and receive all the data required by the grid interconnection provider.
5. Tests to demonstrate that the system is able to receive and store all the data from the permanent meteorological station.

Commissioning tests shall also demonstrate that the system is able to record:

1. Ten-minute average values for wind speed, direction, and power operational status from all Wind Turbines
2. Occurrence and correction of Wind Turbine events
3. Ten-minute average values of power, reactive power, frequency, and power factor from the grid monitoring station(s)

## 1.7 PERFORMANCE TESTS FOR ACHIEVING SUBSTANTIAL COMPLETION

Performance tests, including a 72-hour Project-wide performance run test, will demonstrate to Owner that the Work operate satisfactorily and safely, comply with the requirements of this document and are suitable for operational handover and for the purpose of achieving Project substantial completion.

If the 72-hour Project-wide performance run test is interrupted due to a fault of Contractor supplied equipment, the 72-hour performance run test shall be restarted.

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

All performance data, faults, errors, trips etc. that occur during performance tests shall be recorded by the SCADA until such time that the test has been successfully completed.

If any significant defects occur during the course of any performance test, they shall be remedied immediately by Contractor and the performance test for the affected item shall start again.

Contractor shall provide Owner with the appropriate documentation for the test period in order to verify the tests have taken place and were successfully completed.

**APPENDIX G2**
**ATTACHMENT 01**
**EXHIBIT 04**

# WIND PLANT PERFORMANCE TESTING

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

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# 1.0 PLANT PERFORMANCE TESTING

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Contractor shall provide all necessary labor, equipment and tools for testing activities, and shall be entirely responsible for efficient and correct procedures and operations associated with transportation of all components associated with the Wind Plant.

Contractor shall adhere to the requirements of this document and the installation, commissioning, and testing requirements set forth in the specifications for the item of work as obtained from the item's original manufacturer.

Contractor shall conform to the requirements of power performance testing met masts in Appendix G2 Attachment 01 Exhibit 01 – Wind Plant Specifications.

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

The tests on the Work are categorized as follows:

- Performance tests for the purpose of confirming performance levels during initial operation (such as power performance test)

## 1.2 PERFORMANCE TEST DURING INITIAL OPERATIONS

Contractor will include power performance testing of the Wind Turbines for compliance with the Wind Turbine's guaranteed power curve.

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

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

Any modifications or deviations on the turbine manufacturer warranty document from IEC 61400-12-1 Ed. 1.0 must be reviewed and approved by an Independent Engineer.

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

# APPENDIX G3

# SOLAR TECHNICAL DOCUMENTS

# RENEWABLE ENERGY RESOURCES

# PORTLAND GENERAL ELECTRIC

# 2018

# REQUEST FOR PROPOSAL

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 01**

# SOLAR PHOTOVOLTAIC PLANT SPECIFICATIONS

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

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# 1.0 GENERAL

## 1.1 EXTENT

Contractor is responsible for the engineering, procurement and construction of the Project. It is not the intention of this section or document to specify all details of design and construction of the complete Project. However, the Work shall conform in all respects to high standards of engineering, design and workmanship and be capable of performing in continuous commercial operation meeting all contractual obligations of Contractor including guarantees and warranties in a manner acceptable to Owner.

If there are other or different requirements than are specified in this document or Agreement (including any exhibits thereto) that are necessary in order to provide Owner with a System that: (i) has no Defects, (ii) reflects Prudent Industry Practices; and (iii) is capable of performing on a sustained, fully operational basis to generate the electricity as described in the Agreement, Contractor is to satisfy such requirements as part of the Work.

# 2.0 APPLICABLE STANDARDS

Applicable codes and standards, laws and regulations shall be in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

Where a reference to the above is made in this document the latest edition shall apply. Furthermore, in the event of any discrepancy in the Applicable Standards, the most stringent standards and requirements shall apply.

Contractor shall be responsible for ensuring that the Work comply with all Applicable Standards and as these may be amended and revised from time to time.

The Applicable Standards are in addition to the requirements set forth in the Agreement, this document, including any additional standards, the Permits, and the Specifications.

Any request for deviation from the Applicable Standards, the referenced codes and standards must be fully explained in writing and submitted for Owner's review and approval prior to implementation.

## 2.1 ENGINEER OF RECORD

All engineering shall be performed under the responsible charge of the engineer of record, who shall be a registered professional engineer, registered in the corresponding discipline for the reports or drawings produced, and the state(s) in which the Project Site is located. The registered professional engineer shall have experience and competence in the area of engineering being performed as defined by laws and regulations of the applicable jurisdiction.

Final “Issued for Construction” engineering drawings and reports shall be signed and stamped by the registered professional engineer in responsible charge of the engineering work.

## 3.0 SCOPE OF WORK

### 3.1 GENERAL

The Work supplied by Contractor shall achieve the objective of connecting the Solar Power Plant to the POI for the purpose of generating electricity into the network and be of a proven, robust and reliable design incorporating protective systems and devices with adequate factors of safety and operability built-in. Work will include, but not be limited to:

1. The engineering, procurement, and construction of the BOP
2. Civil works
    a. Access, grading, drainage, hydrology.
3. Electrical array layout and Balance of System (BOS)
4. Electrical balance of plant (EBoP)
    a. DC Combiner system
    b. AC Collection system
    c. AC Combiner system
    d. Collection substation
    e. Transmission line
5. SCADA (supply delivery, installation and instrumentation)
6. Meteorological Station(s) (supply delivery, installation and instrumentation)
7. The supply, delivery, and installation of the photovoltaic modules, inverters, BOS and other major equipment.
8. The engineering, procurement, and construction of the O&M Building (if applicable)
9. Transmission line between the collection substation and point of interconnection

The Work shall be carried out in accordance with and meet the requirements of the following:

1. The Agreement including but not limited to this document
2. Applicable Standards
3. Warranty obligations
4. Land lease and easement agreements
5. Components technical specifications
6. The Project geotechnical constructability study
7. The Project grid interconnection agreement

Contractor shall be responsible for obtaining all relevant permits and authorizations required to undertake the Work.

Contractor shall be responsible for the actions required to enable the engineering, procurement and construction of the Work. Contractor shall accompany Owner on

factory visits to major equipment suppliers to review quality processes and verify equipment is being built and delivered.

Contractor shall be responsible for all restoration activities as required for all areas disturbed during the Work.

Contractor shall be responsible for the establishment of appropriate O&M procedures, quality management system documentation and warranties for the Work.

Contractor shall plan and execute its own Work so as to minimize the effect of work by others on its own operations and the effect of its work on the operations of others.

All equipment supplied by Contractor shall be supplied new, complete and operational and shall include all necessary accessories and incorporate all miscellaneous material, minor parts and other such items, whether or not the items are indicated on the drawings or in this document, where it is clearly the intention that they should be supplied or where they are required and necessary to complete and commission the equipment.

## 3.2 PROJECT DESCRIPTION

Owner is requesting proposals for a newly constructed solar photovoltaics power project meeting all requirements of the Agreement including but not limited to those listed in this document.

## 3.3 SITE CONDITIONS

Contractor will ensure that all aspects of the Work are fit for purpose and suitable for the current and reasonably predicted conditions at the Site through inspection, examinations, investigations, explorations, surveys, tests, studies and data collection. All inspections, examinations, investigations, explorations, surveys, tests, studies and data collection will be included in Contractor proposal and thus, Contractor will not be entitled to any scope change based on results included in these investigations.

It is Contractor's responsibility to ensure that all aspects of the Work are suitable for the existing and predicted conditions of the Site including but not limited to:

1. Climatic (including, but not limited to, both local and regional wind and snow loading) as included in [insert document].
2. Environmental including any wildlife habitat protection requirements
3. ALTA Survey Map
4. Community acceptance and impact
5. Geotechnical
    a. Including thermal resistivity and electrical resistivity measurements taken at locations intervals that will adequately characterize the entire site.
6. Transmission and interconnection
7. Hydrological conditions

If aerial survey techniques are employed, Contractor will validate aerial survey data with ground based data collection.

## 3.4 DESIGN LIFE

Contractor will design, engineer, procure, and construct the Project according to the following intended design life:

1. Civil Works (including racking system and foundations): 30 years
2. Electrical Works (including system combiner circuit systems, substation, and communications): 30 years
3. Solar Modules: 25 years
4. Inverters: 25 years
5. O&M Building (if applicable): 30 years
6. Transmission Line: 50 years

Contractor shall provide the expected reliability and availability for the first five years of operation of the photovoltaic modules, inverters, medium voltage padmount transformers and the main step-up transformers specified in their bid.

## 3.5 EQUIPMENT REQUIREMENTS

### 3.5.1 PV Modules

Requirements for PV modules are included in Appendix G3 Attachment 01 Exhibit 02 – Solar Photovoltaic Module Specification.

### 3.5.2 Inverters

Requirements for inverters are included in Appendix G3 Attachment 01 Exhibit 03 – Solar Photovoltaic Inverter Specification.

### 3.5.3 Racking

Requirements for racking are included in Appendix G3 Attachment 01 Exhibit 04 – Solar Photovoltaic Racking Specification.

### 3.5.4 Transformers

Requirements for transformers are included in Appendix G1 Attachment 04 Exhibit 02 – General Transformer Specification.

### 3.5.5 Substations

Requirements for substations are included in Appendix G1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.

### 3.5.6 Transmission line

Requirements for transmission lines are included in Appendix G1 Attachment 05 Exhibit 01 – Transmission Line Design Specification and Appendix G1 Attachment 05 Exhibit 02 – Transmission Line Construction Specification.

### 3.5.7 Combiner Boxes

Each combiner box shall include a fused connection between any ungrounded DC circuit wiring from PV strings to provide over-current and short-circuit protection. When applicable, the grounded DC circuit wiring from PV strings shall be connected to the designated terminal block. The combiner box output circuit (homerun) shall be provided with a load-break disconnect switch with exterior lockable handle, rated for the voltage and current of the combined PV strings. When lightning protection device is included, combiner boxes shall include blown fuse and visual trip indication.

The string fuses and fuse holders shall be finger-safe and rated according to the string DC current and voltage, and environmental conditions. The power terminal blocks shall be rated for use with both copper and aluminum conductors and rated to match maximum system voltage (continuous duty, 600 V DC, 1000 V DC, or 1500V DC, as applicable) and 90°C conductor temperature. The combiner box shall be equipped with a mechanical ground lug and bus, rated for terminations with Al/Cu grounding conductors. Short circuit withstand rating shall be 10 kAIC minimum.

The combiner box enclosure shall be nonmetallic, outdoor-rated, weatherproof, NEMA 4 (Note: breather/drain valves are recommended for NEMA 4 and NEMA 4X), and the doors shall be easily interchangeable. The manufacturer shall supply a fully assembled combiner box and shall provide detailed drawings, specifications sheets, mounting instructions, and maintenance requirements of its product.

Each combiner box shall provide “touch-safe” power circuit terminations and include provisions for bolted terminations of the output power circuit to the inverter. Each combiner box shall include a provision for a padlock, including a padlock and key.

The combiner box door shall be interlocked with a load-break disconnect switch in such a manner that the door cannot be opened when the switch is “closed.” In addition, the switch shall not be capable of being placed in the “closed” position unless the combiner box door is fully closed. An external door interlock defeat mechanism shall be provided to allow authorized personnel access to the interior of the combiner box while the switch is in the “closed position for periodic inspection, troubleshooting, and electrical field measurements.

The combiner box shall be listed to UL 1741 for use in United States applications. IEC 60146-1-1 and CSA C22.2 No. 107.1 may be substituted if authorized by Owner.

The combiner box shall be rated for an operating temperature range of -20°C to +50°C.

Each combiner box shall be suitable for application of permanent labels in the field and shall include electrical warning labels. The combiner box shall provide a permanent warning label stating the following. Additional labeling shall be required per NEC requirements:

| |
|---|
| WARNING:<br>ELECTRIC SHOCK HAZARD<br>DO NOT TOUCH TERMINALS<br>TERMINALS ON BOTH THE LINE AND LOAD<br>SIDES MAY BE ENERGIZED<br>IN THE OPEN POSITION<br><br>DC VOLTAGE IS ALWAYS PRESENT<br>WHEN SOLAR MODULES<br>ARE EXPOSED TO SUNLIGHT |

### 3.5.8 Lightning Protection

Contractor shall provide a lightning hazard assessment performed to industry standards by a certified lightning protection professional. Flash density estimates shall be confirmed by Owner. The results of this risk assessment, in consultation with Owner, shall be the basis for determining the requirements and extent of the facility Lightning Protection System (LPS), grounding system (including equipotential bonding considerations) and surge protection system that provides protection of the PV modules, DC balance of system circuits and equipment, inverters, measurement control and communications systems, and other major electrical equipment. If LPS is necessary, contractor shall produce an LPS design that minimizes shading/energy impact.

#### 3.5.8.1 Lightning Protection System (LPS)

Lightning protection with traditional air terminals shall be implemented as necessary. Lightning protection equipment shall be either Class 1 or Class 2, depending on the height of the structure to be protected in accordance with NFPA 780. Lightning protection equipment shall include, but not be limited to, the following:

1. Air terminals
2. Air terminal supports
3. Main conductor
4. Bonding conductor

All lightning protection equipment shall be UL listed.

#### 3.5.8.2 Grounding System

Grounding system shall be designed to support the LPS and establish equipotential bonding across the PV array field as necessary per the lightning hazard assessment.

#### 3.5.8.3 Surge Protection System

A staged, comprehensive surge protection system, inclusive of Type 1, 2, and 3 surge protective devices (SPDs), shall be incorporated as determined by the lightning risk assessment or as required by the photovoltaic and inverter manufacturers in all relevant pieces of electrical equipment. Protection shall be provided within the inverter on both the DC and AC sides as required by the inverter manufacturer. Additionally, surge protection shall be provided in combiner boxes, trackers, and measurement control and communication systems as determined by the lightning risk assessment study. Type 3 surge protection installed within that equipment shall be mounted on DIN rails, and must have finger safe replaceable modules that can be exchanged without the use of tools. SPDs shall be applied on all power circuits (AC and DC) and all communications and control circuits in a coordinated, staged manner. The operating status of the power SPDs shall include visual indication, and shall be able to be remotely monitored by a set of integral contacts.

In addition to the performance requirements indicated above, all SPDs shall be compliant to the respective domestic or international standards, including, but not limited to, the following standards and guidelines:

1. Underwriters Laboratories, Inc. (UL) Standard 1449 3rd edition.
2. IEEE Guideline C62.41.1-2002
3. IEEE Guideline C62.41.2-2002
4. IEEE Standard C62.42-2005
5. IEEE Standard C62.45-2002
6. IEEE Standard 1100-2005

#### 3.5.8.4 Installation

The lightning protection system shall be installed in accordance with Section 6.12.

### 3.5.9 Raceways

Contractor shall design, provide, and install a complete electrical raceway and/or duct bank system as required by applicable codes and as specified herein. Source circuits and harnesses shall be supported in free air shall be installed in accordance with the NEC, shall be sunlight resistant and shall be protected from all sharp edges using sunlight resistant listed split loom and other approved edge protection.

Direct-buried conductors shall be listed for direct-burial.

Messenger systems shall be submitted for Owner approval and shall be listed for the application.

Conduits shall be EMT, RGS, LFMC, or PVC schedule 40 or 80, as applicable, and as specified below. Bell-end or bushings shall be used at the end of each conduit to protect conductors.

Electrical Metallic Tubing (EMT) shall meet the following requirements:

1. Hot dip galvanized, corrosion resistant
2. Listed to UL 797 and UL 514B
3. Conform to ANSI C80.3
4. Fittings shall be integral compression type and watertight

Rigid Galvanized Steel (RGS) conduit shall meet the following requirements:

1. Hot dipped galvanized, corrosion resistant
2. Listed to UL 6 and UL 514B
3. Conform to ANSI C80.1
4. Fittings shall be threaded type and watertight

PVC Schedule 40/80 Conduit shall meet the following requirements:

1. Sunlight or UV Resistant
2. Listed for UL 651
3. Conform to NEMA TC-2

Liquidtight Flexible Metallic Conduit (LFMC) shall meet the following requirements:

1. Hot dipped galvanized steel core
2. Flame retardant PVC jacket
3. Sunlight or UV resistant
4. Moisture and oil resistant
5. Listed to UL 360
6. Fittings shall be threaded type and watertight.

### 3.5.10 Low Voltage Dry-Type Transformers

Low voltage dry-type transformers shall be provided in the phases, kVA, and voltages as specified on the drawings.

Transformers shall have copper windings.

Transformers shall be air cooled, dry type, wall- or floor mounted, and enclosed for wiring in conduit.

Transformer enclosures shall be NEMA 4, weatherproof.

Transformers shall have at least two full capacity voltage taps.

Transformers shall meet NEMA TP1 guidelines for energy efficiency.

Transformers shall be UL listed.

### 3.5.11 Low Voltage Panelboards

Panelboards shall be dead front with molded case circuit breakers of the size and type as specified on the drawings.

Panelboards shall be 120/240 volt, single phase.

Panelboards shall have a flush-mounted or surface-mounted enclosure.

Enclosures shall be NEMA Type 1 for installations indoors, or NEMA Type 4 for installations outdoors.

The enclosure shall have a hinged trim (cover).

Breaker operating handles shall be accessible through a latched, lockable, door.

Circuit breakers shall be thermal magnetic, bolt in, individually front replaceable, and shall indicate "On," "Off," and "Tripped."

Breakers indicated as multiple pole shall be common trip.

Breakers shall have interrupting ratings in excess of fault current required.

Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed.

Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the drawings.

The panel shall have main and neutral buses insulated from the cabinet, and a ground bus.

Buses shall be copper, with ampere ratings and main lugs or breaker as indicated.

The ground bus shall be similar to a neutral bus and shall have a solid ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

If panelboards are proposed for dc applications within the BOS they shall be approved by the Owner and they shall be rated and listed for the application (ie. rated for backfeed).

### 3.5.12 GFCI Receptacles

Ground fault circuit interrupting receptacles shall meet the following requirements:

1. Duplex type.

2. 125 volts.
3. 20 amperes.
4. Differential tripping at 5 milliamperes.
5. NEMA configuration 5-20R.
6. Interrupting rating of 1,000 amperes without damage.
7. No. 12 AWG copper TW wire insulated pigtails.
8. Feed-through configuration for downstream protection.
9. Conform to NEMA WD 1.
10. UL listed.
11. Industrial grade, at a minimum (residential grade not permitted)

### 3.5.13 Light Switches

Light switches for standard lighting systems shall meet the following requirements:

1. 120 or 277 volts.
2. 20 amperes.
3. Screw terminals.
4. One-way or three-way switches, as required.
5. Totally-enclosed.
6. AC type.
7. Quite tumbler
8. Suitable for LED lamp loads.
9. Weatherproof, gasketed enclosure
10. High conductivity copper.
11. Brown or ivory operating handles.
12. Conform to NEMA WD 1.
13. UL listed.

### 3.5.14 Disconnect Switches

Disconnect switches shall meet the following requirements:

1. Voltage rating shall meet or exceed the circuit maximum possible voltage.
2. Continuous current rating as specified on the drawings (minimum 30 A)
3. Number of poles required to obtain disconnect rating and wired in accordance with manufacture's requirements.
4. NEMA 4 enclosure or better
5. Copper bussing or connection cables when available.
6. Visible blades for Utility disconnects, and visible or indicators are allowed in other locations.
7. Positive, quick-make, quick-break mechanisms
8. Operating handle whose position is easily recognizable and which can be locked in the OFF position with three padlocks.
9. The ON and OFF positions shall be clearly marked.
10. Door interlock that prevents the door from being opened while the operating handle is in the ON position.
11. Conform to NEMA 4 standard.
12. UL listed.

### 3.5.15 Low Voltage Junction Boxes

Junction boxes shall meet the following requirements:

1. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters, shall be constructed of sheet steel, shall be galvanized after fabrication.
2. Bolt on junction box covers 3 feet square or larger, or heavier than 25 lbs, shall have rigid handles.
3. Covers larger than 3 by 4 feet may be split.
4. Junction boxes and covers shall be traffic rated if subject to vehicle traffic.
5. Above-ground junction boxes shall be bordered by red-colored bollards for traffic protection.

6. Boxes shall be sized in accordance with the minimum requirements of the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Where requirements are not explicitly stated within the National Electric Code, owner underground medium-voltage design standards shall be used.

7. Conduit arrangement shall leave maximum space for future conduits.

### 3.5.16 Vaults and Handholes

Vaults and handholes shall meet the following requirements:

1. Pre-cast reinforced concrete body.

2. Pre-cast reinforced cover.

3. If subject to traffic, concrete pull boxes and covers shall be HS20 traffic rated.

4. Extensions, as necessary.

### 3.5.17 Meteorological Stations

Contractor shall supply and install one stand-alone central meteorological monitoring station. The station shall have a data sampling rate of at least 4 seconds. The average of these samples shall typically record at a time interval of 15 minutes, but should be capable of producing 1 minute interval data as necessary to support performance testing. The station shall have autonomous storage of a minimum of 15 days of data, and shall have continuous remote network access. The station will track global horizontal irradiance (GHI) and insolation over time, plane-of-array (POA) solar irradiance and insolation over time, ambient temperature, module temperature, and other parameters using the following instruments:

One primary POA pyranometer at the same tilt of the array placed adjacent to the secondary POA pyranometer in a location free of shade all year. Pyranometer shall be a Kipp & Zonen Model CMP 11 or Owner-approved industry equivalent. Heated and dried with heater/desiccant attachment if location has snow.

One secondary POA pyranometer at the same tilt of the array placed adjacent to the primary POA pyranometer in a location free of shade all year. Pyranometer shall be the same model as the primary POA pyranometer. Heated and dried with heater/desiccant attachment if location has snow.

Three or more module temperature sensors, with accuracy of +/- 1 degree Celsius or better. These sensors shall be of the platinum RTD variety attached to back of modules halfway down a row with a thermally conductive adhesive at the base, mid-level and top of a row. Temperature sensors shall be installed at the center of a cell and installation location on the modules shall be consistent amongst the site.

One ambient temperature sensor enclosed in a naturally aspirated radiation shield and installed at a height similar to the average height of the arrays. Accuracy of this device shall be ¬+/- 1 degree Celsius or better.

One primary horizontal pyranometer placed adjacent to the secondary horizontal pyranometer in a location free of shade all year. Pyranometer shall be a Kipp & Zonen Model CMP 11 or Owner-approved industry equivalent. Heated and dried with heater/desiccant attachment if location has snow.

One Remote Terminal Unit / data logger to condition the instruments' signals, record data and communicate to the SCADA server or DAS provider.

One anemometer and one wind vane, installed at the average array height in a location that does not shade the array at any time of the year. Anemometer shall be accurate to within +/- 1 m/s or better, and wind vane to within +/- 5 deg or better.

One barometric pressure sensor, accurate to +/- 1mbar or better.

One relative humidity sensor, accurate to +/- 2 percent or better.

The records stored at the meteorological station shall be time stamped and collected at a sampling rate of at least 4 seconds. The records shall be automatically flushed every 15 days to avoid overflow. The data logger shall include its own power backup system that may or may not be connected to the SCADA UPS system, to allow for standalone operation for at least 5 days. The meteorological station shall include a communications port compatible with a standard laptop computer running Windows OS to be able to read and download data on site. The access to the data logger shall be password protected and Contractor shall provide the required software, cables and instruction manual to connect to the port and access the data.

### 3.5.18 Distributed Solar Measurement Stations

Contractor shall supply and install a distributed solar measurement station if the plant's rated capacity is greater than 10 MW, and another centrally-located station for each 10 MW block thereafter. The stations shall have a data sampling rate of at least 4 seconds. The average of these samples shall typically record at a time interval of 15 minutes, but should be capable of producing 1 minute interval data as necessary to support performance testing. These stations shall have continuous remote network access. The stations will track insolation and module temperature. The stations shall include the following instruments for each station:

One primary POA pyranometer at the same tilt of the array. Pyranometer shall be a Kipp & Zonen Model CMP 11 or Owner-approved industry equivalent. Heated and dried with heater/desiccant attachment if location has snow.

Two or more module temperature sensors, with accuracy of +/- 1 degree Celsius or better. This sensor should be attached to back of modules with a thermally conductive adhesive in the middle of a row at the mid-level of a row.

One ambient temperature sensor enclosed in a naturally aspirated radiation shield and installed at a height similar to the average height of the arrays. Accuracy of this device shall be ¬+/- 1 degree Celsius or better. Required for first distributed station, optional thereafter.

One anemometer and one wind vane, installed at the average array height. Anemometer shall be accurate to within +/- 1 m/s or better, and wind vane to within +/- 5 deg or better. Required for first distributed station, optional thereafter.

One barometric pressure sensor, accurate to +/- 1mbar or better. Required for first distributed station, optional thereafter.

## 3.6 OPERABILITY, MAINTAINABILITY AND ACCESSIBILITY

Design for accessibility, maintainability, and operability shall be in accordance with Appendix G1 Attachment 01 Exhibit 04 – Access, Maintenance, Operation, and Reliability.

### 3.6.1 Operability

Where redundant (standby) equipment is supplied, the idle component shall be capable of automatic initiation by the plant control system or immediate initiation by the operator upon failure of one or more of the operating components without interruption to critical equipment or systems.

Based on the design and equipment type necessary instrumentation shall be supplied installed to either:

1. Detect a failure of one or more of the operating components.
2. Assess the condition of the equipment so that maintenance can be performed before failure occurs.

### 3.6.2 Accessibility

Convenient and safe access, including sufficient clearance, shall be provided to all valves, instruments and equipment for both operation and maintenance.

Equipment that only requires access for maintenance shall be accessible from either a ladder or a platform

Contractor shall provide sufficient access around all of the Work, in accordance with good utility design practice and Applicable Standards, to allow effective maintenance and removal of items from service or parts thereof, while maintaining operation of the Work unaffected by maintenance tasks.

### 3.6.3 Maintainability

The Work shall be provided by Contractor to allow maintenance to be performed safely and efficiently without significant dismantling or disruption to other items or parts of the Work or unduly curtailing power generation.

The Work shall allow maintenance activities that can be performed by a limited crew using mobile plant and operating in remote locations.

## 3.7 FACILITY SAFETY

1. The Work shall be designed and constructed so that they comply with all relevant health and safety requirements in accordance with Appendix G1 Attachment 01 Exhibit 06 – Safety, Health, and Environment.

2. The Work designed and provided by Contractor shall ensure satisfactory operation in which safety of personnel and Work and continuity of service are the first considerations, and equally to facilitate inspection, cleaning, maintenance and repairs.

3. The design shall incorporate industry best practices for the safety of all those concerned in the operation and maintenance of the Work and of related works supplied under other contracts.

4. Safe operation shall not rely on the connection of the Equipment to the SCADA system or a remote monitoring center.

5. Equipment shall be designed and installed to ensure the safe isolation of personnel from energy sources when either routine or invasive maintenance is being performed. Energy sources include but are not limited to:

    a. Electrical
    b. Mechanical
    c. Potential (gravity)
    d. Hydraulic (if applicable)
    e. Pneumatic (if applicable)

6. The design shall include a safe and sufficient means to isolate and test the equipment during startup, and operation for purposes of troubleshooting and maintenance.

7. Equipment and systems shall be designed and installed to allow for:

    a. Safe dispensation of energy released or created by equipment or system failure
    b. Safely commissioning and/or troubleshooting equipment while the equipment is operational.

c. Satisfactory operation under the environmental conditions prevailing at the Project Site and under such variations of load as may be met with under working conditions on the grid including those due to synchronization and electrical faults including short circuit.

8. Prior to any paving, gravel walkways and roads shall be maintained for safe movement of personnel and vehicles to all construction locations in accordance with 29 CFR 1910 Subpart D.

9. Cover temporary holes with metal plates (or other rot-proof material) in accordance OSHA Regulation 29 CFR 1926, Subpart M.

## 3.8 PERMITS

Contractor will obtain and maintain, at its sole cost, all permits required to design, engineer, procure, and construct the Project, including but not limited to 1200c (NPDES and Sediment and Erosion Control) permit, removal fill permit, septic or WPCF permit. Contractor shall be required to receive code variance(s) as necessary for 1500V systems (if applicable). Copies of all Contractor obtained permits will be provided to Owner within 5 business days after they are obtained and/or completed.

## 3.9 MISCELLANEOUS

Contractor shall be responsible for any damage to the Project Site caused by it or its Subcontractors.

## 3.10 PROJECT MANAGEMENT AND CONTROL

Project management planning, scheduling, project status reports, risk assessments, and recovery planning shall be in accordance with Appendix G1 Attachment 01 Exhibit 05 – Project Management and Controls.

## 3.11 PROJECT MILESTONES

In addition to Project Controls requirements of Section 3.10, Contractor will define milestones with associated completion certificates to include, as a minimum:

1. Racking System Foundation Completion
2. Combiner Circuit System Completion
3. DC Circuits Completion
4. Substation Completion
5. Transmission Line Completion
6. Solar Plant Mechanical Completion
7. Solar Plant Commissioning Completion
8. Access Road Completion
9. Solar Plant Substantial Completion
10. Remediation/Restoration Completion
11. Drawings and Documentation Requirements Completion

12. Solar Plant Final Completion

Contractor will provide a guaranteed Project Substantial Completion date with associated damage provisions. Project Substantial Completion will be achieved after the facility commissioning has been completed, mechanical completion has occurred; all public and access roads, combiner circuits, the substation and the transmission line have been completed, all strings are connected and synchronized with the grid, commercial operation has been achieved according to the Project interconnection agreement, and Contractor and Owner have agreed upon a final punch list.

## 3.12 Quality Control and Quality Assurance

Contractor will meet the requirements of Appendix G1 Attachment 01 Exhibit 08 – Quality Management System.

Contractor shall operate a quality system equivalent to the ISO 9000 series of standards and as approved by Owner.

Contractor's quality management system plan will be adequate to cover all construction operations.

Contractor will submit all quality assurance / quality control documentation to Owner to show compliance with the requirements of this document.

As the market supports, Contractor shall select manufacturers that have furnished equipment of similar type and size which has been in successful operation for not less than the past 5 years. Due to rapid development of new equipment in the solar industry, it is reasonable to expect that a specific model number for a piece of equipment may not have been on the market for the duration specified above and if not, Owner approval is required. Contractor shall refer to Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers for a list of recommended suppliers. Deviation from the criteria in this section is acceptable with Owner approval, if Contractor can provide sufficient evidence to support the bankability and track record of a proposed vendor.

## 3.13 DESIGN AND ENGINEERING

Contractor will complete design and engineering services and will provide comprehensive drawings and specifications for a complete and fully operational Project that meets the requirements of Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

Contractor will submit 30% (preliminary) design packages for the entirety of the Project for Owner review. Such packages will include, at a minimum, drawings, specifications, and assumptions.

Contractor will submit 60% (issued for review), 90% (issued for permit and procurement), and 100% (issued for construction) design packages for the entirety of the Project for Owner review. Such packages will include, at a minimum, drawings,

specifications, design calculations, studies, materials, and assumptions. 100% (issued for construction) design packages shall be issued prior to the commencement of construction.

## 3.14 SOLAR FIELD LAYOUT

For a ground-mounted system, the area available for the PV arrays is defined in the Project Site Certificate or otherwise limited to the project boundary minus any easements, right of ways, agreements and other encumbrances specified in the ALTA Survey Map and other constraints outlined in the project studies which include but not limited to; geotechnical survey, environmental impact study, hydrology study, FEMA flood zones, seismic hazard zones and other planning/zoning requirements.

Design parameters other than those specified in this document shall be defined by Contractor.

Row spacing (frame to frame) shall be specified by the Contractor's design optimization efforts including shading considerations, but shall be adequate to allow access for customary maintenance vehicles, including commercial mowing equipment, suited for ground-mounted systems, and maintenance personnel for rooftop systems.

Module tilt shall be specified by the Contractor's design optimization efforts, but shall be adequate to allow proper water (snow if applicable) shedding. Tracker stow considerations should be made clear and presented to the Owner.

The inverters shall be specified by Contractor, but shall be commercially viable, as approved by Owner.

The DC to AC ratio, defined as the ratio of the sum standard test condition (STC) rating of modules to the sum nameplate rating of inverters (otherwise known as the inverter loading ratio – ILR), shall be defined by Contractor, but shall not violate requirements and limits of the inverter manufacturer.

## 3.15 TEMPORARY UTILITIES

### 3.15.1 Office Trailers

Requirements for office trailers and temporary site buildings are provided in Appendix G1 Attachment 02 Exhibit 02 – General Onsite Buildings.

### 3.15.2 Electric Power

Contractor shall determine the type and amount of power necessary and make arrangements for obtaining temporary electric service, metering, and shall bear the costs for electric power used during the construction period.

### 3.15.3 Lighting

Contractor shall provide lighting to all construction areas during construction including but not limited to all indoor areas and areas around equipment, temporary trailer areas, storage areas, roads, walkways, and parking areas per 29 CFR 1910 Subpart M. This shall include general site lighting provided by high mast lights per OSHA regulation 29 CFR 1926, Subpart D.

### 3.15.4 Water

Contractor shall provide potable water for construction and drinking by construction personnel during construction.

### 3.15.5 Sanitary Facilities

Contractor shall provide and maintain sanitary facilities on Site during construction.

## 3.16 ELECTRICAL DESIGN CRITERIA

The design shall take into account ambient temperature, relative humidity, elevation above mean sea level, and proximity to potentially corrosive environments. The electrical design shall take into consideration the available short circuit current, from the utility, and ensure that all specified equipment meets the appropriate protection levels to prevent hazards or damage to that equipment or personnel.

All electrical equipment shall be designed in accordance with all applicable codes and standards, to ensure that it is safe to operate within the specified application, and that it will be reliable.

All design drawings and specifications produced shall be sealed by a Professional Electrical Engineer licensed to practice in the state where the Project is located. The professional Electrical Engineer of Record shall review drawings and specifications that are produced by other disciplines in order to ensure compatibility and consistency throughout the design.

## 3.17 CIVIL AND STRUCTURAL DESIGN CRITERIA

The design shall take into account all applied loads including dead, live, dynamic, wind, snow, seismic, and other loading conditions where appropriate. Temporary loads during maintenance and erection shall be considered. Site conditions to be provided in accordance with [ insert contract document].

All structures and structural elements, including array structures, shall be designed in accordance with all applicable local and international building codes and standards pertaining to such structures.

All structural components, including array structures shall be designed in a manner commensurate with attaining a minimum 30 year design life. Particular attention shall be given to the prevention of corrosion at the connections between dissimilar metals.

All design drawings and specifications produced shall be sealed by a Professional Engineer licensed in civil or structural engineering and in the state where the Project is located. The Professional Engineer of Record shall review drawings and specifications that are produced by other disciplines in order to ensure compatibility and consistency throughout the design.

Steel structures shall be designed by either the allowable stress design (ASD) method or load and resistance factor design (LRFD) method. Reinforced concrete structures shall be designed by the ultimate limit state method.

- Wind Loads

  The Project design wind speed is required by the local authority having jurisdiction (AHJ). All structures shall be designed per the 2012 or most recent applicable International Building Code (IBC) with local amendments or as required by the AHJ based on Contractor's overall system design components, at no additional cost to Owner, but in all cases Contractor is ultimately responsible for system survivability.

- Site Flooding

  For ground-mounted system, the Project Site shall be designed to handle runoff from a 100-year storm. The drainage report provided will study and present the analysis of the 100-year storm event. The report should include the respective calculations, drainage exhibits and provides conclusions and recommendations of mitigation with respect to the 100-year stormwater flood inundation to the Project's electrical equipment and any site scour potential that could undermine any site foundations.

- Seismic Loads

  Structures shall be designed in accordance with the 2012 IBC and local amendments. Contractor shall determine the appropriate seismic design parameters for the Project Site based on 2012 IBC and design the foundations and structures accordingly. For module support structure design only, Risk Category II shall be utilized to determine the importance factor. The module support structure shall be able to operate after the seismic event it was designed for based on the criteria above.

Calculations documenting the design parameters and results shall be submitted for review and approval prior to construction of any systems in the field.

## 3.18 ENGINEERING COMPLETION

No less than 120 business days prior to commissioning activities, Contractor shall prepare and deliver to Owner an Operations and Maintenance (O&M) Manuals-Draft.

No less than 30 business days prior to commissioning activities Contractor shall prepare and deliver to Owner an Operations and Maintenance Manuals – Final (in accordance with Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables). Vendor will submit the O&M manual in hard copy and electronic form.

User manuals shall not substitute for System Descriptions. A complete System Description shall be provided by Contractor for all systems and related equipment.

## 3.19 DELIVERY, STORAGE AND HANDLING

### 3.19.1 Delivery

Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Agreement. These requirements also apply to any sub-suppliers making direct shipments to the jobsite.

Owner shall, from time to time and at their discretion, supply equipment, spare parts, special tools, and materials to the site. Contractor shall coordinate receipt of such items and shall apply all requirements set forth herein to those items.

Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Agreement by Contractor before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, commissioned, placed in operation and found to comply with all the specified requirements.

All items shall be checked against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay, at no additional cost to Owner when it is Contractor supplied.

Delivery of portions of the equipment in several individual shipments shall be subject to review of Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

### 3.19.2 Storage

Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work. It is assumed that all materials can be received and stored at the project site. If offsite storage is required, it shall be coordinated and approved by Owner. Contractor shall designate laydown areas and provide a laydown plan to ensure material is not damaged and construction activities are not impacted.

Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground. Galvanized steel with architectural purposes shall be stored with appropriate spacers to protect against galvanic discoloring. Galvanic discoloring is not applicable to ground mount array piles for which some discoloring is acceptable. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe, fittings, may be stored outdoors, but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

Motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F [16°C]. Electrical equipment, controls, and insulation shall be protected against wind, moisture, water damage, or induced electrical energy. Space heaters furnished in equipment shall be connected and operated appropriately to protect equipment from condensation.

Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be followed by Contractor.

Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

When applicable and reasonable, the packaging of spare units and spare parts shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

### 3.19.3 Handling

Stored items shall be laid out to facilitate their retrieval for use in the Work. Care shall be taken when removing the equipment for use to ensure the precise piece of equipment is removed and that it is handled in a manner that does not damage the equipment.

Shipping fixtures and containers shall be returned to avoid demurrage costs, as applicable. Contractor shall note the date of notification for pick-up and ensure parts shipped are all noted on the container packing list.

## 3.20 TRAINING

Contractor will develop and provide training to Owner personnel in the safe operation of Project equipment including but not limited to modules, inverters, electrical combiner system, and Substation.

Contractor will involve Owner’s personnel during Project start-up activities.

Contractor will provide training materials and manuals for all equipment provided by Contractor, to facilitate a smooth transition of operational responsibility from Contractor to Owner.

## 4.0 GEOTECHNICAL INVESTIGATION

### 4.1 GENERAL

The Project shall have a site-specific design level geotechnical investigation completed to evaluate the subsurface conditions and provide recommendations for design and construction of foundations for ground-mounted systems supporting solar arrays, as well as infrastructure listed in Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

### 4.2 DOCUMENT REVIEW

A document review shall be conducted consisting of available geotechnical and geologic documentation, as per Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

### 4.3 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, as per Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

### 4.4 GEOTECHNICAL EXPLORATION

The geotechnical exploration shall consist of soil borings performed across the site to assess the subsurface conditions. Soil borings shall be sufficiently spaced across the site in order for the collected information to be representative of the overall characteristics at the site. The number of soil borings shall be consistent with the current practice in the United States which is one soil boring for every 1.0 MW.

Samples shall be obtained using Standard Penetration Testing (SPT) split barrel samplers in accordance with ASTM D1586 in order to collect representative samples for soil classification and laboratory testing. Soil sampling shall be performed at about 2.5 ft intervals in the top 10 ft and at 5.0 ft intervals to the total boring depth. Soil boring depths shall extend to at least 15 ft or 125% of the anticipated depths of the foundation, whichever results in greater boring depth. The anticipated depth of the foundations is to be discussed with the designer and thus each boring should be advanced to a minimum depth below the ground surface covering the depth that can influence the foundation behavior.

The soil borings shall be advanced by use of rotary drilling equipment capable of penetrating large boulders and cobble layers, if encountered. Alternatively, the boring location may be moved in order to avoid an obstruction, as long as the minimum exploration depth is achieved, and the boring location is within 30 ft of the proposed

location provided by the Owner. In the case that shallow hard soils and/or bedrock formations are present and early drilling refusal is encountered, alternate exploratory methods shall be proposed to and approved by Owner, as recommended in Section 4.7.

Groundwater levels shall be observed and measured during and after drilling operations. Special techniques shall be used for groundwater measurement if drilling slurry is used to advance the soil borings.

### 4.4.1 Geophysical Testing

In the case that shallow hard soils and/or bedrock formations are present and early drilling refusal is encountered, geophysical testing methods, such as electrical imaging (EI) surveys, shall be considered in order to obtain the apparent stratification below the refusal depth. Electrical imaging surveys that consist of electrical resistivity measurements shall provide a picture of the subsurface resistivity distribution that can be compared with typical resistivity values for different types of subsurface materials and the geology of the area surveyed. Any alternate exploratory method shall be proposed to and approved by Owner.

## 4.5 GROUNDWATER CONSIDERATIONS

Refer to Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.6 GEOTECHNICAL LABORATORY TESTING

Refer to Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements.

## 4.7 SOIL CORROSION STUDY

The geotechnical investigation shall include a soil corrosion study for the project site to determine the potential to concrete chemical attack or corrosion risk to buried ferrous metals. The evaluation shall be performed on the basis of soil chemistry testing as well as minimum resistivity measurements. Results of the corrosion study shall include corrosion classification of the soils across the site, as well as service life calculations for the anticipated foundation elements indicating whether the foundation meets the design life indicated by the Owner. Service life at the selected piles for testing and expected reduction in net steel section properties owing to loss of material due to corrosion shall also be determined as part of the corrosion study.

## 4.8 PILE LOAD TESTING

A full-scale pile load testing program shall be included to evaluate the axial tensile (uplift) and lateral capacity and deflection of pile foundations. Uplift load testing shall be performed following ASTM D3689 (Standard Test Methods for Deep Foundations under Static Axial Tensile Load) with incremental sequence of applied loading in order to capture the load-deflection curves for evaluation of pile-soil behavior. Applied loading shall be performed to failure or 200% of design loads. Results of the load testing shall

be documented and generally indicate whether the piles are able to sustain uplift loads with no excessive deflection.

Lateral load testing shall be performed following ASTM D3966 (Standard Test Methods for Deep Foundations under Lateral Load) with incremental sequence of applied loading in order to capture the load-deflection curves for evaluation of pile-soil behavior. Applied loading shall be performed to failure or 200% of design loads. Results of the load testing shall be documented and generally indicate whether the piles are able to sustain lateral loads with no excessive deflection.

Aspects that can influence the pile-soil behavior shall be taken in consideration during the pile load testing program, including but not limited to:

1. Scour potential
2. Frost heave
3. Other aspects that may affect the pile resistance

In the case that uplift and lateral load tests are performed on a single pile per testing location, the Contractor shall consider uplift load testing to be performed before lateral testing, since lateral testing could impact the results of the uplift resistance.

Criteria for selecting the pile load testing location shall be based on the proposed array layout, wind zone maps developed for the array layout, hydrology study report and geotechnical exploration locations.

## 4.9 GEOTECHNICAL ANALYSES AND RECOMMENDATIONS

In addition to the geotechnical analyses and recommendations for ancillary and civil infrastructure indicated in Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements, recommendations specific to solar plants shall be provided in the geotechnical report for the following for incorporation into design of the Project:

1. Foundation design parameters for proposed PV systems and inverter facilities including:
    a. Foundation bearing capacity
    b. Axial capacity (skin friction and end bearing) for individual piles
    c. Lateral capacity for individual piles
    d. Foundation settlement (total and differential)
2. Pile drivability and/or excavation characteristics
3. Pile downdrag loading (negative skin friction), if applicable
4. Pile response to axial tensile and compressive loading, as well as lateral loading

## 4.10 ROAD DESIGN RECOMMENDATIONS

The geotechnical report shall provide recommendations for access roads, aprons, driveways and right of way permits are included in Contractor scope (whether inside or outside the fence) as required to connect with existing public roads. The vehicular

access will accommodate the type of vehicle and/or equipment that will reasonably be expected to need periodic access to the equipment locations; including but not limited to inverter installation/replacement, emergency vehicle access, module water washing trucks and maintenance vehicles. If required, fire department access shall be incorporate into the design.

Access roads and parking areas shall be designed and constructed to provide proper drainage and prevent erosion, washout, or potential for potholes. Access roads and parking space will be provided as indicated in the site plan and/or other Facility drawings. Array arrangement and access roads shall provide area for the operations and maintenance of the facility.

## 5.0 CIVIL AND STRUCTURAL REQUIREMENTS

### 5.1 GENERAL

It is the Contractor's sole responsibility to ensure the Project civil and structural facilities comply with all local code requirements and all industry codes and standards (including, but not limited to, those listed in Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards).

Contractor is responsible to determine all Site data necessary for the design and construction of the Project. This includes, but is not limited to, determination of local design wind speed, seismic design coefficients, flood design criteria, frost depth, and any areas restricted from construction.

Contractor shall perform all necessary hydrological and drainage studies of the Site to establish all required design-related parameters related to stormwater impacts including, but not limited to flood depths, 100-year flood limits, scour potential and flow velocity. The Contractor will provide a final hydrology report that provides a discussion on potential increased post construction permeability, scour potential and mitigation, flood depth elevation, C-value, descriptions of pre and post development basins and flows, FEMA flood zones, snow melt (if any), retention or overland flow recommendations, quantity control, on-site quality control, conveyance and end-of-pipe control, temporary and permanent sediment and erosion control recommendations, flow velocities, existing and proposed drainage structures, temporary and permanent sediment control structures and hydrologic volume calculations to assess the volume of total containment required within the transformer foundations, if applicable

Contractor shall perform all necessary subsurface investigations to establish all soil parameters for design of the Project. The Geotechnical study shall meet requirements of Section 4.0. GEOTECHNICAL INVESTIGATION.

Contractor shall comply with the recommendations of all Site studies performed.

Flood water depth and velocity must be accounted for in the structural design and layout of the system, to ensure all electrical equipment is at or above the 100 year flood

inundation elevations and that all scour potential has been accounted and mitigated for. All recommendations from applicable studies must be met.

Contractor shall develop all necessary design documents and plans and perform all Site preparation activities, including but not limited to grading, excavating, roadway access, installing drainage and storm water improvements, cutting and backfilling and demolition and removal of existing structures.

The Contractor shall provide all structural calculations and drawings to the Owner, with the 30%, 60%, 90% and 100% Design Documents.

The drawings and calculations to support the design of all structural elements shall include, but are not limited to:

1. Array rack mounting structures, array, and other equipment foundations where applicable.

2. Inverter pad foundations, MET stations foundations, transmission poles, fencing foundations, and any other ancillary structure foundations as dictated by Owner.

3. Product specifications, installation manual, operations and maintenance manuals and other commissioned or forthcoming reports.

The Owner and Owner's agent will review documents and submit comments. The Contractor shall address in writing any and all comments received from Owner.

## 5.2 STRUCTURAL STEEL AND FASTENERS

Steel members of any structural system shall be Grade 50 and meet the requirements of the applicable ASTM standard based on the application.

Stainless steel hardware shall conform to ASTM F593.

Mechanical fasteners used in any structural or support system shall meet the requirements of ASTM A325 or A490 for bolts nominally ½" diameter and larger, or ASTM A449 for bolts smaller than ½" diameter.

Anchor bolts used to secure any structural member to the ground or a foundation shall be galvanized and specifically identified by the structural engineer and include installation requirements, minimum projection, material grade, appropriate ASTM standard and torque specification. Anchor bolts shall conform to ASTM A449, ASTM F1554, Grade 36, or A307. Anchor bolt sleeves shall conform to ASTM A501.

All structural welding shall conform to the requirements of American Welding Society (AWS) D1.1.

## 5.3 ALUMINUM

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

Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308.

## 5.4 SITE DEVELOPMENT AND EARTHWORK

For ground-mounted system, environmentally and culturally sensitive areas shall be identified and protected during construction. Contractor shall comply with permits and instructions from the governing AHJs with respect to the required environmental and archaeological surveys. Contractor shall coordinate the grading activities with the onsite certified specialist(s) on a daily basis or as required by the local authority.

All earthwork shall be per the site’s Geotechnical Engineering Report’s recommendations. A third party materials testing program will be implemented in parallel with earthwork and structural operations.

All grading shall be per an agreed upon vertical tolerance prior to commencement of construction. An As-Built surveying verification program shall be coordinated and approved prior to construction.

All site preparation shall be per the Geotechnical Engineering Report recommendations, as required for installation of the specific site improvements within the construction drawings.

## 5.5 STRUCTURAL DESIGN REQUIREMENTS

### 5.5.1 Structural Design Loads

The design loads and other information pertinent to the structural design – including, but not limited to, wind design data, snow and snow drift design data and earthquake design data – shall be indicated on the construction documents.

Load combinations shall be determined in accordance with ASCE 7, Design Loads for Buildings and Other Structures, and from appropriate material codes. Load combinations found in the National Building Code that differ from those found in ASCE 7 and material codes shall govern over those found in ASCE 7 and material codes.

Dead loads shall include all gravity loads due to self-weight of permanent structural and nonstructural components, including permanent hung loads and ballast.

Wind loads shall be in accordance with the International Building Code, and the current edition of ASCE 7, as modified by any locally adopted code. The module rack shall be designed in such a way that deflections due to wind will not damage the modules.

Loading due to dynamic effects of wind and resulting wind induced vibration shall be incorporated into the design of the racking system.

Seismic loads shall be in accordance with ASCE 7, the International Building Code as modified by any locally adopted code. The Site classification of soil shall be determined by the Contractor based on the results of the subsurface investigation, which shall be performed by the Contractor.

Structural design shall account for thermal loads including thermal expansion, contraction and cycling. Buildings and structures shall be designed for forces and/or displacements resulting from changes in ambient temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.

### 5.5.2 Structural Design Calculations

The structural analysis shall conform to Applicable Standards, the IBC, ASCE 7, and local code amendments (including, but not limited to, those listed in Section 4).

Contractor shall provide a complete and comprehensive report demonstrating structural adequacy of the PV module mounting structures that considers all structural components, hardware, and connections, in a complete load path to the foundation. The structural analysis shall conform to the locally adopted code, using design loads determined according to ASCE 7, and shall be signed and sealed by an appropriately licensed Professional Engineer.

Structural systems and members thereof shall be designed to have adequate stiffness to limit deflections and lateral drift.

Structural analysis shall consider the static and dynamic effects of wind. Structural design shall not result in dynamic excitation of the structural system during wind events. The Project must resist wind loading without damage due to resonance or fatigue.

Contractor shall provide a test report from the racking supplier identifying critical mode shapes and natural frequencies of critical mode shapes based on appropriate boundary layer wind tunnel testing of the racking and module system. If lowest natural frequency is not greater than 4 Hz, Contractor shall provide additional analysis with consideration of wind induced vibration, to verify whether the mounting system could experience dynamic amplification of loads.

Wind and other environmental loads must be calculated for individual PV modules as well as all structural components in the System.

Worst-case wind loads on individual modules shall be calculated using an effective wind area of one PV module, unless testing can be provided by the racking manufacturer as evidence of increase effective area, and must not exceed the wind rating of the PV module.

Structural design calculations shall consider loss of material due to corrosion over the design life of the System.

## 5.6 DISPOSAL OF UNUSABLE SOILS

Excavated materials that meet standards for clean fill and are suitable for fills per the Geotechnical Engineer's recommendations shall be spread uniformly across the Project Site. These materials shall be graded and compacted so as to not interfere with proper drainage from the Project Site. Unused materials shall be disposed of away from the Project Site unless otherwise approved by the Owner.

## 5.7 PROOF ROLLING

Following stripping and rough grading, exposed surfaces are to be proof-rolled under observation by the Geotechnical Engineer of record to detect soft spots and assess sub-grade suitability for the proposed improvements.

## 5.8 EROSION CONTROL

Temporary facilities shall be provided for control of wind and water erosion and turbid runoff during earthwork and land disturbance operations and from graded areas until they are stabilized. Temporary facilities shall be acceptable to the proper AHJ. Contractor shall be responsible for obtaining any necessary erosion control and dust control Permits.

Permanent erosion control facilities for surface runoff as required for ditches and slopes, such as riprap, headwalls, grass, rock surfacing, and slope pavement shall be provided and be acceptable to the proper AHJ.

## 5.9 CORROSION PREVENTION

All Project Equipment shall be protected from corrosion due to known or expected atmospheric and soil conditions local to the Site in accordance with the Design Life and good industry practices. Consideration shall be given to humidity, salinity, acidity, condensation, air particulates and other conditions likely to cause or accelerate corrosion of materials.

A service life analysis shall be completed that takes into account atmospheric conditions at the Site in order to estimate corrosion rates. The service life shall meet or exceed the required minimum Design Life.

Structural design calculations shall be based on the reduction in steel thickness due to corrosion over the Design Life of the Project.

Contact of dissimilar metals and finishes shall be avoided or intentionally managed to prevent premature galvanic corrosion. Aluminum shall not be in direct contact with concrete or copper.

Support structure components in contact with soil shall be protected from detrimental subsurface corrosion for the Design Life of the Project.

Fasteners and hardware shall be stainless steel (300 series, if available with required mechanical strength) or hot-dipped galvanized steel.

Galvanizing of steel products shall conform to the requirements of ASTM A123, ASTM A153 or ASTM F2329, as appropriate.

For any components where the galvanization is disturbed due to factory processing or during installation, those surfaces shall be repaired in accordance with ASTM A780 and A780M-09.

## 5.10 ROAD ACCESS

All access roads, aprons, driveways and right of way permits are included in Contractor scope (whether inside or outside the fence) as required to connect with existing public roads unless otherwise specified. Access roads or access routes shall be provided to all major equipment located on the Site. Design of all access roads shall be in accordance with the site permits and Applicable Laws and Governmental Approvals.

Vehicular access roads shall be large enough for a crane and a flat bed truck to access and remove inverter station/skid. Such access shall extend to any pad mounted Equipment. Setbacks and access shall meet all code (including applicable fire code) and safety requirements. Contractor shall ensure that critical Equipment components are mounted zero (0') above 100-year flood inundation elevations or as required by Applicable Laws and project permits and Government Approvals, whichever is higher.

## 5.11 DUST CONTROL

Contractor shall be responsible for dust control during construction operations and shall adhere to all applicable codes and requirements of the governing AHJ(s). Water shall be used to control dust as required. Dust palliatives if allowed by applicable law and applicable permits shall be used to control dust on all unpaved roads and any other non-vegetated areas as necessary to comply with the project's dust control plan or environmental permits.

## 5.12 EXISTING UNDERGROUND FACILITIES

Contractor shall be responsible for identification, protection, redesign, relocation, or removal of underground lines, services, obstructions, or other facilities present at the Project Site. Contractor shall contact underground service alert for location of underground utilities at least 48 hours prior to commencement of construction – phone (Dial 800-332-2344) or 811. Contractor shall verify all existing utilities prior to beginning of any work on the Project Site.

## 5.13 EXCAVATION

Contractor shall be responsible for dewatering and shoring of excavation works.

All excavation shall be carried out and supported in such a manner as to prevent flooding or ponding of water and damage or interference to structure services, or stored equipment/materials.

The Work shall include removing and disposing of unsuitable materials, such as organic matter, from areas on which fill is to be placed, and excavating and deposing of materials from area where existing grade is to be raised. Unsuitable material will be disposed of properly, as defined by the governing AHJ. Grading of cuts, fills, and drainage ditches shall be provided as required within the approved construction drawings.

## 5.14 TRENCHES

Cables and conduits installed in trenches shall comply with NEC requirements and shall be supported by ampacity studies (as required). Trenching under arrays shall be minimized wherever possible.

Directly buried cables shall not directly cross, rest or touch adjacent cables, except in a single circuit tri-foil arrangement.

Directly buried cables shall have a minimum of 4” of soil or approved backfill material between layers.

All buried cables and conduits shall include a marker tape 12” below grade continuously over the conductors. Trenches wider than 36” shall have two parallel marker tapes.

Trench backfill shall comply with the recommendations of the engineering studies.

Trench shall be backfilled with clean fill material free from aggregate, debris, organic material and stones. An engineered fill shall be used if required based on the cable ampacity calculations.

Trenches shall be backfilled in layers of no more than 6” each and mechanically compacted to 95% of maximum density at optimum moisture content per ASTM D698, or as recommended by the geotechnical engineer.

Contractor shall take appropriate measures to minimize the time that trenches are left open.

Trenches shall not be backfilled while there is any standing water in the trench.

Contractor shall inspect and repair sand beds in open trenches after rainfall events.

Conduit stub-ups and sweeps shall be used for all conductors entering and exiting a trench.

Open conduit ends shall be equipped with bushings or bell-ends and approved sealant to reduce intrusion of water, rodents and insects.

Trenches shall be designed and constructed, to the extent possible, in straight lines and not routed below Project Equipment.

## 5.15 GRADING

Finish grading at the Project Site shall be sloped to deter surface ponding and promote positive surface drainage away from equipment and structures and to provide release. Grading within the PV arrays shall meet the requirements specified by the Geotechnical recommendations and the manufacturer of the module mounting system. All grading and drainage shall be per the approved civil engineering plans.

## 5.16 FILL

Fill materials at a minimum must meet Oregon standards for clean fill or local standards if more stringent. Fill cannot contain any hazardous materials and shall be suitable for the intended purpose and shall not include materials susceptible to swelling or shrinkage under changes in moisture content.

Areas to be backfilled shall be prepared by removing unsuitable materials. The bottom of excavations shall be examined for loose or soft areas. Such areas shall be excavated fully backfilled with compacted fill.

Areas below foundations shall be over excavated to the depth below the bottom of foundations specified by the Geotechnical Engineer and backfilled with approved engineered fill. Areas below pavement shall be over excavated to the depth below the bottom of pavement specified by the Geotechnical Engineer and backfilled with engineered soil type A-2 or better (AASHTO Soil Classification System).

Backfilling shall be done in the layers of uniform thickness of six (6) to eight (8) inches or as recommended by the Geotechnical Engineer. Soil in each layer shall be properly moisture conditioned to facilitate compaction to achieve the specified density, within -2 percent to +4 percent of optimum moisture content or as directed by the Project Geotechnical Engineer. In order to verify compaction, representative field density and moisture-content tests shall be taken during compaction.

Granular load-bearing backfill shall be sound, durable coral rock; crushed rock; clean sand; and/or gravel.

Selected suitable backfill material shall be approved material in accordance with the soils report, and shall not contain organic material or rocks larger than three (3) inches. Contractor is responsible for verifying acceptability of excavated soils for fill and for providing suitable fill material from other sources.

Trench bedding material shall be clean sand, as required. If suitable for use, Contractor may use excavated material for trench bedding.

Where it is necessary to remove only a portion of the unsuitable materials and backfill, the backfilling operation shall begin by stabilizing the existing materials to enable proof rolling or normal construction equipment to operate thereon.

## 5.17 COMPACTION

Compaction of fill materials shall be carried out as soon as practicable after deposition of fill materials. Fill shall be compacted to the densities appropriate to the design requirements, fill type, and depths of layers.

Structural fill supporting foundations, roads, and parking areas shall be compacted to a minimum of 95 percent of the modified proctor maximum dry density, in accordance with ASTM D1557, or as specified by the Geotechnical Engineer. Embankments, dikes, and backfill surrounding structures shall be compacted to a minimum of 95 percent, or as specified by the Geotechnical Engineer. General backfill shall be compacted to at least 95 percent, or as specified by the Geotechnical Engineer.

## 5.18 SOLAR ARRAY FOUNDATION

Type of foundations required and allowable bearing values for soil and rock shall be as recommended by Contractor's Geotechnical Engineer based on the subsurface conditions found in the Geotechnical studies.

Contractor shall use a mounting structure to mount the PV Modules. Racking design shall be capable of adapting to the Site topography to minimize required earth movement.

The PV Module mounting structure supplier shall approve Contractor's design and installation to ensure that the mounting structure warranty remains in effect.

For ground-mounted projects to be constructed in locations with expansive soil, consideration shall be given to uplift pressures during the wet season as well as increased neglected depth owing to possible loss of soil/foundation contact during the dry season.

For steel pile foundations – including driven or vibrated piles, helical piles, or ground screws – field tests shall be performed to determine final capacity. The test program and final report shall be prepared under the responsible charge of an appropriately registered or licensed Professional Engineer.

1. Axial tension tests shall be conducted in conformance with ASTM D3689.

2. Axial compression load tests shall be conducted in conformance with ASTM D1143.

3. Lateral load tests shall be conducted in conformance with ASTM D3966.

4. An appropriate Factor of Safety in accordance with industry standards of practice shall be determined by the engineer of record and incorporated into the design of the foundation system.

For cast-in-place concrete foundations, all loose material shall be removed from excavation bottoms.

## 5.19 CONCRETE EQUIPMENT FOUNDATIONS

Design of structural concrete shall be in accordance with the latest version of the American Concrete Institute (ACI) 318. All concrete formwork shall conform to ACI 347.

Construction of the concrete shall be in accordance with ACI 301.

Steel reinforcement shall be grade 60 minimum and conform to ASTM A615. Welded steel mesh shall conform to ASTM A185. Plain wire shall conform to ASTM A82. Placement shall be in accordance with Chapters 7 and 12 of ACI 318 and the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.

Concrete shall conform to ASTM C150 with a 28 day compressive strength of 4,000 psi (27.5 MPa) minimum.

Aggregates for normal weight concrete shall conform to ASTM C33.

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

Water used for concrete shall be clean and potable.

## 5.20 SITE RESTORATION

Contractor shall restore all areas that have been disturbed during the Work by replanting and seeding in conformance with the requirements of any Permits, Project Agreements, and revegetation plans, including the 1200c-approved Storm Water Pollution Prevent Plan (SWPPP) or Sediment and Erosion Control Plan and Project Site grading plan. The seed mix and plant species are to be approved by Owner prior to re-seeding. Restoration shall be in accordance with the Permits and planning and environmental constraints on the Project. Restoration seeding must occur during the first optimum seeding window for the location and before the final completion of all construction activities. Contractor is responsible for monitoring and maintaining site vegetation for one year after construction, including re-seeding of any areas where the initial seeding is unsuccessful.

## 5.21 TESTING AND INSPECTIONS

A program shall be utilized for testing soils during earthwork and when underground Services and foundations are installed. The program shall include the following:

In-place representative field density tests shall be performed, at the frequencies specified below or as approved by the Geotechnical Engineer of Record, in accordance with ASTM D2922. The following frequencies shall be increased in areas where apparent difficulties exist:

| Fill Class | Testing Area | Frequency / Cubic Yards per Test |
|---|---|---|
| A | Structural Fill and Foundation Subgrades | 250 (or 1600 $ft^2$ of each lift, once per work shift, or one per foundation, whichever is more frequent) |
| B | Backfill Surrounding Structures | (Same as Class A) |
| B | Roads, Shoulders, and Parking Lots | 650 |
| C | General Backfill | 1800 |

If a compacted area fails to meet the specified compaction requirements, two additional tests shall be performed for that area. If the results of either of the two additional tests prove unsatisfactory, the area shall undergo additional compaction and testing until test results meet the minimum compaction requirements.

Records of inspection and testing of soils to ensure compliance with design assumptions shall be turned over to Customer and shall comply with Prudent Industry Practices and the requirements of applicable Law and the local authority regarding notification and inspection.

Testing and inspections of structures shall be in accordance with the state building codes and other licensing requirements.

Concrete test cylinder sets shall be taken at the minimum rate of one set per day, but not less than once for each 150 cubic yards for slabs, foundations, or walls. Concrete test cylinder sets for paving shall be taken at the minimum rate of one set per day, but not less than once for each 150 cubic yards, nor less than once for every 5,000 square feet. As a minimum, one set of cylinders shall be taken for each equipment foundation, with the exception that one set of cylinders may be made for each concrete truck load where multiple small foundations are poured from a single load. Test procedures shall

be in accordance with the appropriate ASTM standards. Copies of test data shall be provided to the Owner.

In the case that mill certificates indicating the mechanical and chemical properties of the structural steel used for the Project are not provided, Contractor shall utilize a system to validate type and grade of high-strength bolts by sampling and metallurgical testing. A testing program of high-strength bolts and nuts shall be conducted by Contractor to ensure that each bolt shipment meets the appropriate ASTM standards for dimensional tolerances and material quality.

## 6.0 ELECTRICAL BALANCE OF PLANT

The Electrical Balance of Plant (EBoP) shall keep all Equipment electrically energized (except under fault conditions or for maintenance) and collect the output of the Equipment and transfer it to the Point of Interconnection (POI).

The design of the EBoP by Contractor shall:

1. Be for high reliability and efficiency;
2. Be compliant with Interconnection Agreement requirements; and
3. Allow safe operation and maintenance.

### 6.1 GENERAL

The Solar Power Plant shall integrate seamlessly with and be fully compatible with the Transmission Service Provider (TSP) interconnection facilities at the POI, including any required communications links.

The POI will be defined in the Interconnection Agreement

Medium Voltage junction boxes shall be located at accessible, safe locations and bollards shall be specified as needed.

### 6.2 TRANSMISSION SERVICE PROVIDER AND INTERCONNECTION AGREEMENT

Contractor shall ensure that the EBoP and components supplied under the EBoP comply with Interconnection Agreement requirements.

Contractor shall undertake studies, prepare a modelling package, information and technical reports that confirm compliance with Interconnection Agreement requirements.

## 6.3 ENVIRONMENTAL CONDITIONS

The Solar Power Plant electrical system, including equipment selection, design and installation, shall be suitable for all environmental conditions expected at the Site, including those as defined in Section 3.3 and, without limitation:

1. Normal and abnormal voltages and currents, and
2. Lightning.

It shall remain Contractor's responsibility to satisfy themselves of the appropriate environmental conditions and to supply equipment that is suitable for operation under those conditions.

## 6.4 MATERIALS AND SUPPLIERS

The Solar Power Plant Electrical System shall consist only of new, un-used equipment made from the highest quality materials and components.

All electrical plant materials shall be sourced from reputable suppliers, consistent with Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers, that are accredited to recognized manufacturing quality systems.

## 6.5 SAFETY AND POWER BLOCK ISOLATION

It shall be possible to locally isolate, de-energize each power block transformer without de-energizing others.

Transformers shall have load-break disconnect switches operable from outside any arc-flash hazard.

## 6.6 ECONOMIC OPTIMIZATION

All components of the Solar Power Plant Electrical system shall be designed by Contractor to minimize electrical losses, as far as is economically advantageous.

Wherever applicable, cable sizes shall be determined in accordance with IEC 60287-3-2 Economic Optimization of Power Cable Size, the NEC, and within the constraints imposed by other limitations such as voltage drop, fault ratings, thermal ratings, and common conductor sizes or insulation types already in use by the Owner.

Notwithstanding the above, the electrical system shall be designed to ensure that electrical losses are minimized as far as economically advantageous and that as a proportion of the total Solar Power Plant generation, over an average year and measured between the Solar Power Plant POI and the sum of the outputs of all the Equipment, shall be less than 2.5%.

## 6.7 PROJECT SUBSTATION

Project substation shall be in accordance with Appendix G1 Attachment 05 Exhibit 03 – Substation Design and Construction Specification.

## 6.8 AC COMBINER CIRCUIT SYSTEM

### 6.8.1 General

1. The Project electrical combiner circuit system shall be buried. Overhead circuits may be permitted with Owner approval.
2. The electrical combiner circuit system will include power and communications cabling in the same trench. See Appendix G1 Attachment 05 Exhibit 04 – Communication Facilities for additional fiber optic specifications.
3. Cable ring out, termination and tagging shall be in accordance with Owner supplied requirements and shall be performed at the time the installation work is performed.
4. The layout of the electrical combiner circuit will follow existing or new roads wherever possible, but not in contradiction to economic optimization as described in Section 6.6.
5. Trenches will be free of water, firm throughout, and of a minimum dimension to facilitate cable installation
6. Backfill will be compacted to 95 percent (95%) of standard proctor density, unless alternatively specified by the Geotech engineer.
7. Blasting for the combiner circuit system trenching is not permitted without authorization from Owner.
8. Studies to be completed as part of Project electrical combiner system design will include, at a minimum, those listed in Appendix G1 Attachment 04 Exhibit 01 – General Electrical Study Requirements and the following:
    - Transient overvoltage and insulation coordination (if necessary)
    - Voltage drop study
    - Thermal design analysis of cable ampacity considering the following assumptions:
        - Trefoil cable installation
        - 25ºC Ambient soil (used for cost estimate only and shall be updated based on site specific available data and analysis)
        - 200 rho (used for cost estimate only and shall be updated with actual measured value from the Geotech report)
        - 48 inches burial depth to top of cable (used for cost estimate only and shall be updated with actual value)
        - 90ºC rating
        - 60% load factor
        - 90% compaction (95% compaction results required in construction to provide margin)
    - Studies shall be completed and submitted in document form, with files native to the software utilized for any simulation, modeling, or studying.

### 6.8.2 Medium Voltage AC Power Cable (AC Combiner Circuit System)

AC combiner circuit system cables shall meet the following requirements:

1. Conductor size and ampacity shall be coordinated with circuit protective devices.

2. Combiner circuit system 34.5 kV cable shall be rated 35 kV, direct buried aluminum conductor with copper concentric neutral. Alternative combiner circuit system voltage shall require Owner approval.

3. All central conductors shall be Class B stranded. No more than one (1) conductor per cable shall be allowed. Conductor material shall be aluminum or copper.

4. Cables shall conform to ANSI/ICEA S-94-649, AEIC CS-8, and RUS U-1.

5. Conductors shall be insulated on the basis of a normal maximum conductor temperature of 90° C in 40° C ambient air, with a maximum emergency overload temperature of 130° C and a short-circuit temperature of 250° C.

6. AC combiner circuit cables shall be rated at for 35kV with 100 or 133 percent TR-XLPE or EPR insulation, MV-105 copper or aluminum conductor, tape shield or concentric neutral, with an overall outer jacket suitable for direct burial. that meets or exceeds all requirements of applicable AEIC, IEEE, ICEA, NEMA, and UL standards.

7. Medium voltage power cable shall be installed in conduits, direct buried PVC conduit, direct buried or underground concrete-encased duct banks.

8. Medium voltage power cable phases shall be maintained in a trefoil configuration in all trenches and conduits. Cross-bonding the cable shields may be allowed as a supplement to, but not a replacement for, the trefoil configuration. Direct buried cables are not acceptable under concrete slabs, buildings, PV access roadways (not array access roadways), or other permanent structures.

9. Cable trefoil configuration shall be maintained by use of zip ties or suitable tape in accordance with manufacturer recommendations and Owner approval, placed at 10 foot maximum intervals.

10. Bedding: Approximately 6 inches of < ¼ inch native bedding (or thermal backfill if required), and twelve (12) inches of < ¼ inch native (or thermal backfill if required) soils shall cover the combiner circuit fiber optic and cable bundle and shall be screened/visually inspected for materials in excess of two (2) inches. Bedding material shall be free of debris, roots, or other deleterious material unsuitable for use within the cable trench. A continuous metallic marking tape shall be laid in the trench a minimum of thirty (30) inches below grade, and at least twelve (12) inches above cable bundle in all cultivated areas.

11. Sufficient slack shall be provided at termination points to allow two future terminations. Establishing slack via coil under the padmount transformer or junction box, in a plenum or vault, is preferred.

12. Cable bending radius shall not be less than NEC and cable manufacturer requirements.

13. Directional drilling bores are allowed for crossings.

14. Cable markers shall be placed at all road, utility and waterway crossings.

15. Combiner system conductor shall be rated for a maximum temperature of 250°C (short-circuit current rating).

16. Combiner system components shall be rated for a basic impulse level (BIL) of 200 kV.

17. In general, for medium voltage power cable using bare copper concentric neutral under jacket, the following guidelines shall be used unless design calculations indicate otherwise:

18. Conductors smaller than 500 kcmil - full neutral
19. Conductors at 500 kcmil - 1/3 neutral
20. Conductors larger than 500 kcmil - 1/6 neutral

21. Tape shield may also be used, unless design calculations indicate otherwise.

22. Medium Voltage Splices

23. Medium voltage splices shall be enclosed in a vault or junction box. There shall be no direct-buried splices. If vaults are used, incoming medium voltage cable from each end shall loop once around the enclosure before splicing.
24. Splice kits shall have a voltage rating that meets or exceeds the voltage rating of the medium voltage cable. Splice kits shall be cold shrink, inline, compression or crimp type, suitable for MV-105 cables. Hot shrink kits are not acceptable.
25. The cold shrink splice body shall be a one-piece molded design made of formulated silicone rubbers.
26. The cold shrink jacket shall be made of EPDM rubber for physical protection. The minimum BIL rating shall be appropriate for the voltage class and meet or exceed the requirements of ANSI/IEEE Standard 404.
27. Splice kits shall be rated for continuous operation at 105° C and an emergency overload of 140° C.
28. Splice kits shall be TE, 3M, or approved equal.
29. Splice-points shall include a capacitive test point and allow means of establishing a ground point with hot-stick applicable accessories. Any splice-point terminations rated over 200A, shall also employ integrated 200A bushing with dust cap, accessible for grounding. All splices and terminations at junctions, pad mount transformers are to be made by experienced personnel, with manufacturer

refresher training on site at beginning of job, with training certificates made part of QA/QC job books.

30. Terminations for cable onto transformer primary bushings or switchgear shall be made with 200 A minimum EPDM type elbows complete with junction modules, bushing inserts, parking stands, grounding wells, bushings, protective caps, standoff insulators, and other necessary accessories suitable for use with subsurface or pad-mounted installations, submersible to 10 feet of water. Termination kits shall be TE, or approved equal.

31. AC combiner circuit system cabling shall be sized to not exceed the “X” percent maximum voltage drop used in the energy production models. If NO value is provided, do not exceed 1.0 percent maximum voltage drop.

### 6.8.3 Inverter AC Power Cable (inverter output to step-up transformer, auxiliary power)

AC cables connecting inverters to step-up transformer, or for auxiliary power, shall meet the following requirements:

1. Copper conductor, copper busduct or copper bus bar.

2. All power and control cables shall be UL listed.

3. Cables shall be routed in UL listed wireway, conduit, direct buried PVC conduit, or underground duct banks, as required.

4. A maximum of 3 percent ac voltage drop is acceptable in other ac circuits not associated with solar power production.

5. Less than 600 VAC applications

    a. Cable insulation levels shall be rated 600 VAC.
    b. Conductors installed in PVC conduit are acceptable.
    c. Low voltage power cables for loads up to 480VAC and control cables (i.e., 120VAC) shall have copper conductor with 600 volt-class insulation.
    d. Power cables shall be Type XHHW-2 with concentric-lay, uncoated copper, strand B conductor, rated for normal maximum operating temperature of 90° C in wet and dry applications, cross-linked thermosetting polyethylene insulation, and conforming to ICEA S-95-658 (NEMA WC 70).

6. Between 600 VAC and 1000 VAC applications

    a. Cable insulation levels shall be rated 1000 VAC.
    b. Conductors installed in PVC conduit are acceptable.
    c. Insulation and jacket materials on all conductors, regardless of location, shall be made from thermoset materials such as XLPE. No thermoplastic

insulation or jacket materials are permitted for conductors. Cable insulation type shall be rated for wet locations, and have a temperature rating of 90° C or better.

7. In cases where inverter output voltage may exceed 1000VAC, a 2000VAC insulation rating is required.

### 6.8.4 Load break circuit switches

Load-break circuit switches shall be provided at each sub-circuit or major branch to isolate major sections of the combiner circuit system in the event of a cable fault or inverter issue, and should be located at every “major” cable system intersection. All load-break circuit switches shall provide means of visibly observing the open/closed state.

### 6.8.5 AC combiner system sectionalizing junction boxes

Junction boxes used are to meet the following requirements at a minimum:

1. Rated Voltage: 35 kV.
2. Number of Phases: 3.
3. Enclosure to accommodate 3-600 ampere dead break elbows per phase.
4. Door: Top hinged, removable, with wind resistant door stop.
5. Cabinet: Fiberglass.
6. Locking Arrangement: Recessed pocket with pentahead bolt and padlock hasp conforming to ANSI C57.12.28.
7. Grounding: Factory installed ground bar or 4/0 bare copper ground wire.
8. Parking Stands (if required): One per phase adjacent to module brackets.
9. Anchoring: Minimum 1-inch bottom flange.
10. Finish: Gel coated on exterior capable of resisting weather and sunlight. Olive green color.

### 6.8.6 Surge arrestors

Surge arrestors shall be fully shielded, submersible, dead-front devices rated at 35-kV class, 600A, 30kV/24.4MCOV and meeting the requirements of ANSI C62.11 for Station Class installation in a 60-Hertz outdoor installation.

### 6.8.7 Grounding (medium voltage AC combiner circuit system)

Medium voltage AC combiner circuit system grounding cables shall meet the following requirements:

1. A minimum of 2/0 AWG bare or coated copper grounding conductor, in non-corrosive soils, shall be installed in the same trench, conduit, or raceway as the AC combiner circuit cables.

2. In corrosive soils, an appropriate ground (e.g., insulated cable or tinned copper grounding conductor) shall be used in place of the bare copper grounding conductor.

### 6.8.8 Power and Control Wiring

Cables shall be selected with an insulation level applicable to the system voltage for which they are used and ampacities suitable for the load being served. The type of cable used shall be determined by individual circuit requirements, temperature, and individual equipment manufacturer's recommendations. Current carrying conductors shall be copper. All exposed wiring shall be clearly indicated as sunlight or UV resistant.

## 6.9 SOLAR PV BALANCE OF SYSTEM (BOS)

### 6.9.1 Grounding

Grounding shall be designed and provided as required by NEC, NESC, IEEE, and local code requirements. In addition, specific requirements are listed below:

Ground grids or ground loops shall be provided under/around major electrical equipment (step-up transformers, medium voltage switchgear, inverters, etc.).

The grounding system shall consist of bare copper conductor and copper-clad steel or stainless steel ground rods.

The system shall be designed to protect Project personnel and equipment from the hazards that occur during power system faults and lightning strikes.

Conductors utilized for grounding shall be appropriate for the Project Site's soil conditions.

Contractor shall design the station grounding grid for adequate capacity to dissipate heat from ground current under the most severe conditions in areas of high ground fault current concentrations, and in such a way that it is possible to maintain grid spacing to achieve safe voltage gradients.

For ground grids below grade, each junction of the grid shall be bonded with exothermic welds.

Major items of equipment such as inverters and transformers shall have integral ground buses connected to the station ground grid.

Perimeter fencing shall be included in the grounding study and shall be grounded as necessary.

Contractor shall route a grounding conductor parallel to all power conductors operating above 208Y/120 volts.

For grounded DC systems (inverter type determines), the module dc system grounding electrode(s) shall be common with, or bonded to, the ac grounding electrode as indicated in NEC Article 690.47. Module grounding shall be in compliance with module manufacturer recommendations and warranty requirements for grounding. Utilizing racking for grounding shall be acceptable as long as the racking is listed for such application.

Contractor shall perform grounding calculations in accordance with IEEE standards and submit to Owner for verification that step and touch potentials are within the acceptable limits. Design shall also conform to IEEE Standard 80. Contractor shall determine the values used in the calculations through testing and shall not use typical values or estimates.

All materials required for a complete grounding installation shall be furnished. Grounding components shall include ground rods, ground conductor, ground bus, above and below grade grounding connections, grounding lugs, and any other hardware required for a complete grounding system.

Suitable grounding facilities shall be furnished on electrical equipment not so equipped. The grounding facilities shall consist of compression type terminal connectors bolted to the equipment frame or enclosure.

The conduit system is not considered to be a grounding conductor. No equipment grounding conductor shall be smaller in size than 6 AWG, unless it is a part of an acceptable cable assembly.

If ground reference transformers are required by study, they shall conform to Owner design standards. This includes, but is not limited to:

1. Zig-zag vectoring

2. Current-carrying rating of 300A per phase conductor for 10-seconds

3. Current-carrying ratting of 900A in the neutral-ground conductor for 10-seconds.

Ground rods shall be copper clad, cold drawn carbon steel, manufactured in accordance with UL 467. The copper cladding shall be electrolytically bonded to the steel rod or bonded by a molten welding process. Individual ground rods shall be 5/8 inch minimum diameter and 10 feet long. Stainless steel ground rods shall be installed where soils conditions are considered to be corrosive or cathodic protection invoked for preservation of materials. Ground rods shall be Type ERITECH as manufactured by Erico, or an equivalent approved by Owner.

### 6.9.2 Grounding (medium voltage AC Combiner Circuit System)

Bare ground conductor 2/0 or 4/0 AWG and larger shall be soft drawn, stranded copper conforming to the requirements of ASTM B-8. Insulated ground conductor shall be soft drawn, stranded copper conforming to the requirements of UL 83. Insulated ground conductor shall be Type TW or THW having green colored PVC insulation.

### 6.9.3 Conductors

1. Exothermic Connections

    a. Exothermal connections shall be a standard duty copper molten weld conforming to the requirements of IEEE 80. Molds and powder cartridges used for making exothermal connections shall be furnished by the same manufacturer. Exothermal connections shall be similar to Type CADWELD as manufactured by Erico, or an equivalent approved by Owner.

2. Ground Lugs

    a. Ground lugs shall be single hole or two-hole, compliant with NEC based on the application, and compliant with the commissioning criteria for dissimilar metals. Copper bars conforming to the requirements of IEEE 837 and UL 467. Ground lugs used with the exothermal weld process shall be similar to Type LA as manufactured by Erico, or a Owner acceptable equal. Ground lugs used with the compression process shall be similar to Type YGHA as manufactured by Burndy Electrical, or an Owner acceptable equal.

3. Grounding Installation

    a. Grounding system components shall be installed as required by IEEE, NEC, NESC and applicable local codes.

4. Ground System Resistance Measurements

    a. All ground resistance measurements shall be made in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

5. DC source circuit cables (module to module or combiner box)

    a. All DC circuit cable testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

6. DC output circuit cables (combiner box to inverter)

    a. All DC circuit cable testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

7. AC Power Cables (inverter output to step-up transformer, auxiliary power)

    a. All AC circuit cable testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

8. Medium Voltage AC Power Cable (AC Combiner Circuit System)

    a. All insulated power cables rated 5000 volts and above shall be tested in accordance with the Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing document.

### 6.9.4 DC Source Circuit Cables (module to module or combiner box)

DC cables connecting modules to modules and modules to combiner boxes shall meet the following requirements:

1. DC cables shall be sized in accordance with the NEC requirements for “Solar Photovoltaic Systems” (Article 690) and shall be rated according to the maximum system voltage. Contractor shall be required to seek variances from the local jurisdictions as necessary for 1500V system.

2. Conductors shall be sized accordingly taking into account any ambient temperature or ampacity de-rate factors and voltage drop considerations. DC cabling (including both source circuit and output circuit cabling) shall be sized to not exceed a maximum voltage drop of 1.5 percent at Standard Test Conditions.

3. Copper “PV Wire” is required for dc string and harness cables.

4. Conduit (flexible or rigid) shall be used for transitions “entering” and “exiting” the cable trench to meet NEC 300.5(D) requirements.

5. DC conductors installed in PVC conduit are acceptable.

6. Cable insulation levels shall be rated according to the maximum PV system voltage.

7. Insulation and jacket materials on all dc conductors, regardless of location, shall be made from thermoset materials such as XLPE or EPR. No thermoplastic insulation or jacket materials are permitted for dc conductors. Cable insulation type shall be sunlight resistant, rated for wet locations, and have a temperature rating of 90° C or better.

### 6.9.5 DC Output Circuit Cables (combiner box to inverter)

DC cables connecting combiner boxes to inverters shall meet the following requirements:

1. Conductors shall be sized accordingly taking into account any ambient temperature or ampacity de-rate factors and voltage drop considerations. DC cabling (including both source circuit and output circuit cabling) shall be sized to not exceed a maximum voltage drop of 1.5 percent at Standard Test Conditions.

2. Conduit (flexible or rigid) shall be used for transitions “entering” and “exiting” the cable trench to meet NEC 300.5(D) requirements.

3. Copper or aluminum DC conductors installed in PVC conduit and/or direct burial are acceptable.

4. Cable insulation levels shall be rated according to the maximum PV system voltage.

5. Insulation and jacket materials on all dc conductors, regardless of location, shall be made from thermoset materials such as XLPE. No thermoplastic insulation or jacket materials are permitted for dc conductors. Cable insulation type shall be rated for wet locations, and have a temperature rating of 90° C or better.

### 6.9.6 Auxiliary Power Cables (lights, receptacles, computers, tracker motors and controllers, PLC, heating/ventilation)

Auxiliary power cables shall meet the following requirements:

1. Auxiliary power cables for loads up to 480 VAC and control cables (i.e., 120 volts ac) shall have copper conductor with 600 volt class insulation.

2. All power and control cables shall be UL listed.

3. Cables shall be routed in UL listed wireway, conduit, direct buried PVC conduit, or underground duct banks, as required.

4. A maximum of 3 percent ac voltage drop is acceptable in other ac circuits not associated with solar power production. The maximum voltage drop shall always be confirmed to against connected equipment’s voltage operating range to ensure proper operation.

5. When not supplied by the manufacturer of the connected equipment, power cables shall be Type XHHW-2 with concentric-lay, uncoated copper, strand B conductor, rated for normal maximum operating temperature of 90° C in wet and dry applications, cross-linked thermosetting polyethylene insulation, and conforming to ICEA S-95-658 (NEMA WC 70).

### 6.9.7 Control Cables (alarms, contacts, etc.)

Control cables shall meet the following requirements:

1. Shall be 600 Volt Type TC, UL VW-1 flammability rating, multi-conductor, copper tape (corrugated or helically applied) shielded, copper cable with EPR or XLPE insulation and CSPE, CPE, or jacket, rated for normal maximum operating temperature of 90° C dry and 75° C wet applications. Conductor size shall be determined by the Engineer; however, in no case shall conductor smaller than #12 for control circuits and #10 for CT circuits be used.

2. Control cables shall be terminated with uninsulated ring-lugs, where applicable.

### 6.9.8 Analog Instrumentation (analog signals)

Cables for analog instrumentation shall meet the following requirements:

1. Twisted Shielded Pair type

2. 16 AWG seven-strand

3. Concentric-lay

4. Uncoated copper conductor

5. Rated for normal maximum operating temperature of 90° C dry and 75° C wet applications

6. EPR or XLPE insulation not less 15 mils average thickness

7. Twisted pair of 1-1/2 inch to 2-1/2 inch (38.10 mm – 63.5 mm) lay

8. Shield consisting of combination aluminum-polyester tape and seven-strand #20 AWG minimum tinned copper drain wire

9. With shield applied to achieve 100 percent cover over insulated conductors

10. Jacket thickness of 4 mils minimum

11. Conductor color identification with one black conductor and one white conductor

12. Conforming to UL 62 for Type TFN, and UL 1277 for vertical-tray flame test requirements.

### 6.9.9 Category 6 Cable (communications and analog signals)

Category 6 cable shall meet the following requirements:

1. Sunlight, oil, and gas resistant

2. Industrial grade
3. 4 bonded pairs, #22 AWG
4. Solid copper conductor
5. Polyolefin insulation
6. Black PVC jacket, 0.03 inches
7. UL listed
8. Operating temperature of -25° C to 75° C

## 6.10 SITE SECURITY SYSTEM

Contractor shall provide a security system for the Project Site that meets requirements of Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

The Project Site shall be enclosed by a steel expanded metal perimeter fence, constructed in accordance with the relevant Section(s) of the NESC and Owner requirements. The grounding study shall determine if fence grounding is necessary.

## 6.11 ARC-FLASH HAZARD DESIGN REQUIREMENTS

Systems and equipment shall be designed and furnished to minimize worker exposure to potential arc flash hazards to the extent practical. At a minimum, the auxiliary electrical system shall meet the requirements of NFPA 70E and IEEE 1584.

At a minimum, switchgear shall be provided with remote breaker racking devices and, if provided, local breaker controls operable in the “connected” position shall be located outside the flash protection boundary. The use of high-speed relaying, “maintenance switch” schemes or other method to minimize available incident energy levels is acceptable. Alternatively, switchgear of Type 2 arc-resistant construction, in accordance with IEEE/ANSI C37.20.7, may be provided.

Contractor shall perform an Arc Flash Hazard Study in accordance with Appendix G1 Attachment 04 Exhibit 01 – General Electrical Study Requirements.

As a minimum requirement, labeling shall be provided per NFPA 70E.

DC arc flash labels shall be provided at the combiner boxes and shall be supported by Lock-out-tag-out procedures. DC arc flash calculations shall be PV specific and shall account for the non-linear current-voltage characteristics of the solar PV modules.

## 6.12 ELECTRICAL EQUIPMENT INSTALLATION

Installation Work shall include receiving, unloading, inventorying assemblies and all sub-system assemblies, storage, removal from storage, hauling, cleaning, installation

on foundations, and other Work necessary to place all equipment into successful operation. Factory test reports shall be filed and stored on Site.

In addition, installation Work shall include complete assembly of equipment shipped unassembled; dismantling and reassembly of equipment to make adjustments and provisions of personnel, equipment, and assistance in testing and placing the equipment into operation.

Equipment shall be checked prior to its installation to ensure that it is in conformance with the purchase documents and manufacturer's drawings. Any discrepancies shall be reported to Owner.

### 6.12.1 Freeze Protection

Freeze protection systems shall be installed in accordance with the equipment manufacturer's installation instructions.

### 6.12.2 Site Security System

Site security systems shall be installed in accordance with the equipment manufacturer's installation instructions.

### 6.12.3 Low Voltage Dry-Type Transformers

All low voltage dry-type transformers shall be installed in accordance with the following requirements:

1. Low voltage dry-type transformers shall be installed in accordance with the equipment manufacturer's installation instructions.

2. Mount transformers approximately where indicated on the drawings.

3. Load any vibration isolators external to the unit properly and provide complete isolation with no direct transformer unit metal in contact with the mounting surface.

4. Connect electrical circuits to transformers by means of moisture proof, flexible metallic conduit in a manner that prevents transformer vibrations from being transmitted to the building or other equipment.

5. Ground neutrals and enclosures of all transformers and all moisture proof flexible conduits in accordance with applicable codes and as otherwise may be indicated.

6. Connect voltage taps on all transformers to give as close as possible to rated output voltage under normal plant load conditions.

### 6.12.4 Low Voltage Panelboards

All low voltage panelboards shall be installed in accordance with the following requirements:

1. Low voltage panelboards shall be installed in accordance with the equipment manufacturer's installation instructions.

2. Mount panelboards securely where indicated, plumb, in-line, and square with walls.

3. Unless otherwise indicated, mount panelboard with top of its cabinet approximately 6-feet above the finished floor.

4. Provide a typewritten circuit directory under a metal-framed transparent plastic cover inside each panelboard.

### 6.12.5 Medium Voltage Switchgear

All medium voltage switchgear shall be installed in accordance with the following requirements:

1. Medium voltage switchgear shall be installed in accordance with the equipment manufacturer's installation

2. All equipment requiring anchor bolts shall be provided with the anchor materials, complete with bolts, nuts, and washers.

3. Sills and anchor materials shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

4. The anchor bolts shall be designed for continued operation following a seismic event.

5. Anchor bolt calculations shall be provided and be signed/sealed by a Structural Professional Engineer.

### 6.12.6 GFCI Receptacles

All ground fault circuit interrupt (GFCI) receptacles shall be installed in accordance with the following requirements:

1. GFCI receptacles shall be installed in accordance with the equipment manufacturer's installation instructions.

2. Mount receptacles with grounding slot down except where horizontal mounting is indicated, in which case mount with neutral slot up.

3. Ground receptacles to boxes with grounding wire, not by yoke or screw contact.

4. Mount weatherproof receptacles with the hinge for the protective cover above the receptacle opening.

### 6.12.7 Light Switches

All light switches shall be installed in accordance with the following requirements:

1. Light switches shall be installed in accordance with the equipment manufacturer's installation instructions.

2. Mount switches for switch operation in the vertical position.

### 6.12.8 Disconnect Switches

All disconnect switches shall be installed in accordance with the following requirements:

1. Disconnect switches shall be installed in accordance with the equipment manufacturer's installation instructions.

2. Mount switches for switch operation in the vertical position.

### 6.12.9 Concrete Pull Boxes

1. Equipment shall be located within +/- 0.5 inch of the dimensional location indicated on the drawing unless otherwise permitted by Owner. Some equipment is indicated schematically without dimensions. Contractor shall coordinate the location of this equipment with all other equipment or materials to be installed.

2. Rigid components such as bus, bus duct, throat connections, and enclosures shall be aligned and connected with special care to prevent excessive stress in joints, supports, and connections. Correct "spacing" hardware necessary for "turning" of field assemblies, usually tracker dampener shocks shall be used.

### 6.12.10 Bolted Electrical Connections

1. Where bolted electrical connections are made to aluminum, the aluminum surface shall be thoroughly cleaned with a wire brush, then coated with joint anti-oxidant compound and thoroughly brushed again through the compound. Additional compound shall then be added and the joint bolted together.

2. Where bolted connections are made between copper or brass surfaces, the metal surfaces shall be thoroughly cleaned and coated with a suitable anti-oxidizing compound.

3. It shall be Contractor's responsibility to certify that the torque of each bolt in all bolted electrical connections is in accordance with the manufacturer's recommendations. Factory bolt torques shall be verified as part of the equipment checkout and test procedures. Mark with torque scribe lines.

4. Bolted electrical connections shall be tightened with manual torque wrenches. Torque wrenches shall be constructed, so that they will visually or audibly indicate when the proper torque is reached. Mark with scribe lines.

5. The tightened bolts in electrical connections shall be checked at random; ten percent of the connections shall be reviewed and documented. Contractor shall be responsible for coordinating the checking of bolt tightness, so that minimum interference with equipment installation and connections will be experienced. If one percent of the ten percent samplings fail, all connections shall be re-torqued and witnessed.

### 6.12.11 Equipment Finish

1. Surfaces of most electrical equipment, such as panels, switchgear, transformers, and circuit breakers are finished at the factory. Care shall be exercised to prevent damage to this original finish during equipment installation and during construction Work.

2. If factory finish is damaged during the course of construction, the damaged component shall be touched-up or refinished to the satisfaction of Owner, at no additional cost to Owner.

3. Refinishing paint, if furnished with the equipment, may be used; otherwise the paint shall be obtained from the equipment manufacturer. Procedure for paint application should be in accordance with the manufacturers' recommendation.

### 6.12.12 Photovoltaic Modules

1. PV modules shall be provided with the following information:

2. The module shall be listed in accordance with UL 1703 for the system voltage.

3. The module manufacturer shall provide results from flash testing of modules being provided.

4. The flash test shall be conducted with an AM1.5G calibrated solar filter to approximate the sun's true spectral distribution following ASTM E927-97(1997) Class A and IEC-904-9 ANSI standards and be made available to Owner in electronic, CSV format.

5. The results of the flash test shall include, at a minimum, the following measured values: Isc, Voc, Impp, Vmpp, and Pmpp, solar irradiancd cell temperature.

6. The flash test data shall also include the PV module serial numbers and associated pallet numbers.

7. Modules shall be shipped and delivered in clearly identified bins that indicate the number of modules and nominal power per module with a manifest of each serial number contained within.

### 6.12.13 Module Mounting System

1. The module mounting system shall be installed in accordance with the following requirements:

2. The PV modules as installed and attached to the PV module mounting system shall not be exposed to a loading pressure in excess of the maximum loading pressure rating specified by the PV module manufacturer, when subjected to any wind and weather conditions over the entire range defined by the local building code.

3. The mounting system shall be listed in accordance with UL 2703.

### 6.12.14 Combiner Boxes

1. All combiner boxes shall be installed in accordance with the following requirements:

2. Adequate room for wiring slack shall be provided inside of each combiner box to allow for both module string wiring and PV output cable electrical voltage and current field measurements.

3. Contractor shall secure combiner boxes such that adequate access and working space per the NEC is provided. For ground based systems, the centerline shall be approximately 48 inches above grade, unless otherwise accepted by Owner. Furthermore, combiner boxes shall be mounted with a minimum of 12 inches of clearance above the established 100 year flood elevation, clear of drive isles, and in a position to not otherwise impede other equipment or cause shading of modules. If aluminum conductors are used, all electrical terminations shall be 18 inches above grade and terminations shall be rated for aluminum.

4. Combiner boxes shall be bounded by red-colored bollards, as appropriate, or located outside traffic areas.

5. Contractor shall install combiner boxes to be plum and level.

6. Contractor shall permanently secure combiner boxes on Unistrut, piperack, pile, steel pier, or any other suitable means of permanent attachment, subject to the approval of Owner.

7. Combiner box shall be listed in accordance with UL 1741 for the system voltage.

### 6.12.15 Inverters

1. All inverters shall be installed in accordance with the following requirements:

2. Inverters shall be installed in accordance with the equipment manufacturer's installation instructions.

3. Contractor shall coordinate with inverter manufacturer to perform commissioning of the inverter when back-feed power is available.

### 6.12.16 Medium Voltage, Pad-Mounted Transformers

All medium voltage, pad-mounted transformers shall be installed in accordance with Appendix G1 Attachment 04 Exhibit 02 – General Transformer Specification and the following:

1. Transformers shall be installed as specified on the drawings.

2. Transformers shall be installed in accordance with the equipment manufacturer's installation instructions.

3. Utility phase rotation shall be confirmed by the Contractor prior to installation to ensure proper connection.

4. Transformers shall be installed to maintain a minimum of 10-ft unobstructed access from the cabinet doors, perpendicular to the cabinet doors, and any adjacent cabinet containing operable electrical components (i.e. load-break switches).

5. Transformers shall be located near drive or road ways, to allow access by a 2-ton service vehicle with trailer.

6. Transformers installations shall include red-colored bollards.

### 6.12.17 Lightning Protection System

The lightning protection system shall be installed per the National Electrical Code, NFPA 70 using appropriately licensed and certified Lightning Protection Installation Subcontractors.

### 6.12.18 Raceway

Conduits for ground-mounted systems shall be installed as follows:

1. All raceway and conductor installations shall be suitable to withstand the potential for rodent damage or intrusion

2. RGS only up to 8 feet above finished grade at ground level (for mechanical protection), EMT above 8 feet AFG and up to roof

3. LFMC for short runs of less than 3 feet to combiner box

4. PVC schedule 40 for underground, direct buried, direct buried conduit or concrete-encased where subject to vehicles

Unless otherwise directed by Owner, underground duct banks subject to vehicular traffic shall be concrete-encased, 3000 psi minimum, with PVC schedule 40 conduits buried at the depth required for direct buried cables. Underground duct banks shall have electrical warning tape installed approximately 12 inches below finished grade in the backfill and a bare copper 4/0 AWG ground in the concrete nest serving as a counterpoise ground. Duct banks shall be designed to include spare capacity after completion of installation to allow for future growth and expansion.

Conduit shall be used to route lighting, telephone, and communication circuits where installed above grade.

### 6.12.19 Cable Installation

Cable installation shall be in accordance with the following general rules:

Cables shall be installed in accordance with the cable manufacturers' recommendations, circuit lists, raceway lists, the drawings, and these Technical Specifications and Scope of Work. Each circuit shall be assigned a unique number.

All cable supports and securing devices shall be installed to provide adequate support without deformation of the cable jackets or insulation.

Oversized sunlight resistant nylon wire ties shall be utilized for bundling conductors for all exposed wiring. Wire ties shall be snug, but allow for thermal expansion.

Contractor shall identify both ends of the circuits with number and/or color-coding matching the drawings. Contractor shall also identify all circuits at manholes and handholes. Insulation of potentials should be color-coded and incorporated into a wire schedule.

All exposed wiring shall be neatly bundled so that exposed wiring is securely fastened. Exposed wiring running along metal surfaces shall be secured to prevent rubbing and damage from the metal surface or wire tie. Maximum spacing of 24 inches on center between fastening locations shall be such that secured wiring is not free to move due to wind, snow, or other environmental conditions. Use insulating foam spiral wrap, split loom, edge protection or other means to prevent contact with exposed bolt threads and sharp surfaces.

Phase tape shall be applied to each conductor at the terminations of all power and lighting circuits that are not already properly color coded.

Green shall be used for ground at every voltage level. Phase taping circuits shall not be required if cable with colored insulation is installed.

| Circuit | Taping |
|---|---|
| 208Y/120 V Circuits | Black – Phase A<br>Red – Phase B<br>Blue – Phase C<br>White – Neutral |
| 480Y/277 V Circuits | Brown – Phase A<br>Orange – Phase B<br>Yellow – Phase C<br>Gray/White – Neutral |

| Conductor | K2 Color Code |
|---|---|
| 1 | Black |
| 2 | Red |
| 3 | Blue |
| 4 | Orange |
| 5 | Yellow |
| 6 | Brown |
| 7 | Red with Black Tracer |
| 8 | Blue with Black Tracer |
| 9 | Orange with Black Tracer |
| 10 | Yellow with Black Tracer |
| 11 | Brown with Black Tracer |
| 12 | Black with Red Tracer |

Cable shall not be handled when the temperature is below the minimum temperature recommended by the manufacturer. If cable heating is required prior to placement, the cable shall be stored in a heated building in accordance with the manufacturer's recommendations for at least 24 hours. Cable shall be placed the same day it is removed from heated storage.

The pulling tension of any cable shall not exceed the maximum tension recommended by the cable manufacturer. Pulling mechanisms of both the manual and power types used by Contractor shall have the rated capacity in tons clearly marked on the mechanism. If any excessive strain develops, the pulling operation shall be stopped at once and the difficulty determined and corrected.

Cable shall not be pulled using trucks, forklifts, cranes, or other devices where the tension of the cable pull cannot be easily controlled.

1. Cable Grips: When pulling loops are used, the entire loop shall be cut off, discarded and recycled when the pull is completed.

2. Inspection: The outside of each cable reel shall be carefully inspected and protruding nails, fastenings, or other objects which might damage the cable shall

be removed. A thorough visual inspection for flaws, breaks, or abrasions in the cable sheath shall be made as the cable leaves the reel, and the pulling speed shall be slow enough to permit this inspection. Damage to the sheath or finish of the cable shall be sufficient cause for rejecting the cable. Cable damaged in any way during installation shall be replaced.

3. Cable Bends: Tape shielded, flat tape armored, and wire armored cable shall not be bent to a radius of less than 12 times the overall cable diameter. All other cables shall not be bent to a radius of less than eight times the cable diameter.

4. Spare Conductors: All spare conductors of a multiconductor cable shall be left at their maximum lengths for possible replacement of any other conductors in the cable. Each spare conductor shall be neatly dressed for future use and marked as “spare.”

5. Lacing: UV rated ties shall be used to neatly lace together conductors entering switchboards and similar locations after the conductors have emerged from their supporting raceway and before they are attached to terminals.

6. Cable Identification

    a. The ends of all circuits listed in the circuit list shall be identified with a circuit tag. Each marker shall bear the number of the circuit according to the Circuit List and drawings. At terminations, Contractor shall identify each circuit. Each phase of multiphase power circuits shall be individually identified. The circuit tag shall be so attached that it is readily visible for circuit identification.

    b. Phase tape shall be applied to each conductor at the terminations of all power and lighting circuits. The phase taping for power conductors shall follow Owner Design Standards.

7. DC String Cable Placement in Free-Air Installations: DC system cables shall be secured with a cable tray, wireway, cable clips or equivalent. Cable ties are not allowed as the only means of securing dc cables. The cables shall be neatly bundled together with no/minimal strain exiting out of the PV module junction box and secured at 24 inches, on center, maximum. If wire harnesses are utilized to connect strings together, same guidelines still apply.

Except as otherwise specified or indicated on the drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage.

Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

Stranded conductor cable shall be spliced by crimp type connectors. Twist on wire connectors may be used for splicing solid cable and for terminations at lighting fixtures.

Splices may be made only at readily accessible locations.

Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions. All shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.

Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

Cable pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J."

Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half lapped layer of 3M "Scotch 77 Arc Proofing Tape," anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape," or with equivalent tape by Anixter or Plymouth/Bishop.

Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.

Spare cable ends shall be taped, coiled, and identified.

Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 times diameter for non-shielded cable and 12 times diameters for shielded cable.

All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Contractor shall not field combine circuits to reduce conduit requirements unless approved by Engineer.

### 6.12.20 Connectors

This section of this Technical Specification defines methods of connecting cable between electrical systems and equipment. In this section, the term “connector” is applied to devices that join two or more conductors or are used to terminate conductors at equipment terminals for the purpose of providing a continuous electrical path. Connectors shall be installed as follows:

Connector material shall be compatible with the conductor material to avoid the occurrence of electrolytic action between metals.

All dc PV connections shall be supported by connectors of matching make and manufacturer and listed for the application.

All medium voltage and low voltage connectors shall be pressure type and secured by using a crimping tool. The tool shall produce a crimp without damage to the conductor, but shall ensure a firm metal-to-metal contact. The tool shall be calibrated and approved by the manufacturer. Low voltage terminations shall be permitted to be screw-down lugs where only screw-down lugs are available, such as molded case circuit breakers.

Medium voltage cables require stress cones at the termination of the cables. Stress cones shall be of the preformed type suitable for the cable to which they are to be applied.

Cables shall not be spliced in trench unless authorized in writing by Owner, cable trays or conduits. Connections shall be made in conduit outlet fittings or junction boxes utilizing terminal blocks or an appropriate connector.

Splices, joints, and connections in cable other than cable terminations at equipment shall be made only in pull boxes or junction boxes unless otherwise indicated on the drawings and shall be made in accordance with the instructions of the cable manufacturer.

### 6.12.21 Auxiliary Power Cables (lights, receptacles, computers, tracker motors and controllers, PLC, heating/ventilation)

All auxiliary power cable testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

### 6.12.22 Control Cables (alarms, contacts, etc.)

All control cable testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

### 6.12.23 Analog Instrumentation (analog signals)

All analog instrumentation testing shall be done in accordance with Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

### 6.12.24 Electrical Tests

Contractor shall provide field-testing of all wire, cable, electrical devices and equipment, and electrical systems delivered and installed on the Project. The following items shall

be performed and procedures as specified in the Appendix G3 Attachment 01 Exhibit 05 – Solar Pre-Operational Startup and Testing.

## 7.0 COMMUNICATIONS AND PLANT SCADA

The SCADA system shall be a proven system, suitable for performing the operation, maintenance and monitoring functions associated with the Solar Power Plant. The SCADA system shall integrate with a plant controller as necessary to comply with the Interconnection Agreement. The SCADA system shall interface with EMS at Owner main and backup control centers. EMS interface shall be constructed in accordance with Owner Master SCADA design documents and shall consist of the components specified therein. Communications and SCADA systems shall be designed in accordance with Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

Other features that include modules for managing O&M may be offered as an option. These may include maintenance scheduling, spare part records, service records and maintenance records.

The Contractor shall prepare and provide the following SCADA documents and drawings in accordance with Owner's substation design standards:

a) SCADA Division of Responsibility

b) SCADA Scope Designation Drawing

c) SCADA Typical Points List

d) SCADA architecture diagram

e) Network drawing

f) SCADA system equipment final bill of materials

g) Panel layout drawing

h) SCADA schematic drawings

### 7.1 COMMUNICATIONS NETWORK

Requirements for communications are provided in Appendix G1 Attachment 05 Exhibit 04 – Communication Facilities.

The solar plant communications network shall connect to all inverters and Meteorological Stations on the Project Site and shall connect to the terminal points as specified in this document, including but not limited to the TSP communication network.

The communications network shall be suitable for the Project Site, including:

1. Immunity from the effects of fault and lightning currents
2. The expected ambient temperature range
3. Geotechnical conditions
4. Protection from pests and rodents
5. Will connect to the terminal points as specified, be compliant with Applicable Standards, and meet any additional requirements of the TSP and Interconnection Agreement
6. Fiber optic cables shall be used for the communication network.

Contractor shall be responsible for achieving a fully functional communications link between the SCADA server(s), each of the inverters and the Meteorological Stations. Installers shall be certified by ETA® International (Electronics Technicians Association) or BICSI (Building Industry Consulting Service International) for fiber optic installation.

Contractor shall furnish all devices necessary to implement the communications networks design as specified herein. These devices shall be installed in system cabinets and may include, but not be limited to, communications Modules, modems, hubs, routers, switches, line drivers, receivers and transmitters, protocol converters, fiber-optic patch panels, fan out kits, media converters, signal conditioners, prefabricated cables, and cable adapters/ connectors.

### 7.1.1 Fiber Optic Network Design

a) Design Requirements

Contractor shall prepare fiber optic overview design drawings; which include transitions from OPGW to underground cable (as applicable) and the connections to the substation, O&M building, and interconnecting utility/transmission facilities.

b) Fiber Optic Network Drawings

1) The BOP Contractor shall prepare detailed fiber optic network drawings showing the fiber loop connections to the inverters and MET towers. This design shall be based on that supplied by the Inverter Vendor and shall be reviewed and approved by the Inverter Vendor and Owner.

2) Contractor shall prepare fiber optic drawings as required for substation connections.

3) The Contractor shall submit for Owner’s review a complete set of project Fiber Optic Network Drawings.

c) Fiber Optic Splice and Distribution Panel Details

1) Contractor shall prepare drawings detailing the splicing/connections required at all OPGW to underground transitions (as applicable), and the substation fiber optic distribution panel.

2) Expected deliverables include: Fiber Optic Splicing Drawings, Fiber Optic Distribution Panel Drawings.

d) Underground fiber optic cable shall be as follows:

1) Conduit SDR 11 minimum to be used for crossings/bores.

2) 12 fiber for individual combiner circuits

e) For rodent protection, a combination of the following methods shall be used:

1) Non-armored fiber-optic cable installed in a minimum of 4” schedule 40 PVC with HDPE innerduct

2) Any concrete encased duct bank or metallic conduit

3) Any owner approved substitution that achieves equal protection from rodent damage

f) Collapsed fiber-optic ring system layout design, installation and testing.

g) The communication network will be designed for a minimum of one (1) GB bandwidth

h) The fiber-optic cabling will be either 12 strand multimode or 12 strand single mode, as applicable and consistent with standard industry practice

i) Fusion splicing of single mode fiber will be used (not required for multimode), and completed in above-ground pedestals.

j) Splice vaults shall be composed of reinforced concrete or fiberglass and equivalent in size to 4’x4’x4’ with interior racking to mount splice case off the bottom of vault. Vault shall have an open bottom with gravel base.

k) Extra fiber-optic cabling (slack) will be included at each end of all cable runs consistent with standard industry practices

l) The communication system will have a maximum attenuation of 0.35 dB/km at 1310 nm or 0.25 dB/km at 1550 nm and will include a minimum system margin of between four (4) and six (6) dB

m) In the event fiber-optic cables are placed in trenches with wiring associated with other parts of the System, underground rated subduct that also provides the ability to eliminate or decrease damage due to wildlife infestation will be used to protect and separate the cable.

n) The communications network shall have redundancy, so that the failure of a single component or communications link in the communications network shall not result in the loss of communication to more than one power block, Meteorological Station, terminal point or interface.

o) Redundancy may be achieved by using ring topology for the fiber-optic network such that communications can be maintained to all power blocks in the event of a break in one of the cores of the fiber-optic cable. Re-routing of data shall take place automatically and not require manual intervention.

### 7.1.2 Fiber Optic Installation

a) Contractor shall install fiber-optic cable and terminations as specified and in accordance with the cable and equipment manufacturer's recommendations. All fiber-optic accessories required for a complete installation shall be supplied and installed by Contractor. Examples of fiber-optic accessories include fan-out kits, end connections, dust caps, cleaving tools, polishing equipment, etc.

b) The Contractor shall furnish and install fiber optic cable interconnecting the inverter units, MET tower(s), and the Project Substation to the O&M building and other locations as required. The BOP contractor shall provide an additional five meters of cable at each end. All cables shall be appropriately labelled with a permanently attached label.

c) The Contractor shall provide conduits as required for any fiber entry into the substation control building including that associated with any transmission lines (e.g. OPGW). Conduit shall have a pull string for pulling the cable. Fiber optic cables may be routed through substation control cable trenches with other control wiring (subject to Applicable Laws, codes, and regulations) provided that a high-visibility colored innerduct is used for identification and protection of the fiber optic cables.

d) Contractor shall furnish and install fiber optic splice and distribution panels as required, including, over head to underground transitions and the project substation. All distribution panels shall be neatly labelled with source and destination information for each fiber pair. Fiber optic distribution panels in the inverters shall be provided and installed by Contractor unless supplied and installed by the inverter Vendor.

e) Contractor shall furnish and install above ground communications cable junction boxes as required. All fiber cable strands including spares shall be terminated on patch panels or appropriate connectors as required and shall be in compliance with the equipment Supplier’s and/or Owner’s specifications. Pre-made duplex fiber jumpers shall be used to connect from patch panels to end devices within a cabinet or panel.

f) Fiber strands shall be terminated with fan-out kits.

g) No splices in the fiber-optic cable are permitted. Prior to fiber-optic cable installation, all cable will be inspected and tested with optical time domain reflectometer.

h) Fiber-optic cable shall be installed in inner duct with a minimum diameter of 1.25".

i) Connectors, break-out kits, and other miscellaneous materials required for terminating shall be provided by the Contractor.

j) For single mode fiber, no field terminations will be accepted. Only field splicing of single mode fiber is allowed.

## 7.2 PROTOCOLS

The SCADA/DAS System shall support RS-232, RS-485, and RS-422 as required by monitored equipment.

The SCADA/DAS System shall support TCP/IP.

All devices shall support either Modbus or DNP3. DNP3 is preferred due to time stamping capability. Modbus will be acceptable only when DNP3 is not an available option. All other protocols must be approved by Owner before use. Owner will only consider open protocols managed by an independent organization. Contractor shall provide a comprehensive list of all protocols which are supported by the system being proposed.

## 7.3 ACCESS TYPES

Native access shall mean the user is equipped with a copy of the native SCADA/DAS software permitting the user (with authentication) to full access of the SCADA/DAS system.

## 7.4 USERS

Users shall be organized into groups based on permission level. Permissions shall be assigned to groups, and alarm notifications shall be sent to groups. Group privileges shall be configurable.

## 7.5 NAMEPLATES AND TAGGING

Nameplates shall be furnished and installed on the exterior of all major SCADA/DAS equipment, including all operator interface cabinets/consoles, control and electrical panels, and cabinets.

Equipment designation nameplates shall be furnished and installed on the front and back interior of all cabinets and panels. This provides for equipment designation with doors removed. Internal nameplates shall also be furnished and installed for all cabinet

and panel internal components including, but not limited to, internal devices, Modules, and terminal blocks (identification scheme to be finalized during detailed design).

Nameplates shall contain the equipment number. The Equipment Number format will be furnished by the Owner.

Equipment Tags shall be furnished for each piece of equipment and contain the equipment number. The tags shall be durable engraved plastic and shall be suitable for outdoor application. Engraving shall be high contrast and suitable for reading low light conditions.

## 7.6 SECURITY SYSTEM INTEGRATION

The system shall have the capability to integrate with a security system to, at minimum, indicate whether any security alarms exist. Security alarms shall be accessible from the alarm screen and home screen.

## 7.7 CYBER SECURITY

Cyber security of the SCADA system shall be in accordance with Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

## 7.8 UNINTERRUPTIBLE POWER SUPPLY

The uninterruptible power supply (UPS) system shall provide for up to 4 hours of backup power to the equipment.

## 7.9 SERIAL CABLING

Serial networks shall use only shielded cable and shall be selected based on the serial interface and maximum distance to monitored equipment.

## 7.10 REQUIREMENTS FOR DAS SYSTEM

The DAS system shall be composed of a primary DAS gateway, remote server, web interface, and all necessary communications equipment and cabling to communicate with all monitored equipment. The DAS gateway shall be installed in the shade.

## 7.11 DAS MONITORED EQUIPMENT

The DAS system will be responsible for communication, monitoring and data acquisition with the following equipment: combiner boxes (if they contain string monitoring equipment), inverters, meteorological stations, and revenue meters.

Contractor shall provide all hardware and drivers to communicate with Owner-furnished foreign devices, such as the Data Processing Gateway.

The communications medium shall be twisted shielded copper conductors for indoor locations and those areas not subjected to induced signal noise. For communications

networks routed outdoors or in areas where induced signal noise is probable, fiber-optic cable shall be used.

Contractor shall furnish all devices necessary to implement the foreign device interfaces (FDI).

## 7.12 TIME BASE AND DATE FORMATS

A GPS satellite receiver shall be installed to provide time synchronization signals. This device shall provide time synchronization signals for the Solar Power Plant SCADA system main SCADA server(s). All other clocks shall automatically be synchronized to the central computer clock. Install a separate GPS satellite receiver for clocks which are located a significant distance from the main SCADA servers and synchronization is required.

Time and date formats shall be chosen to eliminate confusion arising from different time zones, summer/winter changes and different country display formats.

All time stamps on time series data shall apply to the end of the averaging period.

All time stamps shall be stored as UTC, regardless of local time setting used.

## 7.13 SCADA HARDWARE

### 7.13.1 SCADA Server

A primary SCADA server shall be provided. The primary SCADA server shall run the HMI. The primary SCADA server shall run the communications engine for communicating with all monitored equipment. The primary SCADA server shall be installed with a copy of each manufacturer's software for all monitored equipment (inverters, met station, relays, etc.)

The primary SCADA server shall be an industrial grade server with Microsoft Windows Server (Microsoft Windows Server 2016 or as recommended by SCADA vendor; version to be approved by Owner; Vista and Windows 7 are not acceptable), and at minimum, 4 GB RAM, removable media storage for backup, 100 Mbps NIC, 4 USB ports, 3 GHz dual core processor, 1080p DVI video interface outputs, 19 inch flat screen display, and a RAID array with a minimum of 500 GB useable storage space.

The primary SCADA server shall meet the recommended system configuration of all SCADA software installed.

### 7.13.2 View Nodes/Workstations

1. General:
    a. SCADA viewing and operation workstations shall allow full viewing, analysis, reporting, fault diagnosis, resetting of faults and control of

inverters consistent with its deployment as the primary SCADA terminal located on the Site.

b. Each workstation shall be an independent Microsoft Windows based computer capable of stand-alone operation.
c. Workstations shall connect to the Plant SCADA system through an Ethernet NIC
d. Rack mountable hardware
e. Equipped with a printer suitable for printing reports from the Plant SCADA system

2. Operating System: Microsoft Windows 10, 64 bit
3. Video Interface: 1080p DVI outputs as needed
4. KVM: Contractor will provide IP-based KVM for accessing all View Nodes/Workstations

### 7.13.3 SCADA Server Backup

The backup SCADA server shall meet the same requirements as the primary SCADA server. The backup SCADA server shall automatically become the primary SCADA server if the primary SCADA server ceases to operate.

The backup SCADA server shall relinquish control of the network when the primary SCADA server resumes control, with bumpless transfer of communication.

## 7.14 SCADA SOFTWARE

### 7.14.1 General

Colors shall be used consistently throughout all software (HMI screens, etc.) Red shall indicate energized, closed, live. Green shall indicate de-energized, open, tripped. Yellow shall indicate loss of communication with a device.

No SCADA software shall require a hardware key.

Software shall fully support redundant servers and networks, as described herein.

### 7.14.2 Lockout/Tagout (LOTO)

SCADA software shall include a LOTO facility that allows the operator to indicate that a device is being locked/tagged out and a description of the service being performed. Contractor shall provide device tagout logic and operator interface configuration for all equipment included in the scope of Contractor’s programming services for control.

The SCADA server shall note the time the LOTO tag was entered in the software and the time that the device in question changed state. LOTO data shall be stored in the historian.

### 7.14.3 General Logs

The SCADA server shall provide facility to enter general log information with customizable categories and time stamp.

### 7.14.4 Editors/Tools

SCADA server shall include software tools to edit/build HMI screens, edit/build reports, edit alarm thresholds, edit user group memberships, edit group privileges, etc. Software tools provided shall include provision to edit/update the points list and device address/mapping.

Contractor shall provide a complete list of all software included as part of Contractor's proposed SCADA system for Owner's approval.

The HMI builder application shall be of the "drag-and-drop" type and not require programming knowledge to: add symbols to a screen, add conditional logic for color coding, change colors, line widths, line types, etc.

Each engineer/operator workstation in the SCADA system shall include a complete set of user-friendly interactive control and information display editors for generation and modification of the displays, macros, custom shapes, and custom colors. The editors shall be of the latest technology including a mouse driven GUI using windowing technology (i.e., drag/drop, cut/copy/paste, etc.) The interactive editors shall allow the user to build, inspect, or modify any display using any or all of the textual, geometric graphic, or symbolic features of the system. New displays shall be able to be created starting from a blank screen or by recalling existing displays, editing, and storing the new display under a new file name.

The SCADA system shall allow the user to create and store frequently used shapes and symbols representing plant and process equipment. These symbols shall be available for use in any process control display. The symbols shall have the capability to be located at any place on a display, to be rotated to any orientation, to be magnified or reduced, to be given any color, and to be dynamically linked to any system variable. The system shall include a library of Contractor's standard set of geometric symbols (similar to ISA S5.5 symbols) related to System equipment. The system shall provide the capability to save user defined groups of geometric graphic elements as macro symbols that can then be imported into other process control displays.

### 7.14.5 Process Logic

Provision shall be made to write simple control algorithms to control equipment and generation alarms based on the status or value of data points. Control algorithms shall be prevented from energizing equipment when other upstream or downstream equipment is in an unacceptable state. Program logic and screen editing shall be in SAMA format.

### 7.14.6 Calculated Points

The SCADA server shall generate the calculated points listed on the points list. Calculated points shall be available for use on HMI screens, trending and reporting as if they were raw data points. Provision shall be made for the creation of additional calculated points.

### 7.14.7 Historian

Historian data shall be available to the trending and reporting screens of the HMI. Historian data shall include all points in the SCADA system. Provision shall be made for future expansion.

The historian shall support 5 years of full data access without requiring backup media to be used. Provision shall be made for regular backup to removable media. Communication shall be via open protocol.

The historian shall be OSI PI historian or Open Protocol Communication. An unlimited site license and two remote site access licenses shall be provided.

## 7.15 SCADA HMI FUNCTIONAL REQUIREMENTS

The HMI screens shall meet, at a minimum, the following functional requirements.

### 7.15.1 Home Screen

The home screen shall be a graphical view of the entire System with device icons to represent field equipment and/or systems.

This view shall display the most important real-time information from each device (including inverters, revenue meter, meteorological stations, etc.) and shall use color-coded icons to denote status (e.g., inverters, relays and meters shall display power, current, and voltage.)

Clicking on a device shall open up a device screen (see below) to display additional details regarding each device and provide control functionality.

The home screen shall display a System layout that approximates the actual relative physical location of equipment with device labels that match design drawings and equipment labeling.

The home screen shall display a data table of key metrics, including kW, power factor, MWh, yield, irradiance and performance ratio for the current date, month to date, year to date, and lifetime.

The home screen shall display a short alarm list of all un-acknowledged alarms and any severe acknowledged alarms that have not been cleared.

### 7.15.2 Electrical One-Line Screen

The electrical one-line screen shall provide a simplified single-line diagram of the System, including all inverters and higher voltage equipment with key operational metrics. Equipment shall be appropriately color-coded to indicate device state. Equipment shall be represented by appropriate electrical symbols. Clicking on a device shall access the device screen for that device.

### 7.15.3 Device Screens

Selecting a device from either the home screen or electrical one-line screen shall produce a device screen displaying (or making available) all data points associated with that device. Device screens shall provide a facility for control of the device (reference point list for typical control devices.)

### 7.15.4 Alarm Screen

The alarm screen shall display all alarms. Alarms shall be sortable by acknowledgment status (acknowledged or not acknowledged), alarm status (still in alarm or cleared), alarm code, and device ID.

Alarms shall use the date/time stamp of the alarm from the device (where supported).

Alarms shall be configurable such that any data point can have upper and lower thresholds set to trigger an alarm. Alarms shall also be configurable such that any data point can have a threshold set over time to trigger an alarm. The SCADA system shall also include an audible alarm that shall have adjustable volume control. The audible alarm shall be user configurable for different tones or patterns to distinguish between a minimum of four alarm priority levels. The system shall use global alarm acknowledgment, allowing a single acknowledgment from any workstation, whether designated as the alarm workstation or not, to acknowledge that alarm on all workstations and to silence the audible alarm.

### 7.15.5 Trending Screen

Graphical and tabular representation of data shall be supported. The graphical view shall support two vertical axes and shall support trending of up to 12 variables.

The trending screen shall allow for a user-selectable time scale and shall have built in support for selecting common date ranges (today, yesterday to today, week to date, last 7 days, last 30 days, last 365 days, month to date, year to date, lifetime.)

Selecting a point in the graph shall display the raw data for that point.

The trending screen shall allow a customized chart/table to be saved as a report for use by the reporting engine (refer to reporting screen below) or for future use in other applications.

The SCADA system shall allow any system variable to be trended and shall allow points from short-term and long-term storage to be trended. The trend display period between points on trends using data from short-term and long-term data storage shall be the same as the storage frequency selected for those points.

### 7.15.6 Reporting Screen

A reporting engine shall be provided allowing for reports to be generated from any data point. Contractor shall indicate if this engine is part of the SCADA package, the historian, or a separate package (like Crystal Reports).

The reporting screen shall allow for simple mathematical operations and display of results on reports (e.g., sum, average, minimum, maximum.)

Reports shall be exportable in CSV format and Adobe PDF format.

Reports shall be configurable to run automatically based on thresholds being reached or regularly scheduled.

Reports shall be configurable to automatically email the report to specific groups.

## 7.16 REMOTE ACCESS

### 7.16.1 Full Access

Remote access shall be provided utilizing Microsoft Terminal Services or equivalent for remote access of the SCADA server, SCADA backup server, SCADA Web server, SCADA historian and SCADA workstation. The system shall support up to three concurrent remote users in addition to a local user.

### 7.16.2 Web-Based Access

a. Contractor shall provide the hardware and software necessary to allow remote access of near real-time process information by any Intranet or Internet web browser on any connected personal computer (PC). There shall be no software-based limit on the number of concurrent connections. Web access shall be separated from the SCADA servers by a firewall.

b. Remote access shall provide for functionally equivalent read-only access as if user was operating the SCADA server or SCADA workstation directly. The interface shall provide the ability to convert HMI graphics to web-based objects to allow graphics access from standard web browsers. The interface shall be dynamic and shall not display data older than 5 minutes.

### 7.16.3 DNP Slave

The SCADA server shall include DNP slave protocol for communication with a higher, supervisory system. The configuration shall include provision for setting the DNP address for the System and mapping any data points required.

The DNP slave shall provide for control access, support DNP report by exception, and shall include the ability to be polled by two separate DNP masters.

### 7.16.4 Vendor Access

No vendor (including the SCADA system vendor) shall have access to the SCADA network or equipment remotely without Owner authorization.

## 7.17 TELEMETRY AND CONNECTIVITY

The SCADA supplier shall comply with all telemetry and connectivity requirements set forth by the utility, system operator or balancing authority.

## 7.18 DATA ACQUISITION

All points necessary to monitor and operate the System shall be listed on the points list and shall be collected and accessible through the SCADA server and HMI.

All points shall be assigned a uniquely identifiable number such that they are available programmatically for alarming, trending, reporting, and screen building.

Contractor shall add I/O card and termination information to the database. In addition to providing information on active I/O, Contractor shall populate the database with the hardware information for all available spare points on all cards.

## 7.19 CONTROL

All control commands shall require a two-step (select before operate) process. Additionally, the user must acknowledge and follow the control requirements (if applicable) by the interconnecting authority.

Users shall have read-only access to the following items:

- Web access with near real-time updates at a frequency of no less than 15 minutes or at rate prescribed by the TSO.
- Remote access through a web-based interface that provides access to the HMI screens, including access to the point database information and live and historical trend data.
- Project’s TSO revenue meter and all Project meter data at the Project Site.

- Real time access to the Project's scheduling and logging for the TSO client application.

## 8.0 ON SITE BUILDINGS

### 8.1 GENERAL

Temporary construction compound, MV substation building (if required), control building, and all permanent buildings shall be in accordance with Appendix G1 Attachment 02 Exhibit 02 – General Onsite Buildings and Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

The final design(s) of all buildings is to be approved by Owner.

All buildings 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

### 8.2 OPERATIONS AND MAINTENANCE BUILDING

Need for a new onsite O&M building is dependent on the plant capacity, nearby owner plant facilities and proximity to communities with appropriate commercial space. Specifications are provided below for a new onsite O&M building, or alternative, reduced facilities, to be selected and approved by the Owner.

#### 8.2.1 On-Site Operations and Maintenance Building

The O&M building and surrounding area shall incorporate sufficient road infrastructure, parking lot and outdoor facilities suitable for the operation and maintenance of the Solar Power Plant and the operational staff requirements during its Design Life during all anticipated weather conditions.

The O&M building shall consist of the minimum indoor and outdoor storage and working areas corresponding to the maintenance provider's requirements, in addition to office and meeting space for Owner's staff, as well as network and SCADA control facilities to support solar power plant operations. The building shall be of steel construction, site specific design, and shall be at least 20 ft. high with a roof having at least a 5 degrees slope. Building and surrounding plot must be elevated by one foot above the surrounding ground level.

The indoor storage area shall be smooth hardened concrete, while the outdoor storage area shall be covered with compacted gravel.

The O&M Building shall include at a minimum:

1. One male restroom and one female restroom
2. Heating/air conditioning, fire containment, etc.
3. Locker areas including lockers and benches
4. A storage room for office supplies and consumables
5. A utility room
6. A workshop area
7. A kitchen which includes refrigerator, oven, dishwasher, microwave, countertop space and cabinets.
8. A conference room with built in projector, screen and seating
9. Card reader access to O&M building, warehouse and Server room.
10. Area for a Work Control Center that is capable of being qualified CIP compliant
11. Communications Room

The office area should be able to accommodate working stations for six technicians as well as the site manager in a separate office of about 250 sq. ft., and a project manager office of 150 sq. ft. The server room shall be approximately 240 sq. ft. and climate controlled for temperature and humidity, with a separate air-conditioning system.

The workshop shall be shall be equipped with 120V outlets and equipment hoist.

The power shall be supplied from the MV Switchroom's LV power supply.

Owner Work Control Center (WCC) area/room shall:

1. be capable of being qualified NERC critical infrastructure protection (CIP) compliant;
2. coordinate with plant controls and other pertinent systems to safely and reliably operate the plant, as specified herein; and
3. interact with all telecommunications and SCADA equipment and systems, as specified herein.

Contractor shall specify and supply suitable waste water disposal via on-site means or connection to a public sanitary sewer system, in accordance with codes and regulations in place in the local jurisdiction.

If drinking water at the site will be provided by a well, Contractor must meet State's requirements for constructing a well, including submitting plan reviews and sample analyses.

The O&M building and yard shall have a fenced perimeter. Access shall be through a sliding or swinging gate, of a width large enough to provide easy ingress to the yard for a full size delivery truck.

A parking area shall be provided with sufficient space for Contractor and Owner, and handicap parking spaces to comply with applicable laws and regulations. The parking area shall be paved with either Portland cement concrete or asphaltic concrete in accordance with local standards.

Structural design for the building shall be conducted in accordance with building code standard regulations for the local jurisdiction and subject to Owner's approval. The structural design shall utilize the parameters obtained from the Geotechnical Investigation Report (Appendix G1 Attachment 02 Exhibit 01 – General Civil Requirements).

### 8.2.2 Operations and Maintenance Building (Alternative)

Subject to Owner approval, plants that are not geographically isolated and are smaller than 15MWac would not be expected to be manned during regular working hours except for preventive and corrective maintenance, and shall not be required to have a dedicated O&M building. The plant shall be considered isolated if it is further than 50 miles from a self-sufficient populated area with suitable amenities.

At a minimum, all plants shall have suitable storage facilities for spare parts that satisfy storage conditions as specified by manufacturer specifications. Control equipment shall be readily accessible and shall provide O&M personnel with adequate working conditions.

## 9.0 REQUIRED DOCUMENTATION

An up-to-date printable index listing all previously issued Contractor drawings and specifications by number and title, showing the revision status of each drawing, shall be maintained and shall be available to Owner at all times.

Contractor shall develop a design package, associated documents, and reports for the Project at the appropriate time during the project, as applicable. The documentation requirements are not intended to be exhaustive and all the requirements of this document relevant to the document submission item shall be considered by Contractor when preparing a submission. Documentation and submittals as well as requirements shall follow Appendix G1 Attachment 01 Exhibit 02 – Engineering Documents, Drawings & Other Deliverables.

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 02**

# SOLAR PHOTOVOLTAIC MODULE SPECIFICATION

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

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# 1.0 GENERAL

## 1.1 GENERAL

Applicable codes and standards, laws and regulations, and engineer of record in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

# 2.0 PHOTOVOLTAIC MODULES

## 2.1 GENERAL

The modules shall be designed to produce electricity for a minimum of 25 years under the environmental conditions of the Project Site. The electricity generation capabilities of the modules shall meet or exceed the capabilities defined by the module electrical data sheet of the product. Annual degradation shall be specified by the manufacturer.

## 2.2 MANUFACTURER

The module manufacturer shall be as agreed upon by Contractor and Owner. A list of approved photovoltaic (PV) module manufacturers are provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

The manufacturer shall have at least five (5) years of experience manufacturing photovoltaic modules.

The manufacturer shall have a current minimum manufacturing capacity of at least 1000 MW per year.

## 2.3 TECHNICAL SPECIFICATIONS

Contractor shall provide detailed electrical and mechanical specification sheets for the module.

Contractor shall provide the estimated annual degradation of the module and justify the value provided with historical production data.

## 2.4 TECHNOLOGY

Module technology shall be proven and used extensively in the field. Experimental or beta type modules are not allowed.

The cell technology for the PV module shall be either mono or poly crystalline silicon, or "thin-film" technology such as amorphous silicon (a-Si) or cadmium telluride (CdTe).

## 2.5 CERTIFICATION

Modules shall either be UL listed by a Nationally Recognized Testing Laboratory (NRTL) to meet the UL 1703 requirements. The certificates of factory/laboratories tests and compliance to the codes and standards referenced by the manufacturer shall be provided to Owner by the procuring Party. Modules must be listed to UL 1703 for the system voltage used in the project as well as compatible with the means of bonding and grounding used in the project (per UL 2703 and the module's installation manual).

## 2.6 LABELING

The modules shall be provided with a permanent label to UL 1703 standards indicating, at a minimum, the following information:

1. Make/model identities
2. Certification Entity
3. Electrical characteristics, including open circuit voltage (Voc); short circuit current (Isc); maximum power point voltage (Vmpp); maximum power point current (Impp); nominal power (W), maximum series fuse size, Peak Power, Power Tolerance
4. Compliances with standards (UL 1703, IEC, CE, etc)
5. Warnings of electrical hazard
6. Maximum system voltage
7. Date and location of manufacture or manufacturing code
8. Serial number
9. Series fuse rating

## 2.7 DESIGN AND CONSTRUCTION

The modules shall be new and, in order to maintain the homogeneity of the plant, all cells, modules and quantity of modules in series strings connected to the same single inverter shall be identical, and supplied by the same manufacturer.

The modules shall include factory installed power conductors rated at 600 V dc, 1000 V dc, or 1500V dc (as appropriate) with clearly defined polarities, weather-proofed, UV resistant/outdoor rated and with locking-type plug-in connectors of single polarity and with same environmental and electrical ratings as the power conductors.

All modules of the same type shall have the same connectors.

The modules shall include a grounding lug, grounding hole, or some other grounding attachment mechanism that is certified to UL 1703 (applicable for framed modules only).

The module, and framing where provided, shall be corrosion-resistant, resistant to damage from snow, wind, hail, windblown dust and sand, and other environment conditions. The module shall be operational rated for temperatures -40 degree C to 55 degree C

Module voltage, current and power must be within the tolerances in a new condition as shown on the label, module datasheet, and as specified in UL 1703.

Preference may be given to module suppliers for which a Bankability Report authored by a qualified third party is available, provided that the Report is of sufficient depth and covers failure rates, warranty claim history, field performance data and extended laboratory reliability testing on modules that are confirmed to have the same Bill of Materials (BOM) as modules used in the Project.

Potential Induced Degradation (PID): Modules used in systems where either the positive or negative dc conductors is not connected to an earth ground shall meet the following requirements:

1. Test report is available showing that the module has been tested to IEC 62804 with a maximum of 5% loss in power;
2. Module manufacturer's installation manual must explicitly allow the module to be installed in an ungrounded configuration (floating or bi-polar, i.e. neither conductor is grounded);
3. Module manufacturer must provide in writing the minimum value for the volume resistivity of the EVA encapsulant; if PID resistance is obtained through means other than high resistivity EVA, additional documentation describing how PID resistance is achieved shall be provided;
4. Module manufacturer shall confirm in writing that their EVA shipments are continually monitored for impurities and that EVA is routinely tested to confirm that the resistivity meets their specifications;
5. Module manufacturer shall confirm in writing that the modules used in the project have the same bill of materials (BOM) as the modules tested to IEC 62804.

Modules shall have load ratings that are compatible with the wind and snow loads at the site, per the engineer of record.

Demonstrate a 25-year rated lifetime via long-term outdoor testing and/or accelerated lifetime laboratory testing. Testing such as Thresher testing, PV Evolution Lab's (PVEL's) "Approved Vendor Program" or "Reliability Demonstration Test," or Technischer Überwachungsverein (TÜV) long-term sequential testing of the specific model of the PV module selected is an acceptable demonstration of a 25-year module rating.

Owner may elect to rely on generic values based on industry literature for various aspects of the energy assessment, including light-induced degradation (LID), Incidence Angle Modifier (IAM), degradation rates and PV module performance characteristics used in the energy model (such as PVsyst PAN file properties). If bidders assume values based on specific test reports, the test reports must be based on a statistically significant sampling of modules that have the same BOM and manufacturing processes as modules that are used in the project. Light exposure must be at least 60 kWh/$m^2$ to provide stabilized values for LID. Degradation data must be based on 5 years or more of outdoor exposure, with a detailed assessment of measurement uncertainty. Copies of these reports must be provided for review.

## 2.8 MANUFACTURING AND QUALITY CONTROL

Demonstrate batch consistency by documenting that the batch of modules proposed for this project meets performance requirements. A minimum of five modules shall be tested to ensure performance and reliability under accelerated lifetime tests. Documentation shall include flash test results and EL images before and after the tests. Costs of the modules, shipping, testing, and summary report are the responsibility of the Contractor. The documentation of the batch, module sampling, EL imaging, flash testing, and summary report shall be provided to the Owner.

Demonstrate manufacturing quality by electroluminescence (EL) testing of every module for defects.

Demonstrate workmanship quality through a third-party factory audit or testing score such as PV+ Test score of “Excellent” or better carried out by Solarpraxis AG/TÜV Rheinland, or Solarbuyer’s Independent Quality Assessment overall rating of “Good” or better with zero critical findings.

Flash test data (Pmp, Voc, Isc, Vmp, Imp) shall be provided in MS Excel or CSV format for all modules used in the project; note this is expected to be submitted at the start of construction but before Mechanical Completion. The serial number for each module shall be listed in the flash test data and must correlate to the serial numbers for all modules used in the project.

The module shall not have any signs of damage, including but not limited to: cracked cells including microcracks or “snail trails”, broken or twisted tabbing, frame deformation or signs of corrosion, damage or discoloration of backing material, voids or delamination within the module packaging, damage to connectors or wiring, delamination or dislodgement of the junction box, or discoloration to the encapsulant.

Manufacturer shall provide an established track record of installed systems throughout the United States.

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 03**

# SOLAR PHOTOVOLTAIC INVERTER SPECIFICATIONS

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

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# 1.0 GENERAL

## 1.1 GENERAL

Inverters must meet the requirements of applicable codes and standards, laws and regulations, and engineer of record in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

# 2.0 INVERTER

## 2.1 MANUFACTURER

The inverter manufacturer shall be as agreed upon by Contractor and Owner or Owner's Engineer. A list of approved inverter manufacturers are provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

## 2.2 SPECIFICATIONS

1. The inverters shall be designed to produce electricity for a minimum of 25 years under the environmental conditions of the Project Site.

2. The inverter shall include the necessary DC circuit breakers/disconnect switches, AC circuit breakers/disconnect switches (external disconnect with visual open if required by Utility), local controls, remote SCADA/DAS interface, grid operator control interfaces, and accessories necessary for the inverter to function properly as part of a power generation facility.

3. Environmental ratings: -20° to +50°C (-4° to 122°F), Humidity: 5 % - 100%, condensing, 6,500 ft elevation.

4. Nameplate: >0.99 power factor above 20% rated power.

5. Inverter shall be capable of providing voltage regulating capability to regulate the voltage at the Point of Interconnection.

6. Inverter shall provide capability to operate in power factor control mode within plus or minus 0.90 pf or as specified in the Interconnection Agreement.

7. Inverter shall include flicker mitigation as required in IEEE 1547 such that it does not cause objectionable flicker on the grid.

8. Inverter shall be IEEE 1547 compliant, including UL 1741 requirements, with allowances for variations to meet Utility specific requirements with approval by the Utility and Owner. Variations shall not defeat or bypass standard safety features or requirements.

9. Output current harmonics shall contain <5% total harmonic distortion (THD) at rated power output, per IEEE 519.

10. Inverter CEC weighted efficiency shall be >98%, without medium voltage step-up transformer.

11. Inverters located outdoors shall be enclosed in lockable NEMA 4 enclosures. The Supplier's design shall include an analysis of the maximum anticipated operating temperature, provided in [insert reference], to ensure that the manufacturer's recommended operating temperature is not exceeded.

12. Enclosure must have a door interlock system to prohibit the door(s) from being opened while energized.

13. The enclosure design shall take arc flash safety into consideration, with safety features to minimize potential exposure to arc flash risks by service personnel.

14. Inverter shall incorporate a non-load break, two (2)-pole, lockable disconnect switch or switches for main DC power disconnect for maintenance personnel safety.

15. Inverter output shall be protected by a circuit breaker with short and long time adjustable over current protection. This circuit breaker shall be externally operated or Contractor shall furnish an external on/off (start/stop) switch.

16. Inverter shall be capable of rated output at 50ºC ambient or higher without derating.

17. Inverter manufacturer shall provide maximum inverter loading ratio (dc/ac) per site conditions.

18. Inverter maximum dc input voltage shall match the project basis of design specifications.

19. The inverter shall have dc ground fault detection and isolation capabilities.

20. Inverter shall employ a maximum power point tracking scheme to optimize inverter efficiency over the entire range of PV panel output for the given Project Site design conditions.

21. Inverter shall be equipped with all hardware for data collection and communication to the central SCADA/DAS server, including the ability to write to the control registers to reset inverter and modify ac output parameters, including power factor and maximum power. Data collection points shall be integrated into the inverter monitoring and communications package. The SCADA/DAS server system synchronizes all the data recorded to the same timestamp. Data collection points included shall be (at a minimum):

a. AC Voltage
b. DC Voltage
c. AC Current
d. AC Frequency
e. DC current per input
f. Ground current (if applicable)
g. Power (kW)
h. Energy (kWh)
i. Alarms
j. Inverter temperature
k. Inverter status and faults (including ground fault interrupts)
l. Date and Time

22. If a skid-mounted inverter package unit is used, it shall include a fused and disconnectable Control Power Transformer (CPT).

23. CPT shall be sized and single-phase breakers shall be included to supply power to a 20A at 120VAC convenience receptacle, inverter heaters or air conditioners (if required to meet manufacturer recommended humidity requirements), fluorescent light fixtures, HVAC (if required to meet manufacturer recommended operating temperature requirements), inverter control power, and power for tracker motors (if applicable).

24. Inverter shall be equipped with multiple fused, disconnectable DC inputs with built in current and fault monitoring for input to the SCADA system.

25. Inverters will be calibrated and set so that the AC output after AC losses will not exceed the Project AC capacity at the Point of Interconnection.

26. Inverters shall be located and oriented away from the sun where practical and sun shades shall be provided for shading the inverter screen, if necessary.

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 04**

# SOLAR PHOTOVOLTAIC RACKING SPECIFICATIONS

## RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

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# 1.0 GENERAL

## 1.1 GENERAL

Racking equipment to meet the requirements of applicable codes and standards, laws and regulations, and engineer of record in accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

# 2.0 GROUND MOUNTING SYSTEM

## 2.1 GENERAL

The mounting system shall meet the following specifications:

## 2.2 MANUFACTURER

The racking manufacturer shall be as agreed upon by Contractor and Owner. A list of approved module mounting system manufacturers are provided in Appendix G1 Attachment 01 Exhibit 01 – Approved Vendors and Service Suppliers.

## 2.3 FOUNDATIONS

1. The design specifications for the foundations of the module mounting system ("mounting system") shall be provided by Contractor as part of the mounting system design specifications.
2. A geotechnical report shall be prepared for the specific site, and the scope shall include, at a minimum: one boring per acre; chemistry (pH, sulfate level, chloride level, soil resistivity); quantification of soil corrosivity and recommendations to ensure a 25-year life for steel piles; soil classification including risk of expansive soils; frost risk assessment; quantify or opine on risk of foundation settlement; groundwater risk assessment; and detailed technical recommendations for the foundations used at the site, including, as applicable, concrete foundations for pad-mounted equipment, drilled and poured concrete foundations for PV support piles, driven and/or helical piles, and ground screws. Refer to Appendix G3 Attachment 01 Exhibit 01 – Solar Photovoltaic Plant Specifications for more details.
3. The foundation shall be designed to withstand the soil chemistry and soil conditions of the Project Site location (ground-mounted system), and conform to all recommendations from the geotechnical engineer for a minimum of 25 years without replacement. Pre-production and production driven and helical pile foundations shall be tested in accordance with ASTM D1143 for compression, ASTM D3689 for tension, and D3966 for lateral. Pre-production tests shall be done on a small sampling of piles to validate the foundation design. Typical amount of pre-production testing to validate the foundation design is one test or

more per 1.0 MW. Production tests shall be done throughout the construction process to verify that variable soil conditions do not have an adverse effect on the pile integrity. Typical amount of production testing to verify the conditions is 1% of all piles to be installed.

4. Detailed drawings of pile and foundation designs, including material and dimensional specifications, concrete specifications and installation instructions shall be stamped by a licensed civil engineer.
5. All batches of concrete delivered to the site shall be tested by an independent agency for 28 day compressive strength, and confirmed to meet the licensed civil engineer's specifications.
6. The foundation shall be designed to comply with all of the environmental conditions of the Project Site.

## 2.4 STRUCTURAL REQUIREMENTS

1. The mounting system shall be designed to withstand design wind speeds up to the maximums specified by applicable codes, over its specified operating lifetime, without compromising its structural integrity for a minimum of 25 years.
2. The mounting system shall be able to operate normally after high wind conditions have been cleared.
3. Wind tunnel testing results in accordance with ASCE 7 shall be provided with the documentation package.
4. A modal analysis for the mounting system that quantifies the system's natural frequencies and damping ratios shall be provided. If any natural frequency is found to be under 4 Hz, a detailed structural analysis on the mounting system, prepared by a licensed civil or structural engineer shall be provided. The analysis shall demonstrate an adequate safety margin when an appropriate dynamic amplification factor is included.
5. A combined loading analysis for all structural components per ASCE 7 or other applicable code shall be prepared by a licensed civil or structural engineer and submitted for review. The analysis shall consider, as applicable, wind, seismic, snow, and gravitational loading.
6. The civil or structural engineer of record shall estimate wind loads on a tributary area that is equivalent to one module, and confirm that the module and module connections to the structure have sufficient capacity.

## 2.5 TRACKERS

1. Trackers must meet all of the requirements in this Exhibit.
2. Preference will be given to trackers listed to UL 3703 and/or trackers certified to IEC 62817.
3. Contractor shall provide a Bankability Report prepared by a qualified third party. The bankability report shall cover with sufficient depth a review of performance data from the field, warranty claim history, failure modes and effects analysis, supplier qualification and manufacturing quality assurance and control, laboratory

reliability test data, an assessment of the drive system and controller reliability, tracker resistance to dynamic wind loading, and overall structural integrity and reliability.

4. For trackers that rely on stow in extreme wind or snow events, documentation shall be provided that demonstrates that the tracker can be moved into a stow position before wind speed accelerates or snow levels increase to levels that could cause damage, In addition, a description of how the stow mechanism will function in the event of lost power or communications shall be provided.
5. All documentation submitted for trackers shall be for the specific tracker design being proposed, for example there should be no significant changes to the tracker design between the product that was evaluated by UL, IEC engineer of record, or third party author of the Bankability Report.

## 2.6 CONSTRUCTION

The mounting system and module frames shall be continuously bonded to the ground grid system. The means of mounting the module to the structure, and the means of bonding the module frame to ground must comply with the module manufacturer's installation manual. The racking must be certified to UL 2703 or 3703 (at a minimum, the Mechanical Load Test and Bonding Tests).

## 3.0 COORDINATION

In addition to meeting the requirements of the mounting system, Contractor in coordination with party procuring the mounting system for the Project, if other than Contractor, shall:

1. Provide detailed drawings, specifications and calculations on the materials and design of the mounting system, including tolerances that must be obtained in the field.
2. Provide a detailed structural analysis of the foundations and demonstrate that the design conforms to the applicable standards and codes, and incorporates the impact of dynamic wind loading (i.e. modal analysis and assessment of dynamic amplification factors).
3. Ensure that the modules will stay attached to the mounting structure under all environmental conditions specified by applicable codes.
4. Ensure that the design of the mounting structure will specify the attachment of the PV modules to mounting structure in accordance with the mounting specifications provided by the PV module manufacturer.
5. Submit all structural designs and calculations for the mounting system to Owner for review and approval prior to purchase of any mounting system equipment.
6. Prepare a design that conforms to the recommendations of the geotechnical engineer, and mitigate the effects of corrosive soils on the structural support system, which includes adding sacrificial layer to the structural steel members,

galvanizing and/or coating the structural steel members with additional epoxy coating.

7. Commissioning and quality control and assurance records shall be submitted, including: pile test data, concrete test data, pile installation data as applicable (embedment depth, torque data for helical piles, inspection data), and visual inspection data that conforms that the foundations and structure meet dimensional tolerances, show no signs of corrosion, cracking, warping or spalling.

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 05**

# SOLAR PRE-OPERATIONAL STARTUP AND TESTING

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
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| 0 | 13Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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## 1.0 SCOPE

Unless otherwise stipulated by the Scope of Work, Contractor is responsible for conducting all Commissioning and Acceptance Tests outlined in this System Commissioning and Performance Tests (Protocol). In addition, Contractor shall perform any additional tests or measurements as required by applicable Standards, Codes or the requirements of the Authorities Having Jurisdiction (AHJ) or Local Electric Utility, and equipment manufacturers. All labor, materials, equipment, and tools used to complete Commissioning and Acceptance Testing shall be qualified and suitable for the assigned task.

The tests shall meet the requirements presented in this specification and all referenced industry standards. All tests shall be in accordance with any applicable manufacturer's instructions and/or protocols. Any discrepancy between this specification and the tests conducted in the field shall be reported to the Owner in writing.

## 2.0 APPLICABLE STANDARDS AND CODES

Startup and testing to be performed per Applicable codes and standards, laws and regulations, engineer of record andin accordance with Appendix G1 Attachment 01 Exhibit 03 – Applicable Codes & Standards.

## 3.0 GENERAL REQUIREMENTS

This section discusses the Commissioning and Acceptance Testing documents which are to be prepared by Contractor and submitted to Owner. These include:

1. Factory acceptance tests
2. Commissioning Test Manual
    a. General Inspection Plan
    b. System Grounding
    c. Cable and Module Testing
    d. Equipment Testing
    e. System Testing
3. Individual Test Reports
4. Final Commissioning Test Summary
5. Acceptance Test Report

Contractor shall collaborate with equipment manufacture representatives and ensure that appropriate technical representatives are available during, including but not limited to, inspection, installation, and mechanical completion.

## 3.1 OWNER'S RIGHT TO WITNESS TESTS

Owner reserves the right to attend and witness all onsite and offsite tests in relation to the Work. Owner shall be offered an invitation two months prior to all testing for right to attend.

## 3.2 FACTORY ACCEPTANCE TESTS

Contractor is responsible for the provision of FAT documentation for all components, including any components manufactured by a third party.

FATs shall be performed in accordance with the relevant manufacturer's established procedures, its approved quality assurance scheme and as identified in Contractors quality plan.

## 3.3 COMMISSIONING TEST MANUAL

Contractor shall prepare and submit an initial draft of the Commissioning Test Manual for the Project to Owner for review no later than thirty (30) calendar days before the scheduled start of commissioning. The Commissioning Test Manual shall include all applicable tests set forth in this Protocol, including the General Inspection, and shall comply with all of the requirements set forth by this Protocol. Owner will return comments to Contractor and Contractor will amend and resubmit the Commissioning Test Manual to Owner no more than ten (10) business days after comments were received. Contractor will be responsible for finalizing the Commissioning Test Manual with Owner.

The test procedures outlined in the Commissioning Test Manual shall include the following information as applicable to the Scope of Work:

1. Prerequisites to the tests
2. Make and model of equipment to be used for measuring data
3. List of the data that will be collected
4. Test procedures which shall be used
5. Successful acceptance criteria
6. Any differences between tests in the Manual and this Protocol
7. Test report templates

The Commissioning Test Manual shall include a testing schedule which is consistent with the overall project schedule and presents the following in detail:

1. Expected duration of each test, including start and end dates
2. Plans for submission of test data and final test report

## 3.4 TEST REQUIREMENTS

Contractor shall comply with the following test requirements:

1. Notify Owner of offsite testing schedules and testing procedures at least 60 days in advance of such testing.
2. Notify Owner of onsite testing schedules and testing procedures at least 30 days in advance of such testing.
3. Provide at least ten (10) business days confirmation notice to Owner prior to the actual commencement of any inspections and/or tests in this Protocol or the Commissioning Test Manual.
4. Provide documentation to Owner certifying that inspections or tests have been conducted in accordance with this Protocol.
5. All testing shall meet the pre-operational requirements set forth by the Local Electric Utility in addition to compliance with the agreed upon Commissioning Test Manual.
6. All testing equipment shall be calibrated in accordance with the applicable manufacturer's requirements and industry standards and be conducted by a certified and recognized equipment testing authority.
7. Provide equipment calibration certificates for all installed instrumentation as part of submission of test documentation.

## 3.5 TEST REPORTS

Contractor shall submit Test Reports that document the results of each of the tests in the Commissioning Test Manual and this Protocol. Individual Test Reports shall include the following, at a minimum for each test:

1. Any mutually agreed upon deviations from the Commissioning Test Manual procedures
2. Instrument calibration sheets and certificates
3. Test data, including corrected test data
4. Field notes (weather conditions, observations, etc.)
5. Test calculations
6. Any deficiencies or issues identified during, or as a result, of testing
    a. Any corrective actions taken shall be documented, and will include any subsequent retesting results, as applicable.
7. Conclusions
8. Signatures of Contractor and Commissioning Manager

A Final Commissioning Test Summary shall be prepared to document the results of all Commissioning Tests in a single document. The Final Commissioning Test Summary shall be submitted to Owner within five (5) business days following the completion of all Commissioning Testing.

An Acceptance Test Report shall be prepared and submitted for Owner review within five (5) business days following completion of the Acceptance Tests.

## 3.6 TEST REPORT LABELING

All test report files submitted to Owner shall be labeled in accordance with the Commissioning Test Manual or this Protocol.

For Example:

1. The Open-Circuit Voltage ($V_{oc}$) String Test found in Section 4.4.1 of this Protocol shall have a corresponding test report labeled "4.4.1_VocStringTestReport.pdf" and associated data files labeled "4.4.1_VocStringTestData.csv".

## 4.0 COMMISSIONING TESTING

### 4.1.1 Use of Temporary or Remote Instrumentation

With the written permission of Owner, temporary or remote instrumentation may be used to perform the measurements required for Commissioning Testing.

### 4.1.2 Test Conditions

All Equipment required for the normal operation of the Facility will be operated in as close to normal, automatic, or manual modes, as practicable. During all tests, Contractor and its subcontractors will have free access to the Project and all operating data for purposes of monitoring and calculating performance.

### 4.1.3 Test Calculations

All calculations prescribed within this Protocol will be carried out by Contractor and submitted to Owner for approval.

## 4.2 GENERAL INSPECTIONS

A comprehensive General Inspection Plan shall be developed by Contractor and presented to the Owner as a part of the Commissioning Test Manual.

The General Inspection of components shall be performed prior to any Commissioning Tests on those components and include, at a minimum, a Visual & Mechanical inspection and a Grounding System inspection. The visual inspection shall include, but is not limited to, the inspection for possible issues and verification of the Project design. Any issues identified by the General Inspection shall be rectified immediately and reported to the Owner. The General Inspection shall be repeated until all issues are resolved.

### 4.2.1 Identification of General Issues

The General Inspection shall identify any issues and/or irregularities, including the following:

1. Physical damage. All readily accessible cables, modules, racking, inverters and other system components shall be visually inspected to be free of physical damage.
2. Poor wire management. All readily accessible wires and cables shall be visually inspected to ensure that they are installed in a clean and workmanlike manner with no loosely hanging wires.
3. Corrosion. All readily accessible system components shall be visually inspected to be free of corrosion or oxidation issues such as rusting.
4. Shading concerns. The Project site shall be visually inspected for unforeseen obstructions which may cause unexpected shading on modules.
5. Poor welds. All readily accessible welds performed in the field shall be visually inspected for issues.
6. Missing torque marks. Visual torque marks shall be visually inspected on a sampling of lug and bolt heads. Torque marks shall extend for the center of the bolt head continuously to the surface on which the bolt is secured.

### 4.2.2 Verification of Design

The General Inspection shall verify the correct installation of system components per the Project design and include a review of the following:

1. Markings and labels
2. Equipment ratings
3. Wire sizing
4. Module flash test review
5. Mounting or racking components
6. Tracker components (if applicable)

## 4.3 SYSTEM GROUNDING

Contractor shall ensure that all components are properly grounded according to design and specifications. Grounding connections shall be inspected by an AHJ or other independent quality control inspector to verify proper installation of all compression clamps, CAD welds, and mechanical connections. The DC and AC system groundings shall conform to all applicable codes and standards. Visual inspection of the grounding systems shall be documented in a report that includes, but is not limited to, the following verifications:

1. Racking posts grounded per specifications and connected to system grid
2. Module grounding components installed correctly (washers, clips, etc.)
3. All readily accessible connections visually verified
    a. Mechanical attachment
        i. Anti-oxidation coatings applied, as required
    b. Lugs fully seated
    c. Whip installed per manufacturer’s requirements
    d. Connections to grounding grid inspected
        i. CAD welds

ii. Compression clamps

4. Grounding Rods
    a. Rods set to depth per drawings or otherwise verified to provide adequate ground connection as determined by the engineer.
    b. Clamp fully engaged
    c. Whip/cable fully engaged
    d. Substation ground grid testing at per substation specification
    e. Inverter ground grid testing per substation specification requirements

## 4.4 CABLE AND MODULE TESTING

### 4.4.1 Open-Circuit Voltage (Voc) String Test

Open-circuit voltage ($V_{oc}$) string testing shall be conducted in order to assess overall module and string performance. The test shall be conducted and witnessed by at least two qualified technicians using best practices and the following procedure:

1. The test shall be conducted during periods of irradiance greater than POA 500 W/m2 and between the hours of 10:00am and 2:00pm. Expanded hours and lower POA values may be authorized in writing by Owner.
2. Inspect string fuses for appropriate use and correct sizing.
3. Measure and record the following for every string:
    a. String number and combiner box location (or similar relevant string identification)
    b. Time of test and weather conditions
    c. Module back-sheet temperature at a location representative of the strings being tested. Measurements made every 5 minutes using an infrared thermometer or thermocouple affixed to the back side of the module
    d. Plane-of-Array (POA) irradiance measurement for area of strings being tested
    e. Open-circuit voltage ($V_{oc}$) measurement of every string within each combiner box. Measurement shall be made using a voltmeter with the suitable voltage rating and accuracy of at least 0.5%
    f. Verification of correct polarity
4. Each measured string Voc shall be within 5% from the expected $V_{oc}$ ($V_{oc-expected}$) and within 5% of adjacent strings under identical temperature and irradiance conditions. The expected $V_{oc}$ shall be calculated using the following equation:

$$V_{oc-expected} = \eta \cdot V_{oc-ref} \cdot \left[1 + \beta \cdot \left(T_{mod} - T_{mod-ref}\right)\right]$$

where:

$V_{oc-expected}$ = expected open-circuit voltage of the string

$V_{oc-ref}$ = module open-circuit voltage at reference conditions

$\eta$ = number of modules in series in tested string

$\beta$ = module open-circuit temperature coefficient (°C$^{-1}$)

$T_{mod}$ = measured temperature at back of module (°C)

$T_{mod-ref}$ = back of module temperature at reference conditions

5. Comparisons between all measured and expected $V_{oc}$ shall be analyzed in a spreadsheet which shall include the following PASS/FAIL tests for each string:

   String $V_{oc-measured}$ is within 5% of $V_{oc-expected}$

   String $V_{oc-measured}$ is within 5% of the $V_{oc-measured}$ of adjacent strings
6. Strings that fail either test shall be investigated for module defects, loose connections, disconnected modules, or other possible defects.
7. IV Curve Trace Testing as described in the following section may be used as source for ($V_{oc}$) upon written approval of Owner.

### 4.4.2 IV Curve Trace Test

Contractor shall perform IV Curve Tracer tests for all strings of modules connected to combiner boxes at each combiner box location. The test shall be conducted and witnessed by at least two qualified technicians using best practices and the following procedure:

1. The test shall be conducted during periods when irradiance is greater than 500 W/m$^2$ and between the hours of 10:00am and 2:00pm. Expanded hours and lower POA values may be authorized in writing by Owner.
2. Verify that the module and IV Curve Tracer are compatible.
3. Shut down the inverter associated with the string and combiner box being tested.
4. Disconnect the combiner box (or relevant DC disconnect switch) from the inverter and all other DC systems.
5. Measure, record and verify the following for every string:
   - o String number and combiner box location (or similar relevant string identification)
   - o Date and time
   - o POA irradiance at precise time of test
   - o Module backsheet temperature (use a string representative of all others being tested)
   - o Ambient temperature
   - o Wind speed
   - o Weather conditions
   - o Correct polarity shall be verified.
6. Using an IV Curve Tracer, perform the curve trace using the manufacturer's instructions. The Curve Tracer shall be configured to record at least 10 current-voltage data points and record the following values:

- o Maximum power ($P_{max}$)
- o Voltage at maximum power ($V_{mp}$)
- o Current at maximum power ($I_{mp}$)
- o Open circuit voltage ($V_{oc}$)
- o Short circuit voltage ($I_{sc}$)
- o Fill Factor (FF)

7. Short-circuit current test: Each measured string short-circuit current shall be greater than the expected short-circuit current ($I_{sc-expected}$) derived using the following equation:

$$I_{sc-expected} = \kappa \cdot I_{sc-ref} \cdot \left(\frac{G}{G_{ref}}\right)$$

where:

$I_{sc-expected}$ = expected short-circuit current of the string

$I_{sc-ref}$ = short-circuit current at Standard Test Conditions (STC) as shown on module datasheet

$\kappa$ = 0.95 (uncertainty and soiling factor)

$G$ = measured irradiance (W/m$^2$)

$G_{ref}$ = 1000 W/m$^2$

### 4.4.3 Low Voltage Insulation Resistance ("Megger") Test

All low voltage (LV) direct current (DC) and alternating current (AC) cables shall be tested for insulation resistance in accordance with the NETA-ATS. Measured insulation resistance values shall be adjusted to a 20°C reference in order to determine acceptance with NETA-ATS Tables 100.1 and 100.14.

All insulation resistance acceptance criteria shall be proposed by Contractor and approved by Owner. Any test results that fail to be in accordance with the NETA-ATS, or do not meet the accepted criteria, shall be documented as a deficiency on the test report. Corrective action shall follow the identification of a failed test, followed by re-testing.

### 4.4.4 Cable Tests (Low and Medium Voltage)

#### 4.4.4.1 Low Voltage Cables (50 – 1000 V AC, 120 - 1500 V dc)

All low voltage cables shall be inspected and tested in accordance with NETA-ATS, Section 7.3.2. Test values shall be in accordance with NETA-ATS, Section 7.3.2.3.

Note: NETA-ATS states that Section 7.3.2 is for low-voltage cables up to a 600 Volt Maximum. This Section shall also be used for cables with voltages up to 1500 Volts.

Test voltages applied in the field shall not exceed the maximum test voltage of NETA-ATS Table 100.1.

Verify uniform resistance for all parallel conductors.

#### 4.4.4.2 Medium Voltage Cables (1000 V AC – 69 kV AC, greater than 1500 V dc)

Inspection and testing shall be performed after all splices and cable terminations have been installed.

All medium voltage cables shall be inspected and tested in accordance with NETA-ATS, Section 7.3.3. Test values shall be in accordance with NETA-ATS, Section 7.3.3.3.

The acceptable test method for Section 7.3.3.2.4 is the Very Low Frequency (VLF) test. The tests shall be performed after cable terminations have been installed. Tan-delta testing measurement shall be performed in conjunction with the VLF test. Other test methods may be used subject to Owner approval, except that dc dielectric withstand testing shall not be used.

Test voltages applied in the field shall not exceed 80% of the factory test value, and shall not exceed the maximum test voltage shown in NETA-ATS Table 100.6.

Verify proper installation of faulted-cable indicators as shown in the project drawings, as applicable.

Test values are to be in accordance with NETA-ATS section 7.3.3.3. Tan-delta results shall be submitted as a chart of the tan-delta value vs. test voltage.

### 4.4.5 Phase Rotation Test (as applicable)

A test that verifies the proper AC phase rotation at the point of interconnection (Point of Common Connection – PCC) shall be completed, documented, and clearly labeled.

### 4.4.6 Polarity Test

Verify that all circuits have the correct polarity according to the design drawings. Verify proper termination of positive (+) and negative (-) cable connections.

### 4.4.7 Copper Communication line Testing

Test all circuits, with connectors in place, with the appropriate communication tester for the circuit, (CAT5, Coaxial, Paired, RJ45, etc.).

Verify all connections between switches and equipment within a building is Category 6 copper.

All insulated conductors of communication cable shall be tested for continuity.

High performance cable certification shall be performed for the permanent link configuration and documented for all CAT6 cables. Testing shall be accomplished with a Level III (CAT6) compliant test set with a minimum spectral frequency range of 1 to 250 MHz (CAT6). The test specifications for all installed cables must meet or exceed the specifications for CAT 6 cabling, respectively, that are documented within the TIA/EIA-568-B.2.

Cables not achieving a PASS rating shall be corrected and re-certified. Cables that cannot achieve a PASS rating shall be replaced and re-certified. A rating of *PASS (marginally pass) or *FAIL (marginally fail) is not acceptable.

### 4.4.8 Fiber Optic Line Testing

All fiber optic network assemblies shall be tested per Fiber Optic Association (FOA) standards with appropriate Optical Loss Test Set (OLTS). Optical Time Domain Reflectometer (OTDR) testing may be required by the engineer.

If required, Contractor shall perform OTDR testing on all OPGW fiber cables and provide tests to Owner for review two weeks prior to energization of the associated equipment. Fiber, splice, and connector losses shall not exceed industry standards and any detected cable damage shall be repaired prior to acceptance of the work.

Verify OPGW fiber cable is AFL DNO-8234 (48-CNT) or Owner approved alternative.

Verify ADSS fiber cable is OFS AT 3BE17NT-060-CMEA (60-CNT) or Owner approved alternative.

As a minimum, all testing shall conform to the requirements of ANSI/TIA/EIA-568B, optical fiber link performance testing, and TIA/EIA-526-14A, end-to-end attenuation testing.

Contractor shall submit test documentation to Owner that includes the circuit number, type of test, date of test, test results, etc. In addition, Contractor shall submit installation, termination and as-built documentation to Owner as follows:

1) Circuit installation documentation shall include circuit number; origin and destination; routing; cable type, size, length; date of installation, etc.

2) Circuit termination documentation shall include circuit number; equipment termination locations; date(s) terminated; etc.

3) Modifications to the fiber-optic routing, if any.

4) Locations and details of any splice points not included in original design documentation, if any.

## 4.5 EQUIPMENT TESTING

### 4.5.1 Circuit Breaker Tests (Low, Medium, and High Voltage)

#### 4.5.1.1 Low-Voltage Insulated-Case/Molded-Case Air Circuit Breakers

Inspect and test each circuit breaker in accordance with NETA-ATS, Section 7.6.1.1.

Confirm that if a breaker is being back-fed, it is rated accordingly.

Verify that the Test values are in accordance with NETA-ATS, Section 7.6.1.1.3.

Proof and documentation of equivalent factory testing, if applicable, may be provided in place of Contractor performing the test described above at Owner discretion.

#### 4.5.1.2 Low-Voltage Power Air Circuit Breakers

Inspect and test circuit breakers in accordance with NETA-ATS, Section 7.6.1.2.

Confirm that if a Breaker is being back-fed, it is rated accordingly.

Verify that test values are in accordance with NETA-ATS, Section 7.6.1.2.3.

#### 4.5.1.3 Medium-Voltage Air Circuit Breakers (as applicable)

Contractor shall unload and place breakers in their final position on the foundation and install the bushings as required. The breaker shall be affixed to the foundation in the method specified on the drawings.

Inspect and test circuit breakers in accordance with NETA-ATS, Section 7.6.1.3.

Confirm that if a Breaker is being back-fed, it is rated accordingly.

Perform the optional power factor test on each pole and bushing (7.6.1.3.2.7-8)

Verify that the test values are in accordance with NETA-ATS, Section 7.6.1.3.3.

#### 4.5.1.4 Medium and High Voltage Oil Circuit Breakers (as applicable)

Contractor shall unload and place breakers in their final position on the foundation and install the bushings as required. The breaker shall be affixed to the foundation in the method specified on the drawings.

Inspect and test circuit breakers in accordance with NETA-ATS, Section 7.6.2.

Confirm that if a Breaker is being back-fed, it is rated accordingly.

Verify that the test values are in accordance with NETA-ATS, Section 7.6.2.3.

#### 4.5.1.5 Medium-Voltage Vacuum Breakers (as applicable)

Inspect and test each circuit breaker in accordance with NETA-ATS, Section 7.6.3.

Perform the optional power factor test on each pole and bushing (7.6.3.2.8-9).

Verify that the test values are in accordance with NETA-ATS, Section 7.6.3.3.

#### 4.5.1.6 High Voltage Breaker, SF6

Contractor shall unload and place breakers in their final position on the foundation and install the bushings as required. The breaker shall be affixed to the foundation in the method specified on the drawings.

For SF6 type of breakers, the gas will be shipped in separate containers provided by the Owner. All gas containers, full, partially full, or empty are to be retained for proper inventory and returned to the Owner at the point of delivery. Contractor shall maintain a log of the amount of gas used for each piece of equipment, the gas container tracking number, equipment PGE number, date received, date used and date returned to Owner.

Contractor, please note that SF6 gas is not toxic but care is advised.

Inspect and test circuit breaker in accordance with NETA-ATS section 7.6.4.

Perform the optional SF6 gas sample test.

Perform the optional dielectric withstand voltage test.

Verify that the test values are to be in accordance with NETA-ATS section 7.6.4.3.

### 4.5.2 Switch Tests (Low, Medium and High Voltage)

#### 4.5.2.1 DC and AC Switches (Low Voltage)

Inspect and test each low voltage switch in accordance with NETA-ATS, Section 7.5.1.1.

Confirm and document correct electrically-bonded equipment ground.

Confirm and document that metal-enclosed switches are clean and that any debris has been removed.

Verify that switches used in DC applications are rated and installed accordingly.

Verify that warning signs (where provided) are in accordance with the National Electrical Code (NEC), or equivalent electrical code that is applicable to the Project.

Verify that test values are in accordance with NETA-ATS, Section 7.5.1.1.3.

### 4.5.2.2 Medium Voltage Switches (Metal-Enclosed) (as applicable)

The three-pole group-operated switches, including ground blades, if supplied, shall be mounted as indicated on the drawings, with manual and control mechanisms to provide for operation from the ground. The switch mechanisms shall be adjusted for proper operation in accordance with manufacturer's instruction data.Inspect and test each medium voltage (MV) metal-enclosed switch in accordance with NETA-ATS, Section 7.5.1.2.

If applicable, include testing of the motorized switch operator device, in accordance with NETA-ATS, Section 7.5.1.2.

Verify that test values are in accordance with NETA-ATS, Section 7.5.1.2.3.

### 4.5.2.3 Medium and High Voltage Air Break Switches (as applicable)

The three-pole group-operated switches, including ground blades, if supplied, shall be mounted as indicated on the drawings, with manual and control mechanisms to provide for operation from the ground. The switch mechanisms shall be adjusted for proper operation in accordance with manufacturer's instruction data.

Inspect and test each medium and high voltage (HV) air break switch in accordance with NETA-ATS, Section 7.5.1.3.

If applicable, include testing of the motorized switch operator mechanism, in accordance with NETA-ATS, Section 7.5.1.3.

Verify that test values are in accordance with NETA-ATS, Section 7.5.1.3.3.

### 4.5.3 Switchgear and Switchboard Equipment Inspection (as applicable)

The Contractor shall be responsible for assembling and preparation of the switchgear. The switchgear shall be placed on the foundation as recommended by the manufacturer.

Assembling includes installing all bushings, external wiring, bus connections, and auxiliary equipment

Contractor shall review factory test documentation to confirm that all MV and HV (as applicable) switchgear assemblies have passed all factory tests including, but not limited to:

1. Insulation Resistance
2. AC High Voltage Withstand
3. Main Contact Resistance (Ductor Tests)

4. Earth Switch Resistance (Ductor Tests)
5. Oil Dielectric Strength
6. Functional Tests
7. Type Tests

Contactor shall review factory test documentation to confirm that all LV switchgear has passed all factory tests including, but not limited to:

1. Insulation Resistance
2. Contact Resistance
3. Functional Tests
4. Type Tests

Inspect and test each Switchgear and Switchboard Assembly in accordance with NETA-ATS section 7.1.

As per NETA-ATS section 7.1.2.11 perform system function tests in accordance with NETA-ATS section 8, which requires interlock system testing.

Perform the insulation-resistance tests on control wiring as per NETA-ATS section 7.1.2.4,

Test values are to be in accordance with NETA-ATS section 7.1.3

### 4.5.4 Transformer Tests (as applicable)

All design, installation, testing, and commissioning shall meet Owner's transformer specifications, as applicable.

#### 4.5.4.1 Liquid Filled Transformers

Inspect and test each Transformer in accordance with NETA-ATS, Section 7.2.2.

Inspect and test the sudden pressure relay when applicable.

Verify that test values are in accordance with NETA-ATS, Section 7.2.2.3.

If not required by the manufacturer, Contractor has the option to also perform the following tests (if applicable):

1. Core insulation resistance test (7.2.2.2.8).
2. Measure the percentage of oxygen in the nitrogen blanket (7.2.2.2.9).
3. Oil tests for water content, and power-factor (7.2.2.2.10.7-8).

Note: Proof and documentation of equivalent factory testing, if applicable, may be provided in place of Contractor performing the tests described above.

#### 4.5.4.2 Dry-Type Transformers (small and large)

Inspect and test each Transformer in accordance with NETA-ATS, Section 7.2.1.1 or 7.2.1.2 (small or large transformers).

Verify that test values are in accordance with NETA-ATS, Section 7.2.1.1.3 or 7.2.1.2.3.

Note: Proof and documentation of equivalent factory testing, if applicable, may be provided in place of Contractor performing the tests described above.

### 4.5.5 Inverter Commissioning

Inverters shall be commissioned by the inverter manufacturer, or an authorized representative of the manufacturer, using the manufacturer's specified procedures. Commissioning reports shall be in a format provided by the manufacturer.

At a minimum, inverter commissioning shall meet the following requirements:

1. Inverters shall be fully operational after commissioning completion
2. All shipping and packing materials shall be removed from inverter cabinets
3. Fuses and air filters shall be checked, verified as correct and in place
4. Torque wrench marks shall be recorded
5. Software updates and data acquisition (DAQ) communication shall be tested and functional

### 4.5.6 Meteorological (MET) Station Equipment

Meteorological (MET) station equipment shall be commissioned, calibrated and tested using the manufacturer's specified procedures with accuracy being compared to the manufacturer's specifications. Calibration certificates for each installed instrument shall be confirmed. Test reports shall be in a manufacturer provided format if available.

The following instrumentation, if it is part of the metrology equipment specified by Owner, shall be tested, at a minimum:

1. Solar irradiance measurement device, as applicable, e.g.:
    - Global horizontal irradiance (GHI)
    - Plane of array (POA) irradiance
2. Anemometer (wind speed), as applicable
3. Module temperature, as applicable
4. Ambient temperature, as applicable
5. Rainfall gauge, as applicable
6. Data-logger and communications equipment, as applicable

Data from the MET station shall be sampled from the sensors at a minimum of once per ten (10) seconds. Sampled data shall be averaged over fifteen minute periods. The test report shall document the expected sampling rate.

### 4.5.7 Protective Relay Equipment (as applicable)

Protective relay equipment shall be inspected and tested in accordance with NETA-ATS, Section 7.9. Each equipment device shall be programmed with the specified relay settings provided by, or approved by, the local electrical utility. The following shall be performed and documented in a report, at a minimum:

1. Verify that all grounding pins have been removed from all shorting-type terminal blocks in non-spare current transformer circuits.
2. Verify that all spare current transformers are properly shorted.
3. Perform functional testing of each control scheme, including breaker trip tests, close inhibit tests, lockout relays, alarm functions, and breaker-failure schemes.

After the equipment is energized, measure the magnitude and phase angle of voltage and current inputs and compare to expected values.

For relays involved with substation equipment, contractor shall also 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.)

### 4.5.8 Instrument Transformers

Contractor shall install the potential transformers on the specified structure as indicated on drawings.

The secondary junction boxes shall be assembled by the Contractor and mounted as shown on the drawings.
The Contractor shall install the current transformers in the locations on the structures as indicated on the drawings.
Inspect and test all voltage and current transformers in accordance with NETA-ATS section 7.10.
Perform the optional dielectric withstand tests on primary windings of all voltage transformers.

Perform the additional tests for capacitor-coupled voltage transformers in accordance with NETA-ATS 7.10.2.3.

Test values are to be in accordance with NETA-ATS section 7.10.3.

### 4.5.9 Metering Equipment

All metering, including panel meters and transducers, shall be calibrated to within the manufacturer's accuracy.
Unless specified otherwise, all meters shall be tested and calibrated with equipment of no more than 50 percent of the manufacturer's stated accuracy instrument being tested.

All meters shall be visually inspected for damage, and wiring connections shall be verified in accordance with the three-line diagrams.
Inspect and test metering devices in accordance with NETA-ATS section 7.11.

Test values are to be in accordance with NETA-ATS section 7.11.3.

### 4.5.10 Batteries

Inspect and test the substation batteries (based on battery type) in accordance with NETA-ATS section 7.18.1.

Test values are to be in accordance with NETA-ATS section 7.18.1.

### 4.5.11 Battery Chargers

Inspect and test the substation battery charger in accordance with NETA-ATS section 7.18.2.

Test values are to be in accordance with NETA-ATS section 7.18.2.

### 4.5.12 Surge Arrestors (as applicable)

The Contractor shall install the lightning arresters on the structure provided and as shown on the drawings.

Surge arrestors shall be inspected and tested in accordance with NETA-ATS, Sections 7.19.1 and 7.19.2. Test values shall be in accordance with NETA-ATS, Section 7.19.2.3.

Perform the optional watts-loss test on each medium -voltage arrester element.

Verify that arrester lead lengths are as short as practical and do not have unnecessary bends.

### 4.5.13 Thermographic Survey (Infrared Scans)

Perform a thermographic (infrared) survey in accordance with NETA-ATS, Section 9. All thermo graphic images will be provided to Owner and the survey shall meet the following requirements:

1. The survey shall be performed after all other commissioning tests are complete and while the Project is operational.
2. An infrared (IR) camera shall be used to detect areas of non-uniform temperature.
3. The test shall be conducted during a minimum POA irradiance of 500 W/m2.
4. The survey shall include the following equipment:
    - All combiner and re-combiner boxes
    - All AC power distribution equipment

- All inverters (if infrared test window is available)
- All transformers (if infrared test window is available)
- Five (5) percent of all PV modules from the front
- Five (5) percent of all PV modules from the rear

5. Any covers, shields, or doors on equipment shall be opened, moved, modified with IR windows/similar, or removed during testing of equipment to ensure the survey is free of obstructions to a clear IR image. Arc flash safety shall be considered and proper means and steps taken.
6. Investigate and comment on the results of the thermographic survey in a report that states either no issues were identified or comments on temperature differences greater than:
    - Three degrees Celsius (3°C) between similar components in the same enclosure
    - Fifteen degrees Celsius (15°C) between components and ambient air

### 4.5.14 Motor testing

1. Motor testing for motor > 100hp, if any motors this size.
2. Baseline vibration and acceptance for motors/combs > 100 hp
3. Direction testing for all motors, i.e., bump test motors to verify direction

## 4.6 SYSTEMS TESTING

### 4.6.1 Grounding System Tests

The Grounding System shall be inspected and tested in accordance with NETA-ATS, Section 7.13. Test values shall be in accordance with NETA-ATS, Section 7.13.3.

Ground resistance testing shall be by the fall-of-potential method, in accordance with IEEE-81. Test results shall be compared to the value predicted by the engineer’s grounding calculations. If the measured ground resistance exceeds the calculated value, the engineer of record shall be notified and shall assess if the results are acceptable.

### 4.6.2 Plant SCADA/DAS and Monitoring System Verification

The Supervisory Control and Data Acquisition (SCADA) or Data Acquisition System (DAS) equipment shall be commissioned and tested using the manufacturer's specified procedures. Tests shall verify the correct operation of the SCADA/DAS system, meters, sensors, weather station instruments, and all inverters, while verifying the correct data input logging from trackers, breakers, and other components monitored by the system.

All data points collected by the SCADA shall be verified for consistency from the field device to the SCADA/DAS master device and, if applicable, on the remote monitoring service. This test shall verify that the data collected is correctly received by the SCADA system and can be used to produce any required performance or operation reports.

### 4.6.3 Security System Testing

Security system equipment shall be commissioned, tested and calibrated per requirements provided in Appendix G1 Attachment 01 Exhibit 07 – Security and Compliance.

### 4.6.4 Mounting System Testing

Mounting systems; fixed or trackers shall be inspected and tested by the manufacturer or authorized manufacturer representative. Trackers shall be operational prior to Acceptance Testing. All aspects of the mounting system shall be inspected and documented including, but not limited to, foundations, verifying tilt angle, fastener torques, module mounting methods, motors, software, global positioning system (GPS), and limits and rotation. All software shall be updated to the most recent version. Tracker back-tracking, rotation and stow function shall be such that maximizes annual power production. Back-tracking and stow functions to be demonstrated using grid and auxiliary power when applicable.

## 4.7 MINIMUM REPORTING REQUIREMENTS FOR COMMISSIONING

The following summarizes the minimum data and results that are required to be included in individual commissioning report documentation provided to Owner.

### 4.7.1 General Requirements

The Commissioning Report shall include:

1. Test period, test conditions and Contractor's personnel responsible for test
2. A statement of whether each of the Commissioning inspections and/or tests either passed or failed
3. If one or more inspections and/or tests failed, a detailed explanation shall be submitted to Owner for review
4. A signed statement from Contractor that the Project complies with all of the Commissioning requirements set forth in this Specification

### 4.7.2 Open-Circuit Voltage (Voc) Test for each String

1. String number and combiner box location(s)
2. Date and time of test and weather conditions
3. Verification of correct polarity
4. Module temperature [$^{o}$C]
5. POA Irradiance [W/m$^2$], ≥500 W/m$^2$], at time of test
6. Measured open-circuit voltage ($V_{oc-measured}$) [V], for each string
7. Expected Voc calculation ($V_{oc-expected}$) [V], for each string
8. Percent difference between $V_{oc-expected}$ and $V_{oc-measured}$

### 4.7.3 IV Curve Trace Test

1. String number and combiner box location
2. Date and time of test and weather conditions
3. Module temperature [$^{o}$C]
4. Module temperature [$^{o}$C]
5. POA Irradiance [W/m$^2$], ≥500 W/m$^2$], at time of test
6. Wind speed [$^{o}$C]
7. Verification of correct polarity
8. Measured short-circuit current ($I_{sc-measured}$) [A], for each string tested
9. Expected short-circuit current calculation ($I_{sc-expected}$) [A], for each string tested
10. Verification that $I_{sc-measured}$ is larger than $I_{sc-expected}$

### 4.7.4 Low Voltage Insulation Resistance Test

Measured insulation resistance for each low voltage cable (in Megohms)

Verification that measured resistance exceeds recommended minimum insulation resistances presented in NETA-ATS

Identification of cables that fail the insulation test

### 4.7.5 Cable Tests (Low Voltage)

Visual and mechanical inspections in accordance with NETA-ATS, Section 7.3.2

Electrical tests in accordance with NETA-ATS, Section 7.3.2

### 4.7.6 Cable Tests (Medium Voltage)

Visual and mechanical inspections in accordance with NETA-ATS, Section 7.3.3

Electrical tests in accordance with NETA-ATS, Section 7.3.3

### 4.7.7 Phase Rotation Test

Verification the proper AC phase rotation at the point of interconnection

### 4.7.8 Polarity Test

Verification that all circuits have the correct polarity according to the design drawings

### 4.7.9 Copper Communication line Testing

Test report certifying that all circuits were tested and their corresponding plan identification.

Test report shall identify any circuits requiring repair or that were repaired during testing.

Test report shall include a description of test equipment and method.

### 4.7.10 Fiber Optic Line Testing

Test report showing the calculated Expected Optical Loss and Actual Optical Loss per FOA standards for each circuit identified on the plans.

### 4.7.11 Test report shall include a description of the test equipment and method. Circuit Breaker Tests

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.6

### 4.7.12 Switch Tests

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.5.1

### 4.7.13 Switchgear and Switchboard Equipment Inspections

Verification and documentation confirming passes factory tests of the following for low, medium, and high voltage switchgear assemblies (if applicable):

1. Insulation resistance
2. AC High Voltage Withstand
3. Main Contact Resistance
4. Earth Switch Resistance
5. Oil Dielectric Strength
6. Functional Tests
7. Type Tests

### 4.7.14 Transformer Tests

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.2.2 for liquid filled transformers or Section 7.2.1 for dry-type transformers

### 4.7.15 Inverter Commissioning

Inverter commissioning report shall be from the manufacturer or authorized manufacturer representative

Commissioning reports shall verify the following:

1. Inverters are fully functional
2. Fuses and air filters have been checked and verified as correctly installed
3. Torque wrench marks have been recorded and mechanically verified
4. Software is up-to-date and functional

### 4.7.16 Meteorological (Met) Station Instrumentation

Provision of calibration certificates for all Met station instruments

Verification that all Met station equipment has been tested and verified as functional

### 4.7.17 Protective Relay Equipment

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.9

Verification of the following items:

1. Grounding pins have been removed
2. Spare current transformers are properly shorted
3. Functional test verification

### 4.7.18 Instrument Transformers

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.10 and the required optional and additional tests.

### 4.7.19 Metering Equipment

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.11.

### 4.7.20 Batteries

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.18.1.

### 4.7.21 Battery Chargers

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.18.2.

### 4.7.22 Surge Arrestors (as applicable)

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.19.1 and 7.19.2, and test values be in accordance with Section 7.19.2.3

### 4.7.23 Thermographic Survey (Infrared Scans)

Submission of infrared scans for:

1. All combiner boxes
2. All re-combiner boxes
3. All AC power distribution equipment
4. All inverters and transformers (if infrared test window is available)
5. Five percent (5%) of all PV modules (both front and back scan)

Report shall comment of the results of the thermographic survey and identify any issues identified

### 4.7.24 Grounding Systems Test

All reported inspections and tests shall be in accordance with NETA-ATS, Section 7.13, and test values be verified to be in accordance with Section 7.3.2.3

### 4.7.25 SCADA/DAS and Monitoring System Verification

Test report shall verify that data collected by the SCADA system is correctly received by the monitoring system and is sufficient to being used for required performance and operation reports

### 4.7.26 Security system testing

Security system installer shall provide verification of the completed commissioning, testing and calibration of the security system

Test reporting shall show that all operating modes and alarm conditions have been tested

### 4.7.27 Mounting System Testing

Reporting on the mounting system commissioning shall be from the manufacturer. For fixed tilt systems, reports shall verify, at a minimum, foundations, tilt angle, fastener torques, module mounting methods. For tracking systems, reports shall verify, at a minimum, that motors, software, limits, rotation, foundations, fastener torques, module mounting methods and global positioning systems are operating and functional so that the system maximizes annual power production. Data collected during foundation installation (driving times or torques information) to be reviewed and compared to foundation design.

# 5.0 ACCEPTANCE TESTING

## 5.1 GENERAL

### 5.1.1 Acceptance Test Director

Contractor will designate an Acceptance Test Director (ATD) who will have the responsibility for test coordination. The ATD will maintain authority to start and stop the test as required. The ATD will maintain the authority to consider and accept any required deviations from the test procedure as mutually agreed with the Owner or Owner's representative.

### 5.1.2 Use Temporary or Remote Instrumentation

With the written permission of Owner, temporary or remote instrumentation may be used to perform the measurements required for Acceptance Testing.

### 5.1.3 Test Conditions

All Equipment required for normal operation of the Facility will be operated in normal, automatic, or manual modes, as applicable. During all tests, Contractor and its subcontractors will have free access to the Project and all operating data for purposes of monitoring and calculating performance.

### 5.1.4 Test Calculations

All calculations prescribed within this Protocol will be carried out by Contractor and submitted to Owner for approval.

### 5.1.5 Acceptance Test Data Requirements

Contractor shall provide sufficient data for the Owner to verify the successful completion of Acceptance Testing in addition to Acceptance Test reports. The following data shall be provided by Contractor to the Owner for the Project.

#### 5.1.5.1 Data required for entire Project:

5 minute interval measurements in CSV[1] format for each project:

1. Energy from revenue meter (at point of grid interconnection)
2. Ambient Temperature (for each sensor)
3. Plane-of-Array (POA) Irradiance (for each solar irradiance measurement device)
4. Wind speed
5. DAS/SCADA system access

[1] CSV stands for Comma Separated Value, which is a common file format for data.

6. Energy report taken directly from revenue meter (kWh units, at least 24 hours)
7. Proof from Operator that an imposed performance alert was acknowledged, e.g. screen shot of monitoring UI, ticket or email creation.
8. Proof from Operator that DAS/SCADA is integrated with other business systems, i.e. energy invoice consistent with energy metered.

#### 5.1.5.2 Data Required per Inverter:

5 minute interval measurements in CSV format for each inverter:

1. Real and reactive power output at inverter
2. Any available status indication of reduced real power generation due to reactive power generation (if applicable)
3. Times when inverter AC and DC disconnect are imposed.

## 5.2 OPERATIONAL TEST

A three (3) day long Functional Test, as defined below in its entirety, that demonstrates the continuous and uninterrupted operation of the Facility shall document the following:

1. Inverters. All inverters shall start at wake-up voltage in the morning, operate continuously during periods of sufficient solar irradiance and enter stand-by mode at dusk (sufficient solar irradiance is the amount of solar irradiance necessary for the inverter to operate before entering stand-by mode). Inverter operation shall be autonomous at all times. Inverters shall react properly to remote or automatic AC and DC disconnections. The inverter disconnection mechanism of the grid interconnection shall be functional during grid interconnection faults or failure unless otherwise required by the grid operator. All inverters shall include a communications interface with standard communications protocol to integrate to an external SCADA. Owner reserves the right to observe the inverter display at site to confirm that the Maximum Power Point Tracking (MPPT) is fully functional.
2. SCADA/DAS and Revenue Meter Verification. The reporting interface shall be functional and shall update with new data within expected time period. The accuracy of energy and power values in the reporting interface shall be validated using energy production data obtained directly from the revenue meter. Performance alerts shall be functional and acknowledged by operations staff. Remote monitoring shall be available at the point of telecommunication connection at the plant.
3. Trackers (if applicable). All trackers shall operate autonomously at all times. Tracking accuracy shall be verified to comply with manufacturer's specifications. Every tracker shall have an inclinometer installed for each of its tracking axis of movement. Each inclinometer shall be monitored by the SCADA System.
    - The inclinometer data shall be recorded by the SCADA system at the same rate as the rate of rotation of the axis or more frequently.
    - The inclinometer data shall be compared to time of the day to ensure that the tracker's movement meets manufacturer's specifications.

4. Functionality: The test shall demonstrate that the Facility is functioning and capable of operating free of inverter error throughout the specified test period.
5. Compliance. Contractor shall provide verification that the Facility has the ability to comply with all material safety, system reliability, environmental, and other applicable Laws, Governmental Approvals, the EPC Agreement, the Power Purchase Agreement, and the Interconnection Agreement.

## 5.3 CAPACITY TEST

### 5.3.1 Purpose

The purpose of the Capacity Test is to determine the measured AC capacity (Measured Capacity) of the Project system and to compare the Measured Capacity to an Expected Capacity. Both the Measured Capacity and the Expected Capacity will be derived at identical Reporting Conditions (RC). Note: The Operational Test must be passed prior to starting the Capacity Test

### 5.3.2 Measurement Requirements

The measured data required for the calculation of Measured Capacity for this test include: plane of array (POA) solar irradiance, ambient temperature, wind speed, and AC power.

1. Ambient Air Temperature: Air temperature measurement equipment shall have a resolution of 0.1 °C or smaller and be accurate to within ±1 °C. The instrument shall include a radiation shield compliant with ASTM D6176. The instrument shall be placed close to the array without interfering with the array's thermal boundary layer.
2. Irradiance: Irradiance shall be measured with a minimum of two ISO 9060 Secondary Standard heated and ventilated pyranometers installed in the plane of array of the modules for every 10 MWp of project capacity. The pyranometers shall be located in different areas of the PV array to sample irradiance in multiple locations. The sensors shall be compared and time periods with differences greater than 10% shall be filtered from use to limit test to stable sky conditions.
3. Wind Speed: The uncertainty of the wind measuring instrument shall be no more than ±0.5 m/s. The instrument shall be placed close to the array but away from any wind flow interference caused by the solar PV array or other obstacles. The sensors shall be compared and time periods with differences greater than 5 m/s shall be filtered from use to limit test to stable wind conditions.
4. Soiling: Soiling shall be assumed to be negligible during the test, modules to be washed prior to testing.
5. AC Power Output: The AC power output of the system shall be measured at the grid interconnection point using a meter which meets or exceeds the accuracy standards per ANSI C12.1.
6. Averaging Interval: The averaging interval shall be 5 minute periods. All measured data shall be recorded as the average over the five-minute period.
7. Sampling rate shall be no higher than 5 seconds for all measurements.

### 5.3.3 Determine Reporting Conditions (RC)

Use ASTM E2939-13 to create RC based on Owner approved reference energy production model and Owner approved historical meteorological dataset

#### 5.3.3.1 Filtered Measured Data and Minimum Dataset Requirements

Contractor shall filter meteorological data and modeled power output data per ASTM E2939-13 and ASTM E-2848-13, Section 9.1, omitting the filter described in ASTM E2848-13 section 9.1.6 (irradiance outside of range) For clarity, section 9.1.8, “inverter not peak power tracking, shall be considered to occur when any individual inverter is operating above 98% of its AC maximum nameplate or when the entire plant is above 98% of its AC nameplate. In addition, any point when the inverter is limited in its real power generation in order to provide reactive power shall be filtered from the dataset.

Filtered data shall provide a dataset that covers at least 5 days of operation.

#### 5.3.3.2 Calculating the Reporting Conditions

The Reporting Conditions (RC) will be determined for each month by following the procedure outlined below in accordance with the test method outlined in ASTM E2848-13. The Reporting Conditions will be averages of the POA Irradiance, Ambient Temperature, and Wind Speed using the filtered datasets.

1. Calculate the reference POA Irradiance for each month ($Irr_{RC,j}$)
    - $Irr_{RC,j}$ shall be selected from the filtered data for each month and shall be the highest of the following values that contains an equal number of data points in the range 0.8 x reference condition –reference condition and reference condition - 1.2 x reference condition : 500, 600, 700, …1000
2. Implement the filter described in 9.1.6 of ASTM E-2848-13 on the already filtered dataset based on the reference irradiation chosen in the above bullet
3. Calculate reference ambient air temperature for each month ($T_{amb,RC,j}$)
    - $T_{amb,RC,j}$ shall be the average ambient temperature of the filtered data for the relevant time period.
4. Calculate reference wind speed each month ($WS_{RC,j}$)
    - $WS_{RC,j}$ shall be the average wind speed of the filtered data for each month.

#### 5.3.3.3 Reporting Conditions Table

[Table 1 shall be filled in prior to Contract signing]. The Reporting Conditions presented in Table 1 shall be used to calculate Expected Capacity in Section 5.3.4.2 of this Protocol.

### 5.3.4 Determine Expected Capacity

Expected Capacity shall be calculated for each month over a complete calendar year (12 months) at the corresponding Reporting Conditions, as determined in Section 5.3.3.2 of this Protocol.

#### 5.3.4.1 Calculate "From Historical" Regression Coefficients and Expected Capacities

Use the filtered modeled power output, filtered plane of array irradiance ($Irr_H$), filtered ambient temperature ($T_{amb,H}$), and filtered wind speed data ($WS_H$) to fit the four (4) "from historical" regression coefficients $\{A_H, B_H, C_H, and\ D_H\}$ defined in ASTM E2848-13, and E2939-13 and compute the resulting target capacities for the selected monthly reference conditions

#### 5.3.4.2 Expected Capacity Table

[Table 1, below shall be filled in prior to Contract signing]. The Expected Capacity recorded in Table 1 shall be used in comparison with the Measured Capacity, as determined per Section 5.3.5 of this Protocol.

**Table 1. Monthly Expected Capacity and Reporting Conditions**

| MONTH (J) | EXPECTED CAPACITY $(C_{exp,j})$ (KW) | REPORTING POA IRRADIANCE $(Irr_{RC,j})$ (W/M$^2$) | REPORTING AMBIENT TEMPERATURE $(T_{amb,RC,j})$ (°C) | REPORTING WIND SPEED $(WS_{RC,j})$ (M/S) |
|---|---|---|---|---|
| January | | | | |
| February | | | | |
| March | | | | |
| April | | | | |
| May | | | | |
| June | | | | |
| July | | | | |
| August | | | | |
| September | | | | |
| October | | | | |
| November | | | | |
| December | | | | |

**Note: in the event that the Measurement Test Period (MTP) for the Measured Capacity spans across the boundary between two months, the Reporting Conditions (RC) corresponding to the MTP will be calculated as a weighted average of the RCs from each of the two months, where the weighting coefficients are based on the percentage of filtered measured data that falls within each month.**

### 5.3.5 Measured Capacity

Measured Capacity shall be determined using ASTM E2848-13, Section 4 using data collected over the Measurement Test Period (MTP). Measured Capacity shall be compared to the Expected Capacity for the Test Month in which the test period occurred and meet the test requirements set forth in Section 5.3.5.4 of this Protocol.

#### 5.3.5.1 Filtered Measured Data

Filter the measured energy production data, measured plane of array irradiance, measured ambient temperature, and measured wind speed in accordance with ASTM E2848, Section 9.1. For clarity, section 9.1.8, inverter not peak power tracking, shall be considered to occur when any individual inverter is operating above 98% of its AC maximum nameplate or when the entire plant is above 98% of its AC nameplate. In addition, any point when the inverter is limited in its real power generation in order to provide reactive power shall be filtered from the dataset.

In addition, data shall be filtered to limit the maximum wind speed to less than 10 m/sec.

#### 5.3.5.2 Minimum Requirements for Filtered Dataset

Post-filtered data shall represent a dataset covering at least 750 minutes of operation.

Therefore, because the test is specified using five (5) minute intervals, a minimum of 150 data points is required.

#### 5.3.5.3 Calculate Measured Capacity

Calculate measured regression coefficients and measured capacity values following the procedure outlined in ASTM E2848-13

#### 5.3.5.4 Minimum Requirement for Measured Capacity

The Measured Capacity of the Project shall be greater than or equal to ninety-seven percent (97%) of the Expected Capacity for the Reporting Period for an acceptable test result.

## 5.4 MINIMUM REPORTING REQUIREMENTS FOR ACCEPTANCE TESTS

### 5.4.1 Operational Test Report

#### 5.4.1.1 General Requirements

The Operational Test Report shall include:

1. Test period, test conditions and Contractor's personnel responsible for test
2. A statement of whether each of the Operational Test either passed or failed
3. If one or more Operational Tests failed, a detailed explanation shall be submitted to Owner for review
4. A signed statement from Contractor that the Project complies with all of the Operational Test requirements set forth in this Specification

#### 5.4.1.2 Required Reporting Data for the Entire Project

The following data for the entire Project, throughout the Operational Test period, shall be included in the Operational Test Report:

1. Verification of proper Met Station functionality, for each averaging interval, including:
    - o POA Irradiance [W/m2], for each solar irradiance measurement device
    - o Ambient Temperature [oC], for each temperature sensor
    - o Wind Speed [m/s], for each wind speed sensor
2. Verification of proper Tracker functionality including average tilt angle(s)
3. Verification of proper SCADA/DAS functionality
    - o Verification of proper communications functionality
    - o Verification that an imposed performance alert was acknowledged
4. Verification of proper Revenue Meter functionality

#### 5.4.1.3 Required Reporting Data for each Inverter

The following data for each inverter, throughout the Functional Test period, shall be included in the Functional Test Report:

1. Verification of proper inverter functionality
2. Real and reactive power output [kWac and kVar] from each inverter, for each averaging interval
3. Any time(s) during when either the AC and/or DC disconnect are imposed
4. Any times(s) during when curtailment was imposed by the utility
5. Any times(s) during when the plant was effectively curtailed due to adverse grid conditions

### 5.4.2 Capacity Test Report

The following data and calculations shall be provided to Owner in the Capacity Test Report and associated documents.

#### 5.4.2.1 General Requirements

The Capacity Test Report shall include:

1. Measurement Test period, test conditions and Contractor's personnel responsible for test
2. A statement of whether the Capacity Test either passed or failed
    - If the Capacity Test failed, a detailed explanation shall be submitted to Owner for review
3. A signed statement from Contractor that the Project complies with all of the Capacity Test requirements set forth in this Specification

#### 5.4.2.2 Data required for entire Project

Mutually agreed upon Historical Meteorological Dataset, including for each hour of a calendar year (8760 hours/year):

1. POA Irradiance [W/m$^2$]
2. Ambient Temperature [$^o$C]
3. Wind Speed [m/s]

Mutually agreed upon Reference Energy Production Model

One calendar year of modeling results at hourly resolution (8760 hours/year) from using the Owner-Approved Historical Meteorological Dataset as input into the Owner-Approved Reference Energy Production Model, including:

1. Energy [kWh]

Calculations and results used to determine the "From Historical" fitting coefficients, for each month:

2. $\{A_H, B_H, C_H, and\ D_H\}$

Calculations and results used to determine the Reporting Conditions, for each month:

3. $\{Irr_{RC,j}, T_{amb,RC,j}, WS_{RC,j}\}$

Calculations and results used to determine the Expected Capacity, for each month:

4. $Expected\ Capacity_j$

A completed version of Table 1, above

Unfiltered measurements for the entire project, for each averaging interval:

1. Energy [kWh] from revenue meter
2. POA Irradiance [W/m2], for each solar irradiance measurement device
3. Ambient Temperature [oC], for each temperature sensor
4. Wind Speed [m/s], for each wind speed sensor
5. Real and Reactive Power output [kWac and kVAr] from each inverter, for each averaging interval
6. Any time(s) during when either the AC and/or DC disconnect are imposed
7. Any times(s) during when curtailment was imposed by the utility
8. Any times(s) during when the plant was effectively curtailed due to adverse grid conditions

Filtered measurements for the entire project, for each averaging interval:

1. Energy [kWh] from revenue meter
2. POA Irradiance [W/m2], for each solar irradiance measurement device
3. Ambient Temperature [oC], for each temperature sensor
4. Wind Speed [m/s], for each wind speed sensor
5. Calculations used to determine the “From-Measured” regression coefficients: $\{A_M, B_M, C_M, and\ D_M\}$
6. Calculations used to determine the Measured Capacity: $Measured\ Capacity$

Calculations and results used to compare Measured Capacity to Expected Capacity

**APPENDIX G3**
**ATTACHMENT 01**
**EXHIBIT 06**

# SOLAR LONG TERM PLANT PERFORMANCE TESTING

# RENEWABLE ENERGY RESOURCES

## PORTLAND GENERAL ELECTRIC

## 2018

## REQUEST FOR PROPOSAL

| NO. | DATE | REVISION | BY | CHK'D | APPROVALS | |
|---|---|---|---|---|---|---|
| 0 | 13Dec17 | Issued for Implementation | DNV -GL | DS | CPA | Craig Armstrong |
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# 1.0 PERFORMANCE GUARANTEE

Contractor shall perform an annual performance test that uses measured annual meteorological data as input into a PVSyst simulation whose output is then compared to the actual measured energy. Commencing on the Project Substantial Completion Certificate Date, Contractor guarantees an Energy Performance Index during the Warranty Period. For avoidance of doubt, the Warranty Period shall be deemed to commence at 12:00 a.m. on the date following the Project Substantial Completion Date, and each year of the Warranty Period shall end on the anniversary of the Project Substantial Completion Date and be comprised of 8760 hours of data. The successful achievement of the Energy Performance Index will be verified annually after each anniversary of the Project Substantial Completion Date according to the procedure defined herein.

## 1.1 PURPOSE

This test is intended to verify that the energy production of the Project meets the Energy Performance Guarantee as calculated with the recorded weather conditions over the course of one year of operation of the Project.

The method requires high-quality field measurements of meteorological data and revenue-grade power generation with a common time interval. Recorded data is filtered to remove missing and erroneous records, and adjusted for various system factors. Meteorological data is used as an input to PV generation modelling software, which is compared to actual Project production. The ratio of actual production over modelled production with identical meteorological conditions defines passing criteria for the Project.

Accuracy of the test is limited by quality of input data, measurement uncertainty, model uncertainty, and applicable assumptions made about system conditions. It is imperative that recorded data be carefully and thoughtfully filtered to reduce biases in the result.

## 1.2 DEFINITIONS

All defined terms shall have the meaning ascribed to them in the Agreement or as defined in [insert contract document].

## 1.3 ENERGY PERFORMANCE TEST

### 1.3.1 Energy Performance Test Plan

No less than 45 Business Days prior to the first day of the Measurement Period, the proposed Energy Performance Test Plan shall be submitted to the Owner by the Contractor for Owner's review and comment in accordance with Section [To BE INSERTED] of the Agreement. The Energy Performance Test Plan shall include (at a minimum) the following information:

1. This test procedure

2. The Project Model with all inputs as applied to the Energy Performance Guarantee
3. Identification of the Project under test
    a. Quantity and make/model of PV modules
    b. Array orientation
    c. Location (latitude, longitude, street address)
4. Identification of interested parties, including contact information
5. The starting and ending dates of the Measurement Period
6. Identification of all sensors and transducers to be used, including cut sheets, calibration records, map of sensor locations with sufficient detail to allow observers to locate the sensors and transducers. This includes sensors required for all applicable Input Parameters (MET station sensors, inverters, and Revenue Meter).
7. Identification of SCADA nomenclature for data channels, and any SCADA calibration parameters (default or custom) for those data channels
8. Identification of sensors intended for Redundant Measurement
9. Identification of Multiple Measurement Set formulas and weighting factors
10. Identification of SCADA data channels intended for use as auxiliary measurements
11. Identification of known data quality concerns, such as time intervals when inter-row shading may be expected to occur
12. Time-stamp convention and data logger averaging technique/interval to be used in reporting data

Measured data are to be made available to the Owner upon request during the Measurement Period, for use in evaluating the progress of the test.

### 1.3.2 Energy Performance Test Report

A draft Energy Performance Test Report will be submitted to the Owner by the Contractor in accordance with Section [TO BE INSERTED] of the Agreement. Owner shall have twenty (20) Business Days to accept or reject the results of the draft Energy Performance Test Report, and provide in writing any comments of Owner on such draft Energy Performance Test Report. In the event that Owner rejects all or any part of the draft Energy Performance Test Report, Contractor shall, within ten (10) Business Days thereafter address any comments of Owner and re-submit the draft Energy Performance Test Report to Owner. This procedure shall continue until Owner accepts the draft Energy Performance Test Report. Any Dispute regarding the results of the Energy Performance Test or the Energy Performance Test Report shall constitute a Technical Dispute.

The Energy Performance Test Report shall contain:

1. The Energy Performance Test Plan
2. The actual start and end date/times of the Measurement Period
3. Comments on environmental conditions during the Measurement Period
4. Summary of data quality control results for all data records

5. Summary of test results
6. Uncertainty analysis considering uncertainty of measurements and model uncertainty, including accuracy of input parameters and loss assumptions
7. Comparison of test results with the Energy Performance Guarantee.

Raw data used as input to the Energy Performance Test, along with quality control (QC) disposition for each input data record, shall be provided electronically (via CSV, XLS, or XLSX formats) to the Owner with the Energy Performance Test Report.

### 1.3.3 Data Quality

Data Quality shall be identified as one item from a set of quality categories for each data record analyzed. Only data from records where all input parameters are valid and within specified limits shall be used in computing production estimates.

Recorded meteorological and power generation data shall be sampled at no greater than 5-second intervals and averaged at no greater than 5-minute intervals. Data shall be averaged and filtered in accordance with the procedures below.

The Measurement Period shall last no less than one year (365 days). No less than 95% of recorded data must be acceptable for use in the Energy Performance Test analysis, after all data filtering has been completed. If this requirement is not met, the Measurement Period shall be extended until such data requirement is met. If the Measurement Period is extended to meet this requirement, Contractor and Owner shall agree, acting reasonably, on an appropriate method to account for seasonal impacts of the revised Measurement Period.

#### 1.3.3.1 Input Parameters

The Input Parameters for the Energy Performance Test shall be:

1. Global Horizontal Irradiance (GHI): For a tracker-mounted system, the average irradiance incident upon a horizontal surface, inclusive of direct and diffuse irradiance and albedo effects.
2. Plane of Array Irradiance (POA): For a fixed-tilt racking system, the average irradiance incident upon the PV module surface (based on system orientation: tilt and azimuth), inclusive of direct and diffuse irradiance and albedo effects.
3. Ambient (Free-Air) Temperature: The temperature of free air at the Site.
4. Wind Speed: In velocity of free air-flow at the Site (sheared to a reporting height of 10 m). Since both measurement height and the obstruction of the Project to air flow affect wind velocity, the measurement must be made at or above 3 m height in a location that will not shade the Project during power-producing hours.
5. Measured Energy Generation: Measured energy generation is the sum of actual power output from the Project, as recorded by the Revenue Meter during the Measurement Period.

### 1.3.3.2 Sensor Requirements

Irradiance sensor classification shall be at a minimum Secondary Standard (ISO 9060). Pyranometers shall include device-specific characterization data that shall, at minimum, include cosine and temperature response. Alternative pyranometers may only be used if approved by Owner. Reference devices are not to be used unless approved in writing by the Owner.

Pyranometers shall be used only within their valid calibration period and shall be cleaned and maintained as per manufacturer instructions and as [specified in the O&M Agreement for the Project], but no less frequently than once per week during the Measurement Period.

Ambient air temperature sensors shall be mounted in radiation shields, and shall be accurate to within ±1°C.

### 1.3.3.3 Sensor Redundancy

A Redundant Measurement set shall consist of sensors located sufficiently close to each other that recorded data is expected to be in agreement. Variations across the Project, such as isolated clouds, should not be evident within a Redundant Measurement set. Any sensors designated as part of a Redundant Measurement set may be identified as invalid and the remaining valid sensors may be averaged to form a valid measurement. Once agreement between Redundant Measurements has been confirmed to within sensor accuracy, remaining data may be averaged with equal weighting. The procedure for quality checking data and confirmation of sensor agreement within a Redundant Measurement set shall be defined in the Energy Performance Test Plan.

### 1.3.3.4 Multiple Measurements

Multiple Measurements shall be recorded for all environmental data throughout the Site in order to capture the operating conditions for all regions of the array.

All measurements identified as part of a Multiple Measurement set (whether from a single sensor or a Redundant Measurement set) must be valid for the data record to be included in further computations.

1. POA: One sensor shall be installed for each orientation (within ±2°) for up to 10 MWp of the Project. Multiple orientations or large arrays shall require Multiple Measurements.
2. GHI: One sensor shall be installed for the Project.
3. Ambient Temperature: One sensor shall be installed for the Project.
4. Wind Speed: One sensor shall be installed for the Project.

Multiple Measurement data sets will be aggregated with a weighted average representative of the portion of the array operating under the associated conditions. Averaging of multiple quality-checked sensors (to be specified in the Energy Performance Test Plan) is required, unless approved otherwise by Owner.

### 1.3.3.5 Data Exclusions

Data records eligible for exclusion consist of items outside the Contractor's control as set forth in this Section 1.3.3.5, such as Utility mandated downtime and Force Majeure Events.

Data records shall be excluded from the Measurement Period only under the following situations:

1. Utility-mandated downtime (e.g., curtailment or other forced outage)
2. Downtime resulting from Force Majeure Events
3. Where one or more Input Parameters is missing (excepting only wind-speed)
4. Where one or more Input Parameters has been excluded for data quality reasons (excepting only wind speed)
5. Erroneous data records and DAS malfunctions

Any excluded records shall be marked as missing with a non-numeric identifier. Missing records shall not have a value included in the analysis, but shall be documented.

For all excluded data records, the corresponding record for all other Input Parameters shall also be removed. For example, at a given time, if the irradiance record is removed from analysis, the power generation, temperature and wind speed records for the same time interval shall also be removed. This is true for the Input Parameters of irradiance, power generation, and ambient temperature. However, if a wind speed record is missing, it may be filled with an irradiance-weighted average of the wind speed calculated with data from the entire year of historical weather data.

Certain minimum criteria must be met for sub-hourly data records to ensure representative hourly averages are calculated. For any given hour, the below criteria must be met.

1. Power Generation: less than 10% of data from the hour is missing
2. Irradiance: less than 10% of data from the hour is missing
3. Temperature: less than 10% of data from the hour is missing
4. Wind Speed: less than 50% of data from the hour is missing

The recorded data set shall be representative of all system losses and conditions as reflected in the first year energy output Project Model. As such, all remaining data shall be included in the analysis without adjustments for PV module degradation, inverter clipping, array soiling, nighttime or parasitic power loads, etc. If certain losses are identified that are not covered in the Project Model, appropriate treatment of such losses must be agreed to by the Contractor and Owner, acting reasonably.

If the Measurement Period extends beyond the first year of operation, adjustments shall be applied as appropriate to ensure equitable application of losses. For example, if PV module degradation is included in the first year energy estimate, no adjustments shall be made for PV module degradation on data recorded during the first year of operation. After that period, however, the agreed upon degradation rate shall be applied to the

modelled data to facilitate a fair comparison to measured power output. All such adjustments must be agreed upon by Contractor and Owner, acting reasonably.

### 1.3.4 Target Energy Generation

The one-year Target Energy Generation is the sum of modelled power output for the Project based on the Project Model and the measured weather conditions during the Measurement Period. The Target Energy Generation is calculated using the modelling software program PVsyst. To accurately represent PV System performance, the PVsyst simulation will utilize defined system parameters and assumptions representative of the Project, as well as filtered in-field measured meteorological data.

### 1.3.5 Measured Energy Generation

The one-year Measured Energy Generation is the sum of actual power output from the Project, as recorded by the Revenue Meter during the Measurement Period. The one-year Measured Energy Generation is calculated using filtered in-field measured energy generation data.

Certain power losses incurred, which are outside the scope of Contractor responsibility, shall be adjusted for when calculating Measured Energy Generation. This includes transformer energy loss and energy loss over the conductor run between the collection switchgear or components and the Revenue Meter, as applicable. In the event that the Revenue Meter applies an adjustment to account for losses in components prior to the Point of Interconnection, that adjustment shall be removed or corrected for in order to calculate the energy at the Revenue Meter.

### 1.3.6 Test Result

The result from the Energy Performance Test shall be the ratio of Measured Energy Generation to the Target Energy Generation (the “Energy Performance Index”). If the Energy Performance Index is less than the Energy Performance Guarantee, then Contractor shall be responsible for the Energy Performance Liquidated Damages as provided in [TO BE INSERTED] of the Agreement.

### 1.3.7 Energy Performance Liquidated Damages

[TO BE INSERTED]

## 1.4 PVSYST PROJECT MODEL

The exact PVsyst model ("Project Model") used to represent the Project for the purposes of the Energy Performance Guarantee is defined in this Exhibit. This section outlines all input parameters required to create the PVsyst simulation, in the event that PVsyst electronic project files are no longer available. This section shall be populated and submitted with the Energy Performance Test Plan.

### 1.4.1 PVsyst Model Files

The table below provides the file names for all model files necessary to run the PVsyst simulation in the PVsyst version specified in the subsequent section. Contractor shall provide all Project Model files with the Energy Performance Test Plan.

**Table 2 PVsyst file names**

| PVsyst file type | File name |
|---|---|
| Project file [PRJ, VC0] | |
| Metrological file [MET] | |
| Site file [SIT] | |
| Module file [PAN] | |
| Inverter file [OND] | |
| Shade file [SHD] | |
| Horizon file [HOR] | |

### 1.4.2 PVsyst Input Parameters

In the event that data files are lost or corrupted, all PVsyst inputs and assumptions have been documented in this section. The table below provides many of the PVsyst inputs required in the simulation.

**Table 3 PVsyst Input Parameters**

| Input Parameter | Value | Comment |
|---|---|---|
| PVsyst Software Version | [ ] | Updates to the software include changes in the calculation of various system attributes. The annual generation value may change based on version utilized. |
| Transposition Model | Perez | For a tracker-mounted system, input irradiance data must be GHI because PVsyst does not allow for import of POA data on a tracker. |

| Input Parameter | Value | Comment |
|---|---|---|
| | | Fixed-tilt racking systems shall use POA irradiance data. |
| Meteorological File Parameters | [Interval End] | It is critical that the time stamp and other parameters are accurately accounted for when importing meteorological data. Data import files and techniques shall be documented and provided with the Energy Performance Test Report. |
| Latitude / Longitude | | °N/ °W |
| Altitude [m] | | |
| Ground Albedo | | |
| Array Orientation (PVsyst Field Type) | [Tracking tilted or horiz. N-S axis] / [Unlimited Sheds] | |
| Tilt | [ ]° | |
| Azimuth | 0° (Due S) | |
| Tracker Backtracking | TRUE | Applicable to horizontal tracker |
| Min / Max Rotation Angle | ± [ ]° | Applicable to horizontal tracker |
| Number of sheds | | Applicable to fixed-tilt |
| Ground Cover Ratio (GCR) | | |
| Pitch [m] | | |
| Collector width [m] | | |
| Electrical Effect | | Applicable to fixed-tilt |
| Number of strings in row width | | Applicable to fixed-tilt |
| Cell size [cm] | | Applicable to fixed-tilt |
| Horizon shade | | |
| Module Type | | |
| Qty. of modules | | |
| Qty. of modules per | | |

| Input Parameter | Value | Comment |
|---|---|---|
| string | | |
| Qty. of parallel strings | | |
| Inverter Type | | |
| Qty. of inverters | | |
| Heat Transfer: Constant loss factor | | |
| Heat Transfer: Wind loss factor | | |
| NOCT [°C] | | |
| DC circuit ohmic loss [%] | | At STC |
| AC circuit ohmic loss [%] | | At STC |
| External Transformer Iron loss [%] | | |
| External Transformer Resistive loss [%] | | |
| External Transformer Nighttime disconnect | | |
| Module quality/efficiency loss [%] | | Includes nameplate (%), modeling correction (%), MPPT (%), and LID (%) |
| Mismatch [%] | | |
| Soiling loss [%] | Jan:<br>Feb:<br>Mar:<br>Apr:<br>May:<br>June:<br>July:<br>Aug:<br>Sept:<br>Oct:<br>Nov: | Modeled loss profile, including [ ] washes per year |

| Input Parameter | Value | Comment |
|---|---|---|
| | Dec: | |
| Incidence Angle effect, ASHRAE Model $b_o$ value | | |

There are many additional settings required to recreate PVsyst files such as meteorological data import techniques, module file [PAN], inverter file [OND], etc. The collection of screen shot images below provides all information needed to recreate the necessary PVsyst model files and system parameters.

#### 1.4.2.1 Meteorological Data Import Technique

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.2 Geographic Site File

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.3 Module PAN

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.4 Inverter OND

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.5 Project

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.6 Orientation

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.7 Horizon

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.8 Near Shading

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

#### 1.4.2.9 System

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

### 1.4.3 Additional Losses

#### 1.4.3.1 Post-Processed Loss

There are multiple losses associated with an operating Project that may not be accounted for in PVsyst. Such losses include night-time demand of inverters, as well as auxiliary loads including but not limited to HVAC, lighting, security, SCADA, etc.

These losses have been included in the modelled power generation, the details of which are defined in the table below.

**Table 4 Model Additional Loss**

| Parameter | Value | Comment |
|---|---|---|
| Availability loss [%] | | |
| Curtailment loss [%] | | |
| Auxiliary Loads [%] | | Accounts for Site lighting, HVAC, security, DAS, tracker motors |
| Nighttime Loads [%] | | |

### 1.4.4 Verification PVsyst Simulation

This section is intended to provide verification that a recreated PVsyst project simulation is calculating the same output as the Project Model. Provided below are the PVsyst output results of a test simulation utilizing a non-applicable meteorological file from the National Renewable Energy Laboratory's (NREL) Typical Metrological Year (TMY) database. All PVsyst input parameters shall match those outlined in the section above and the PVsyst output report provided below. Prior to calculating the modelled power generation target, verification must be provided that the model can successfully repeat the simulation below, within ±0.25% on a monthly basis.

### 1.4.5 PVsyst Output Report

[Screen shot images and any necessary additional information such that file could be completely recreated to be included with the Energy Performance Test Plan.]

### 1.4.6 Year One 8760 Pivot Table

Modelled output data from the above simulation shall be provided in the table below, organized by monthly, hourly subtotals [MWh]. The purpose of this data is for increased visibility to verify agreement between the original energy estimate and the calibration estimate made just prior to applying the measured weather data to the model. This table shall be used for the confirmation of accurately reconstructed Project Model only. The values from this table shall not be applied for any other purpose.

**Table 5: Sample PVsyst 8760 Pivot Table**

| Hour | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | | | | | | | | | | | |
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | |

| Hour | Jan | Feb | Mar | April | May | June | July | Aug | Sept | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | | | | | | | | | | | | | |
| 16 | | | | | | | | | | | | | |
| 17 | | | | | | | | | | | | | |
| 18 | | | | | | | | | | | | | |
| 19 | | | | | | | | | | | | | |
| 20 | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | |
| 22 | | | | | | | | | | | | | |
| 23 | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | |

# 18 Appendix H – Scoring Procedures

# APPENDIX H

## SCORING PROCEDURES

## Overview

Appendix H details the RFP's Price and Non-Price Scoring components, which all bids will be subject to. The maximum possible price score will be 600 points, and the maximum possible non-price score will be 400 points. The maximum overall offer score a bid may receive is 1,000 total points. This 60/40 weighting of the price and non-price scores provides a balance between cost and risk, similar to that in the 2016 IRP, and consistent with past Commission-approved RFP processes. Appendix H also provides additional description on PGE's portfolio analysis methodology.

## Price Scoring

Price accounts for 60% of the maximum overall offer score, or a maximum of 600 points out of 1,000 total. The price score will be determined by the ratio of the offer's projected total cost to its total benefits using real-levelized, or annuity methods, per Guideline 9a of Order No. 14-149 (Oregon Competitive Bidding Guidelines). The price scoring will incorporate benefits of expected energy value, capacity value, and flexibility value associated with each offer.

### Price Scoring Ratio

Following the quantification of offer costs and benefits, including any necessary offer price adjustments (as outlined in the RFP main document section 8.5), each offer's component cost and benefits will be converted to a cost-to-benefit price score ratio. Real-levelized offer costs, divided by the equivalent real-levelized benefits value (incorporating energy, capacity, and flexibility benefits) will be the basis for the offer's price ratio.

### Score Allocation

Once price ratios have been calculated for all offers, PGE will allocate price scoring points on a scaled basis, with 600 points allocated to the offer with the lowest (best) price ratio. The point allocation system is illustrated in the tables below, which are populated with fictitious cost-to-benefit and price scores for the sole purpose of illustrating the score allocation method.

**Table 1. - Illustrative Scoring Example - Cost-to-Benefit Score**

| Cost-to-Benefit Ratio (%) | Price Score |
|---|---|
| 75% | 378 |
| 50% | 528 |
| 80% | 348 |
| 91% | 282 |
| 60% | 468 |
| 38% | 600 |
| 88% | 300 |
| 42% | 576 |
| 101% | 222 |

**Table 2 - Illustrative Scoring Example - Price Ratio to Price Score**

| | Price Ratio | Price Score |
|---|---|---|
| Lowest (Best) | 38 % | 600 |
| Highest | 101% | 222 |
| Average | 69.4% | 411 |
| Ratio Highest/Lowest | 2.66 | 2.70 |

The lowest price ratio offer will receive the highest amount of points possible. All other offers will receive a scaled score, out of the 600 possible points, depending on their relative scores compared to the best score:

The lowest offer with a 38% price ratio will receive 600 points;

Any offer at or above a 138% price ratio will receive 0 points; and

An offer with a 75.0% price ratio will receive:

600-[600*(75%-38%)]

= 600-(600*37%)

= 600-222

= 378

## Determination of the Energy Value

An offer's energy value reflects the value of energy generated throughout the offer's economic life or term. Energy value for the duration of the offer's term is expressed on a present-value basis and included in the denominator of an offer's cost to benefit price score ratio. The energy

value will be based on the offer's simulated dispatch and the projected revenue associated with PGE's hourly market price forecast. The methodology used to create the hourly market price forecast is further described in Exhibit C, the 2016 IRP and the 2016 IRP Update.

### Determination of Capacity Benefits

An offer's capacity benefit reflects PGE's need to acquire new, physical capacity resources due to the offer's estimated system capacity value. PGE is facing a capacity deficit, and requires capacity products, to otherwise displace the need to contract with or construct new peaking generating facilities. The capacity benefit will be included in the denominator of the offers cost to benefit price score ratio.

An offer's capacity benefit will be calculated as the product of the offer's capacity value and the avoided capacity cost. The product's capacity value will be calculated annually using the Renewable Energy Capacity Planning (RECAP) model. RECAP is described in Chapter 5 of the 2016 IRP. The model has been updated to accurately reflect the assumptions included in PGE's 2016 IRP Update filed in March 2018. The offer's capacity value will be expressed as the quantity of avoided simple-cycle combustion turbine (SCCT) needed to meet PGE's long-term capacity targets. The avoided capacity cost will be based on a per kilowatt, real-levelized cost (net of wholesale revenues) of a simple-cycle combustion turbine (SCCT). The assumed costs and performance of the SCCT are consistent with 2016 IRP capital costs and performance metrics (described in Chapter 7) operated under the updated reference case gas and wholesale power prices. The product of the offer's annual capacity value and levelized avoided capacity cost constitute the offers annual capacity benefit. Capacity benefit for the duration of the offer's term is expressed on a present value basis and included in the denominator of the price score ratio.

### Determination of Flexibility Benefits

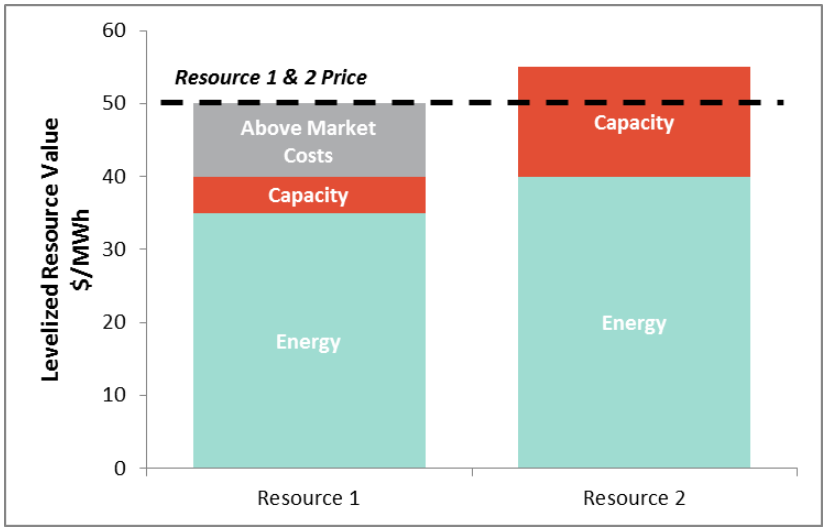
The flexibility value associated with an offer reflects any additional value that the offer may bring to PGE's generation portfolio due to its ability to ramp, respond to forecast errors, and/or provide ancillary services that is not captured by its energy value. PGE approximates flexibility benefits using the Resource Optimization Model (ROM), which the Company relied on in the 2016 IRP to quantify flexibility value associated with energy storage systems and the costs due to flexibility challenges (i.e., integration costs) associated with variable renewable resources. An offer's flexibility benefit is calculated using a methodology further explained in Example B. The flexibility benefit for the duration of the offer's term is expressed on a present value basis and is included in the denominator of the offer's cost-to-benefit price score ratio.

## Price Screen

The cost-containment screen will be unique for each resource evaluated by PGE. The screen will be elevated for resources that provide more value to PGE customers due to the resource's

geographic diversity. For this reason it is possible that a lower priced resource does not pass the economic screen, while a higher priced resource passes the economic screen due to increased resource value (e.g., higher capacity contribution, more valuable energy production profile or higher flexibility value). For example, Figure 1 illustrates a possible application of the proposed cost-containment screen. Resource **1** and Resource 2 have the same resource pricing. However, Resource 1's levelized cost exceeds the resource's energy, capacity and flexibility value. The resource is found to have above-market costs on a real-levelized forecasted basis and does not pass the economic screen. Resource 2 passes the economic screen as its resource value exceeds the resource cost.

**Figure 1: Example of cost containment screen**




It is PGE's expectation that the most economically competitive resources are capable of passing the proposed cost-containment screen. Table 3 provides an example of the applicable economic screen for generic 100 MW renewable resources.

**Table 3: Example energy and capacity values for generic 100 MW resources***

| | Gorge Wind ($/MWh) | Solar ($/MWh) | MT Wind ($/MWh) |
|---|---|---|---|
| Energy Value | $ 44.47 | $ 38.70 | $ 44.05 |
| Capacity Value | $ 6.73 | $ 8.15 | $ 12.72 |
| **Total** | **$ 51.20** | **$ 46.85** | **$ 56.78** |

*Generic wind and solar resources are not considered dispatchable and therefore do not include flexible value.

Were these generic IRP resources to be evaluated within the RFP, the resources would only pass the cost-containment screen if priced below the total resource value. Importantly, each actual resource offered into the RFP will be screened against its unique resource value (not a generic threshold).

## Non-Price Scoring

Non-Price accounts for 40% of the maximum overall offer score, or a maximum of 400 points out of 1,000 total. The non-price scoring will capture elements of the offers that are not easily captured in the price scoring. This is consistent with the RFP Guidelines, specifically 9a. The four main areas of focus are Development Criteria, Physical Characteristics, Performance Certainty, and Credit. See attached Exhibit A for the detailed Non-Price Scoring Rubric.

## Portfolio Analysis

Portfolio modeling will provide PGE with additional information regarding the cost and risk profile of all offers considered. Portfolio analysis methods, consistent with the 2016 IRP, will demonstrate how resources perform together, on a cost and risk basis, due to their specific size, term, portfolio capacity value, and portfolio flexibility value.

### Portfolio Construction

Portfolio analysis begins with the assembly of portfolios evaluating many different unique combinations of resources. The candidate portfolios will be developed through multiple techniques including 1) portfolio size optimization, 2) portfolio net-cost optimization, 3) cost-screened permutations, and 4) additional analyst selected portfolios (if necessary). The specific methodologies used to construct portfolios are described in further detail in Exhibit D.

Each portfolio will include sufficient resources to meet the RFP targeted capacity need in each year. The unique portfolio capacity value for each portfolio will be calculated using the IRP's RECAP methodology. The portfolio capacity calculation will recognize the resources' capacity diversity included in each portfolio. The RECAP model is described in Chapter 5 of the 2016 IRP. Any portfolio whose capacity contribution does not meet the RFP capacity target will also include a specified fill resource ('fill'). Including a fill resource ensures the portfolio incorporates the total cost necessary to meet the RFP capacity target in each year of the analysis. The specified fill resource will be sized to fulfill the resource target in each year of the analysis.

The specified fill resource will have cost and performance characteristics comparable to the average cost and performance of new resources of like product type offered into the RFP.

### Portfolio Analysis

Portfolio analysis will test combinations of resources across multiple futures. The futures will evaluate portfolio exposure to multiple scenarios of gas prices, carbon costs, and hydro conditions. The futures are discussed in Exhibit C. For each portfolio, the relevant resources' variable costs and energy benefits will be calculated recognizing AURORA results under 27 economic and hydro futures. The variable net income for each resource will be reported annually for all futures. The AURORA dispatch simulation is described in Exhibit C.

A unique portfolio flexibility value will be calculated using the portfolio flexibility tool. The portfolio flexibility calculation will recognize the flexibility diversity included in each portfolio. The portfolio flexibility calculation is further detailed in Exhibit B.

For each portfolio, the portfolio flexibility value and the relevant resources' net incomes will be subtracted from the relevant resources' fixed costs to calculate the portfolio's total net cost for each future.

For each portfolio, the total present value net cost for years 2019 through 2050 under each future will be calculated to estimate the cost impact of the additions on the PGE system. This expected cost impact will be measured as the total portfolio net present value of revenue requirement (NPVRR) under reference case conditions. Portfolio risk will be evaluated using the standard deviation of future results. Portfolios will be ranked according to a blended cost and risk metric based 50% on reference case expected cost and 50% based upon the standard deviation of portfolio costs. In addition, portfolio risk will be characterized using additional IRP risk metrics including severity, variability, and durability as described in the 2016 IRP Chapter 11.

Portfolio results will be stress tested under multiple resource targets and qualifying facility planning scenarios.

Portfolio analysis performance will be based on the inclusion of specific offers across multiple top-performing portfolios. Those resources that appear most frequently in top-performing portfolios are those that best reduce cost and economic risks. However, non-price factors are not evaluated or considered in portfolio analysis.

# Exhibit A – Scoring Criteria

## Exhibit A - 2018 RFP Scorecard Template

### Summary

| **Bid Number:** | | **Fill In** | |
|---|---|---|---|
| **Summary** | **Max Score** | **Bid Score** | **Description** |
| 1. Price Scoring | 600 | | |
| 2. Project Development Criteria | 100 | 0 | Includes Development team experience, Permitting, Project Finance, Cost Certainty |
| 3. Project Physical Characteristics | 130 | 0 | Interconnection, Transmission rights, Resource Certainty (production assessment), Engineering Reliability |
| 4. Project Performance Certainty | 120 | 0 | Firmness of Energy, Scheduling, Technological maturity, Online date, Contractual elements |
| 5. Credit Evaluation | 50 | 0 | Score based on counterparty's ratio and debt rating |
| Total Score | 1,000 | 0 | |

*Exhibit A - 2018 RFP Scorecard Template*
**Thresholds**

| Bid Number: | | Required at Bid Submittal or Short List | Yes | No |
|---|---|---|---|---|
| **1. Proposal satisfies minimum bid quantity and duration criteria:** | | | | |
| Size and Term | Minimum size of 10 MW with minimum 20 year duration. | Submittal | | |
| Qualifying Product | Projects must include all associated Renewable Energy Credits (RECs) and all environmental attributes. | Submittal | | |
| Registered Product | Bidder will be responsible for ensuring RECs are established in WREGIS. | Submittal | | |
| **2. Proposal satisfies minimum development criteria** | | | | |
| Site Control | Title, executed lease or executed option agreement for a minimum of 80% of site, with 100% required two weeks prior to final short list. | Submittal and Shortlist | | |
| Permitting | Refer to attached permitting table attached. | Submittal and Shortlist | | |
| Project Financing | Demonstrated ability to internally finance project or evidence of good faith commitment from financing institution/financial backer prior to final short listing. | Shortlist | | |
| Equipment costs estimates - PPA | OEM Supply agreements or quote. LTSA quote optional. | Submittal | | |
| Equipment costs estimates - Utility Ownership | OEM and APA+EPC/BOT bid quote. LTSA quote optional. | Submittal | | |
| Tax Credit Eligibility | New Wind projects must include PTC Opinion from qualified accounting firm for PTC eligibility.<br><br>Solar projects claiming ITC eligibility must demonstrate plan to receive the credit. | Submittal | | |
| **3. Proposal satisfies minimum physical characteristics criteria** | | | | |
| Interconnection | Executed System Impact Study Agreement. | Submittal | | |
| Off System Bidders - BPA Transmission: | Already have long term firm service, PTSA for long term firm service, or CF bridge service agreement transitioning to long-term firm upon near-term, viable upgrades.<br><br>Alternatively, has completed phase four of BPA's TSEP process (Record of Decision issued) and requires near-term viable upgrades which must be completed at least six months prior to COD. | Submittal | | |
| On System Bidders - PGE Transmission | Already have service or granted facility plan with approved construction plan targeting completion at least six months prior to COD. | Submittal | | |

| | | | | |
|---|---|---|---|---|
| Resource certainty - Historical Data Requirements: | Wind/Solar/Hydro resources must provide a minimum 3-years of data and include an output study from verifiable third-party.<br>Geothermal proposals must have feasibility report completed, based on a year or more of test data from full diameter production wells.<br>Biomass/biogas proposals must come with long-range fuel supply plan with identified, established suppliers and transportation options. | Submittal | | |
| **4. Proposal satisfies minimum performance certainty criteria** | | | | |
| Quality of Power | Must be at a minimum unit contingent agreement associated with an identified resource. | Submittal | | |
| Power Scheduling | Off-system resources: Must be integrated by third-party balancing services delivered to PGE using hourly schedules.<br><br>On-system resources: Must be designated Network Resources. | Submittal | | |
| Technological acceptability - Utility Ownership | Major equipment manufacturer must be on attached preferred vendor list. | Submittal | | |
| Online Date | Online on or before December 31, 2021. | Submittal | | |
| Contractual requirements | Proposed contractual structure, redline or otherwise, must contain provisions related to: Liability Caps, Indemnification, Default/Termination Rights, Performance Guarantees, Remedies for non performance, and Security/Collateral. | Submittal | | |
| **5. Proposal satisfies minimum credit threshold criteria** | | | | |
| Security requirements | PGE will only award contracts to Bidders that have, at a minimum, investment grade credit rating (or with investment-grade guarantors) and can prove that they can provide acceptable performance assurance at time of execution.<br>Investment grade as rated by S&P, Moody's, DBRS and/or Fitch, requires ratings at a minimum must be BBB-, Baa3, BBB low, or BBB- respectively. | Submittal | | |

*Exhibit A - 2018 RFP Scorecard Template*

**Development Criteria**

| Development Criteria | Score | Weight | Total | Scoring Rules |
|---|---|---|---|---|
| **2. Project Development Criteria Max Score = 115** | | | 100 | Measures likelihood that project to support proposal will be placed into commercial service on time and on budget |
| 2. Project already in service | 0 | 14 | 0 | Use the following scoring rules for projects that are already in operation: Operating plants should be given a score of 5 points, however this score can be reduced by 1 point if the plant has experienced extended outages, shutdowns or closures during the asset life. For scoring product development from portfolios use the following rules: (1) If product mostly supplied from a specific plant, use that plant for scoring (2) If product supplied from several plants, use the average score from all plants. |
| For projects not in service proceed with questions below, otherwise go to Section 3 | | | | |
| 2.a Permitting status (see permitting attachment) | 2 | 10 | 20 | 2 = All project permits and Site Certificate approved.<br>1 = Major permits approved<br>0 = Permit process underway, all permits timely acquired consistent with identified thresholds |
| 2.b Experience of Project Team | 2 | 5 | 10 | 2 = Successfully developed multiple similar projects in WECC delivered on time without material facility unplanned outages within first year.<br>1 = Successfully developed multiple similar projects in US.<br>0 = Successfully developed similar project in US. |
| 2.c Project Financing | 1 | 10 | 10 | 1 = Project can be internally financed by developer. Alternatively, project has financing agreement (e.g. primary lender, and tax equity as appropriate) with credible funding source with joint commitment to proceed.<br>0 = PGE bid award needed to obtain financing (e.g. lender commitment contingent on bid award) |
| 2.d Site Control: Including all rights required for project including access to the project site, easements and resources rights appropriate for the project | 1 | 15 | 15 | 1 = Title/Executed lease or options for a minimum of 100% of site<br>0 = Title/Executed lease or options for a minimum of 80% of site |
| 2.e Cost Certainty - equipment | 3 | 5 | 15 | 2 = Pricing guarantee for identified major equipment in addition to executable agreement for prime movers (e.g. turbines, panels)<br>1 = Executable agreement for prime mover (e.g. turbines, panels)<br>0 = OEM quotes for prime mover (e.g. turbines, panels)<br>+1 for LTSA or other long-term service quote |
| All proposals regardless of current online status | | | | |
| 2.f Cost Certainty – Value of Extension | 2 | 10 | 20 | 2 = Allows contract extension at original contract price or purchase option at book value or allows for continued operation at cost for benefit of customers<br>1 = Allows contract extension at price certain or purchase option at known price<br>0 = Allows for no rights for contract extension or purchase option. Alternatively allows for contract extension or purchase option at unknown price (e.g. fair market value) |

| | | | | |
|---|---|---|---|---|
| For ownership proposals regardless of current online status | | | | |
| 2.g Cost Certainty - Milestone payments | 1 | 10 | 10 | 1 = Payments at, or under PGE suggested milestone schedule (i.e. payments total less than actual completion percentage prior to completion) |
| | | | | 0 = Payments match with PGE suggested milestones |
| | | | | -1 = Payments front loaded relative to proposed schedule of values and milestone payment schedule |
| For PPA proposals regardless of current online status | | | | |
| 2.h Cost Certainty – Pricing Structure | 0 | 5 | 0 | 2 = Contract price does not escalate and does not does include capacity payment |
| | | | | 1 = Contract price escalating at known and committed escalation rate and does not include capacity payment |
| | | | | 0 = Contract price escalating at market based escalator (e.g. historical CPI) or does include capacity payment |

*Exhibit A - 2018 RFP Scorecard Template*
**Physical Characteristics**

| Physical Characteristics | Score | Weight | Total | Scoring Rules |
|---|---|---|---|---|
| **3. Physical Characteristics Max Score = 150** | | | 130 | Measures project specific physical attributes for each offer.<br><br>For scoring physical characteristics from portfolios use the following rules: (1) If product primarily supplied from a specific plant, use that plant for scoring; (2) If product supplied from several plants, use the average score from all plants. |
| 3.a Interconnection Rights | 5 | 10 | 50 | 5 = Executed LGIA or project in operation. |
| | | | | 4= Tendered LGIA, in Negotiations. |
| | | | | 3 = Executed optional Engineering and Procurement Agreement (E and P) or procurement agreement for long-lead interconnection items if applicable. |
| | | | | 2 = Completed Interconnection Facility Study (must be completed prior to final short list). |
| | | | | 1 = Completed Interconnection System Impact Study. |
| | | | | 0=Executed System Impact Study Agreement. |
| 3.b.1<br>Long Term Firm Transmission Rights on BPA's transmission | 4 | 10 | 40 | 4 = Existing long-term firm rights to BPAT.PGE POD. |
| | | | | 3 = Existing long-term firm rights confirmed by transmission provider to be redirectable to PGE's system. |
| | | | | 2 = Executed PTSA for existing firm transmission to BPAT.PGE POD. |
| | | | | 1 = PTSA agreement executed for identified upgrades. PTSA contains offer of conditional firm-bridge service that converts to long-term service upon completion of upgrades. Facility upgrades to be completed no later than one year after COD. |
| | | | | 0 = Have completed TSEP and require near-term viable upgrades which must be completed at least six months prior to COD. PTSA agreement not yet executed. |
| 3.b.2 Long Term Firm Transmission Rights on PGE's Transmission | 0 | 10 | 0 | 4 = Executed Interconnection Agreement with Network Resource Integration Service or existing long-term firm rights. |
| | | | | 2 = Tendered Interconnection Agreement with Network Resource Integration Service or executed Construction Agreement. |
| | | | | 1 = Completed Facility Study. |
| | | | | 0 = Completed System Impact Study. |
| 3.c Projects Subject to BPA Oversupply Management Protocol | 0 | -10 | 0 | 1 = Project subject to BPA Oversupply Management Protocol. |
| | | | | 0 = Project not subject to BPA Oversupply Management Protocol. |
| 3.d Remedial Action Scheme Projects Subject to (RAS) | 1 | 10 | 10 | 1 = PGE able to use resource as a credit for its obligation to support AC intertie RAS. |
| | | | | 0 = No RAS. |
| | | | | -1 = Subject to RAS other than the AC intertie. |
| 3.e Engineering Reliability | 5 | 2 | 10 | For all project types (maximum of 5 points) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | 1 = PGE is able to influence in maintenance and availability decisions impacting reliability (0 if no influence). | |
| | | | | 2 = The experience and expertise of O&M operator (<5 years=0, 5-9 years=1, >10 years=2). | |
| | | | | 1 = The owner and/or operator is supported by local or centralized engineering staff (0 otherwise). | |
| | | | | 1 = The seller has an established relationship with prime mover vendor including vendor support through a service agreement<br>(<5 years=0, 5-9 years=.5, >10 years=1). | |
| **Resource Specific Issues** | | | | | |
| 3.f Resource Certainty | **Wind/Solar/Hydro Resources** | | | | Select Resource type for 4.a |
| | 4 | 5 | 20 | 4 = 7+ years data.<br>3 = 6-years data.<br>2 = 5-years data.<br>1 = 4-years data.<br>0 = 3-years data (threshold).<br>2 = Wind project is a staged build-out of an adjacent project (assumes adjacent project has at least 7 years' wind data and the adjacent project has a similar wind microclimate to the original project). | |
| | **Geothermal Resource** | | | | |
| | 0 | 20 | 0 | 1 = Production and injections wells for the project drilled and completed.<br>0 = Feasibility report completed, based on >1 year of test data from full diameter production wells. | |
| | **Biomass/Biogas – Project Fuel Supply** | | | | |
| | 0 | 5 | 0 | 4 = Firm access to multiple fuel sources for 100% or greater of need, with ability to store fuel on site and options for fuel transportation.<br>3 = Firm access to multiple fuel sources for 100% or greater of need.<br>2 = Have executed long-term fuel supply contract for minimum of 60% of need with ability to store fuel on site and options for fuel transportation.<br>1 = Have executed long-term fuel supply contract for minimum of 60% of need with plan for remaining need.<br>0 = Have fuel supply plan with identified, established suppliers and transportation options. | |

*Exhibit A - 2018 RFP Scorecard Template*

**Performance Certainty**

| Performance Certainty | Score | Weight | Total | Scoring Rules |
|---|---|---|---|---|
| **4. Performance Certainty Max Score = 100** | | | 120 | Measures project specific commercial and delivery attributes for each offer. |
| 4.a Quality of Power - Firmness of Energy | 2 | 10 | 20 | 2 = Backed by physical resources or system with resupply obligation for curtailments or outages including make whole provisions for bundled RECs. |
| | | | | 1 = Backed by physical resources or system with finite resupply obligation for curtailments or outages including finite make whole provisions for bundled RECs. |
| | | | | 0 = Finite resupply obligation without make whole provisions for RECs. |
| 4.b Quality of Power - Scheduling Period Commitment | 2 | 5 | 10 | 2 = Weekly or greater in scheduling. |
| | | | | 1 = Pre-schedule. |
| | | | | 0 = Hourly. |
| 4.c Online Date | 2 | 10 | 20 | 0 = prior to 12/31/2019. |
| | | | | 2 = After 12/31/2019 and prior to 12/31/2020. |
| | | | | 1 = After 12/31/2020. |
| 4.d Output Guarantee | 10 | 3 | 30 | Project owner financially guarantees project output for PGE customers through AUT forecast or PPA Form Contract Specified Amount provisions, defined over the following time period: |
| | | | | 10 = Monthly On/Off Peak or more granular. |
| | | | | 8 = Monthly. |
| | | | | 6 = Quarterly. |
| | | | | 2 = Annually. |
| | | | | 0 = Multiple Consecutive Years. |
| 4.e Guarantee Available Factor | 2 | 5 | 10 | 2 = Minimum mechanical availability agreement of 97% or greater for any two out of three calendar years on a rolling basis. |
| | | | | 0 = No stated minimum mechanical availability commitment. |
| 4.f Liability Cap Contractual Terms and Conditions Redlines | 6 | 1 | 6 | 6 = All highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk. |
| | | | | 3 = Most highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk. |
| | | | | 1 = Most highlighted terms conform to contract form and present low risks to schedule, performance or cost. |
| | | | | 0 = Most highlighted terms conform to contract form and present medium risks to schedule, performance or cost. |
| 4.g Indemnification Contractual Terms and | 6 | 1 | 6 | 6 = All highlighted terms conform to contract form and |

| | | | | |
|---|---|---|---|---|
| Conditions | | | | present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>3 = Most highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>1 = Most highlighted terms conform to contract form and present low risks to schedule, performance or cost.<br>0 = Most highlighted terms conform to contract form and present medium risks to schedule, performance or cost. |
| 4.h Default & Termination Contractual Terms and Conditions | 6 | 1 | 6 | 6 = All highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>3 = Most highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>1 = Most highlighted terms conform to contract form and present low risks to schedule, performance or cost.<br>0 = Most highlighted terms conform to contract form and present medium risks to schedule, performance or cost. |
| 4.i Security and Collateral Contractual Terms and Conditions | 6 | 1 | 6 | 6 = All highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>3 = Most highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>1 = Most highlighted terms conform to contract form and present low risks to schedule, performance or cost.<br>0 = Most highlighted terms conform to contract form and present medium risks to schedule, performance or cost. |
| 4.j Performance Guarantees and Remedies of Non-Performance Contractual Terms and Conditions | 6 | 1 | 6 | 6 = All highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>3 = Most highlighted terms conform to contract form and present low risk to schedule, performance or cost, and additional terms are included that lowers Company risk.<br>1 = Most highlighted terms conform to contract form and present low risks to schedule, performance or cost.<br>0 = Most highlighted terms conform to contract form and present medium risks to schedule, performance or cost. |

*Exhibit A - 2018 RFP Scorecard Template*

**Credit**

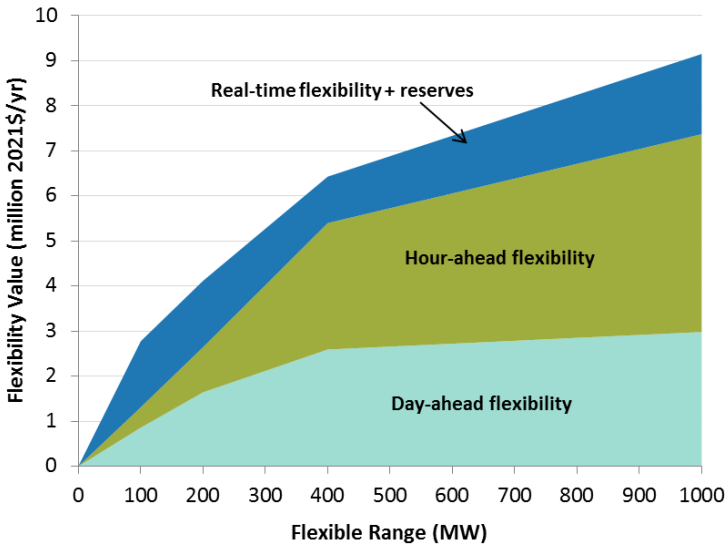
| Credit | Score | Weight | Total | Scoring Rules | |
|---|---|---|---|---|---|
| **5. Credit Evaluation Max Score = 50** | | | 50 | **Score based on Bidder, not Guarantor** | |
| 5.a PGE ratio analysis score | 10 | 2 | 20 | 10=Credit score of 10 | 5=Credit score of 5 |
| | | | | 9=Credit score of 9 | 4=Credit score of 4 |
| | | | | 8=Credit score of 8 | 3=Credit score of 3 |
| | | | | 7=Credit score of 7 | 2=Credit score of 2 |
| | | | | 6=Credit score of 6 | 1=Credit score of 1 |
| 5.b Bond Rating | 10 | 2 | 20 | 10=Aaa/AAA | |
| | | | | 8=Aa/AA | |
| | | | | 6=A/A | |
| | | | | 4=Baa/BBB | |
| | | | | 2=Baa-/BBB- | |
| | | | | 0=Below BBB- or not rated | |
| 5.c Tangible Net Worth | 10 | 0.5 | 5 | 10 >1,000mm | 5=600mm-501mm |
| | | | | 9= 1000mm-901mm | 4=500mm-401mm |
| | | | | 8= 900mm-801mm | 3=400mm-301mm |
| | | | | 7= 800mm-701mm | 2=300mm-101mm |
| | | | | 6= 700mm-601mm | 1= <100mm |
| 5.d Corporate Structure | 5 | 1 | 5 | 5=Publicly Traded | |
| | | | | 4=Publicly Traded subsidiary | |
| | | | | 3=Private Corporation | |
| | | | | 2=Private LLC | |
| | | | | 1=Sole Proprietorship/Partnership | |

# Exhibit B – Flexibility

## B.1 Flexibility value functions

In preparation for the evaluation of offers, PGE conducted a series of simulations with the ROM tool to isolate the flexibility benefits of perfectly flexible products available in various time frames (day-ahead, hour-ahead, and real-time[1]) and at various sizes (100MW, 200MW, 400MW, and 600MW) in a 2021 test year. For each simulation, the resource operational value was calculated as the annual operational cost difference between the PGE resource fleet with the perfectly flexible resource and the PGE resource fleet without the perfectly flexible resource. The flexibility value was isolated by subtracting the market revenues that the resource was capable of providing if it had dispatched to market in all hours from the total operational value obtained by optimizing its dispatch in coordination with the PGE resource fleet. This exercise yielded a set of functions that could be used to approximate the flexibility value associated with each offer in each stage according to its "flexible range" – the portion of the resource capacity that could be approximated as perfectly flexible in each stage. These functions are shown in the figure below.

**Figure 1. Flexibility value functions by stage and size**




The annual flexibility values shown in the above figure were allocated to each season based on the seasonal distributions of the flexibility values identified by ROM. The

[1] Real-time flexibility was bundled with the ability to provide load following, regulation, spinning, and non-spinning reserves, since the incremental value of these ancillary services was found to be relatively small.

resulting allocation factors, which are summarized in the table below, were used to obtain monthly flexibility values by stage and flexible range.

**Table 3. Flexibility value seasonal allocation factors**

| Stage | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| Day-ahead flexibility | 25% | 34% | 30% | 10% |
| Hour-ahead flexibility | 19% | 34% | 33% | 13% |
| Real-time flexibility + reserves | 27% | 23% | 39% | 12% |

Flexibility values were assumed to escalate at inflation through the analysis horizon.

## B.2 Flexible ranges

For each offer, flexible ranges are calculated for the day-ahead, hour-ahead, and real-time stages based on the operating characteristics of the resource. The flexible range calculation is conducted on a monthly basis over the full duration of the resource in the PGE portfolio. This calculation depends on whether the offer reflects an energy-limited or non-energy-limited resource. Energy-limited resources are those with a fixed amount of energy that much be used over a stated length of time – in other words, they behave like hydro resources. Non-energy-limited resources are all other resources that do not have this energy-driven constraint – they behave more like thermal resources.

## B.3 Energy-limited

In the flexibility evaluation, each energy-limited resource is characterized by its minimum ($p_m^{min}$), maximum ($p_m^{max}$), and average ($p_m^{avg}$) dispatch level by month throughout the resource duration. Flexible ranges may also be limited by a fixed amount in each stage ($f_k$). In month $m$ and stage $k$, the flexible range for an energy-limited resource is:

$$\min\left[2\left(p_m^{max} - p_m^{avg}\right), 2\left(p_m^{avg} - p_m^{min}\right), f_k\right]$$

## B.4 Non-energy-limited

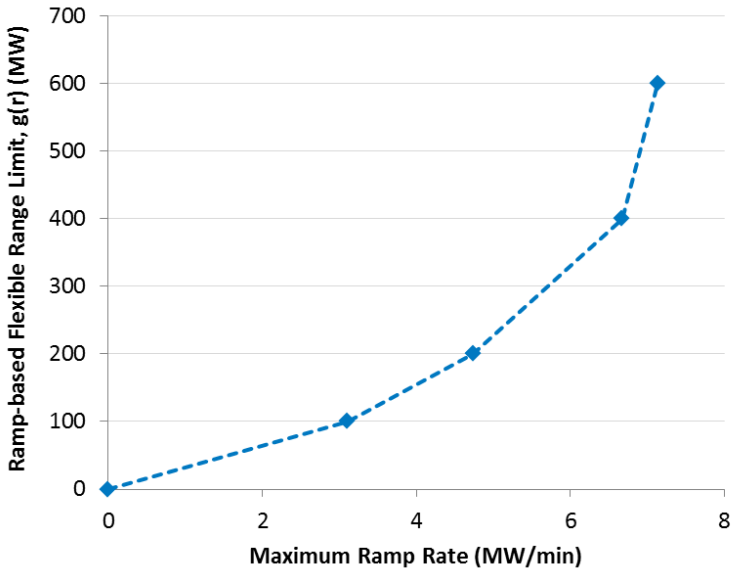
Non-energy-limited resources are characterized in the flexibility evaluation by their monthly maximum output ($p_m^{max}$), minimum output ($p_m^{min}$), availability in each stage ($a_{km}$), ability to be re-comitted in each stage ($c_k$), ability to redispatch in each stage ($d_k$), and maximum ramp rate ($r$). The availability in a given month is defined as the fraction of hours that the resource is committed (i.e., has non-zero output) in that month in the AURORA dispatch simulation. If a resource can be re-committed and redispatched in a given stage, then its flexible range reflects the full capacity range between its minimum and maximum output regardless of its availability. However, if the commitment is fixed in a given stage (due to fuel or operational constraints) but the resource can be redispatched, then the flexibility range is scaled by the availability in order to reflect the

probability that the resource has been committed in a prior stage. The flexibility range is also limited by a function, $g(r)$, of the maximum ramp rate, which is discussed further below. In month $m$ and stage $k$, the flexible range for a non-energy-limited resource is:

$$\min\left[d_k\left(p_m^{max} - p_m^{min}\right)[c_k + (1 - c_k)a_{km}], g(r)\right]$$

The ramp rate-based function, $g(r)$, limits the flexible range based on the ramping capability of the resource. In the day-ahead and hour-ahead stages, this function was determined by calculating the ramping capability needed to meet 95% of all ramps experienced by the perfectly flexible resource in the ROM simulation. Because units ramp between hourly schedules over the last 10 minutes of each hour and the first 10 minutes of the following hour, the function assumes that the resource must be capable of meeting simulated hourly ramps over a 20-minute period. The resulting function is shown below.

**Figure 2. Ramp-based flexible ramp limit, *g(r)*, for day-ahead and hour-ahead stages**




The ramp-based limit on the flexible range for real-time flexibility and reserves is equal to 10 minutes times the MW/min ramp rate to reflect the approximate time scale of modeled subhourly dispatch needs and reserve requirements.

## B.5 Portfolio flexibility values

The flexibility value in the portfolio modeling stage is calculated using the same methodology and the same flexibility value functions used to evaluate specific resources. In this exercise, the flexible range in each month associated with the portfolio is the sum of the flexible ranges of the component resources in the corresponding month. Because the flexibility functions are sub-linear, the monthly portfolio flexibility value is less than the sum of the monthly flexibility values of the component resources. This approach therefore captures the declining marginal value of flexible resources in PGE's resource portfolio, a phenomenon identified in the energy storage evaluation and

discussed in Chapter 8 of the 2016 IRP. Within the portfolio flexibility value assessment, PGE will recognize the flexibility value effects of the bilateral capacity agreements executed by PGE in Q1 2018 and described in the 2016 IRP Update.

# Exhibit C – Aurora Dispatch

As discussed in PGE's 2016 IRP, AURORAxmp allows PGE to perform fundamental analysis of the western power markets under various assumptions and test the performance of candidate resource portfolios in those environments. PGE uses the net present value of revenue requirements (NPVRR) to summarize the expected cost of portfolios. The NPVRR includes the fixed and variable costs associated with operating the respective resources, as well as the net market revenue or expense associated with net sales or purchases in the portfolio. PGE evaluates portfolio risk according to two primary categories:

1. Reliability risk: Serves as a threshold for portfolio design; and,
2. Deterministic risk: Referred to above as "futures."

To evaluate the variable benefits of the candidate resources in the bilateral capacity acquisition initiative, PGE used AURORAxmp consistent with the Integrated Resource Plan (IRP) methodology. This methodology includes:

1) Western Electric Coordination Council (WECC) Capacity Expansion
2) Generate Market Power Prices
3) Compute the "Value" of all candidate resources

***WECC Capacity Expansion***: PGE used the three capacity plans developed under various carbon price futures in the 2016 IRP. PGE used Wood McKenzie's database for information regarding the existing resources in WECC. It was not necessary to execute new long-term capacity expansion studies as long-term market fundamentals have not moved significantly enough to justify the effort required to perform long-term studies.

***Market Power Prices****:* Using the applicable WECC capacity plan, hourly Mid-Columbia power price curves until year 2050 under 27 various futures were generated. The futures were designed to study impacts of three factors on power pricing: carbon pricing, natural gas pricing, and regional hydro availability. More detail for each factor is shown below.

*Carbon pricing:* PGE used three carbon price estimates: zero carbon prices, reference carbon prices, and high carbon prices. Consistent with the IRP, PGE used Synapse's forecasts for the reference and high carbon pricing.

*Natural Gas pricing:* PGE used three natural gas pricing scenarios: Low, reference and high. Consistent with the 2016 IRP Update data source assumptions, the trading curve was used until 2021 for all three scenarios.

*Regional hydro availability*: PGE used three regional hydro scenarios: low, reference and high. The reference case value is the average of historical hydro estimates provided by Wood Mackenzie.

For low and high values, consistent with the 2016 IRP Update, PGE adjusted forecasted hydro volumes by ten percent.

PGE simulated all combinations of carbon price, gas price and regional hydro availability scenarios to create 27 futures.

# Exhibit D – Portfolio Construction

Candidate portfolios will consist of executable combinations of all offers. The total resources selected must meet the energy target identified in Commission Order No. 18-044. PGE will optimize portfolio selection with the following two-step processes:

1. Select the starter resource. There will be an optimal candidate portfolio based on each resource.
2. Use the Excel solver to select additional resources to add to the starter resource. Excel will select resources under different optimization routines such as minimizing the deviation from the target MWa energy addition in 2021 or total net costs.

The first optimization routine consists of an optimization problem to minimize the difference (delta) between a portfolio's total energy and the energy target in 2021. The optimized portfolio under the first optimization routine will be calculated using the following formula:

$$f(\underline{x}) = \left| TG_t - \sum_{i=1}^{n} E_{t,i} \cdot \underline{x} \right|$$

$$\min_{\underline{x}} f(\underline{x})$$

$$s.t.\ \underline{x}\ is\ binary$$

where:

$\underline{x}$ : A binary vector representing resource selection in a portfolio
(0 represents exclusion, and 1 represents inclusion)

$E_{t,i}$ : Energy of the resource $i$ for the year $t$

$TG_t$ : Energy target of the year $t$

$t$ : Year 2021

$i$ : Resource index

The second optimization routine set up an objective function to minimize a portfolio's total present value net cost. The optimized portfolio under the second optimization routine will be calculated using the following formula:

$$f(\underline{x}, y_t) = \sum_t^T P_t \cdot \{TC_{t,i} \cdot \underline{x} + F_t.y_t\}$$

$$\min_{\underline{x}, y_t} f(\underline{x}, y_t)$$

$$s.t.\ \underline{x}\ is\ binary$$

$$\text{and } \underline{x} \cdot E_{t,i} + y_t \geq TG_t$$

where:

$\underline{x}$ : A binary vector representing resource selection in a portfolio

(0 represents exclusion, and 1 represents inclusion)

$y_t$ : Amount of the fill resource needed for the year $t$

$TC_{t,i}$ : Total net cost of the resource $i$ for the year $t$

$TG_t$ : Energy target of the year $t$

$E_{t,i}$ : Energy of the resource $i$ for the year $t$

$F_t$ : The fill resource's total net cost
(standardized by the fill resource's name plate capacity)

$P_t$ : Present value factor

$t$ : The beginning of the period

$T$: The end of the period

To supplement the optimized portfolios, PGE will also develop all possible portfolio permutations with total energy ranging from 75MWa to 125MWa in 2021 and will advance the top 50th percentile of these portfolios to portfolio evaluation. Performance in the 50th percentile screen will be measured on the basis of present value net cost, with the top portfolios achieving the lowest present value net cost.

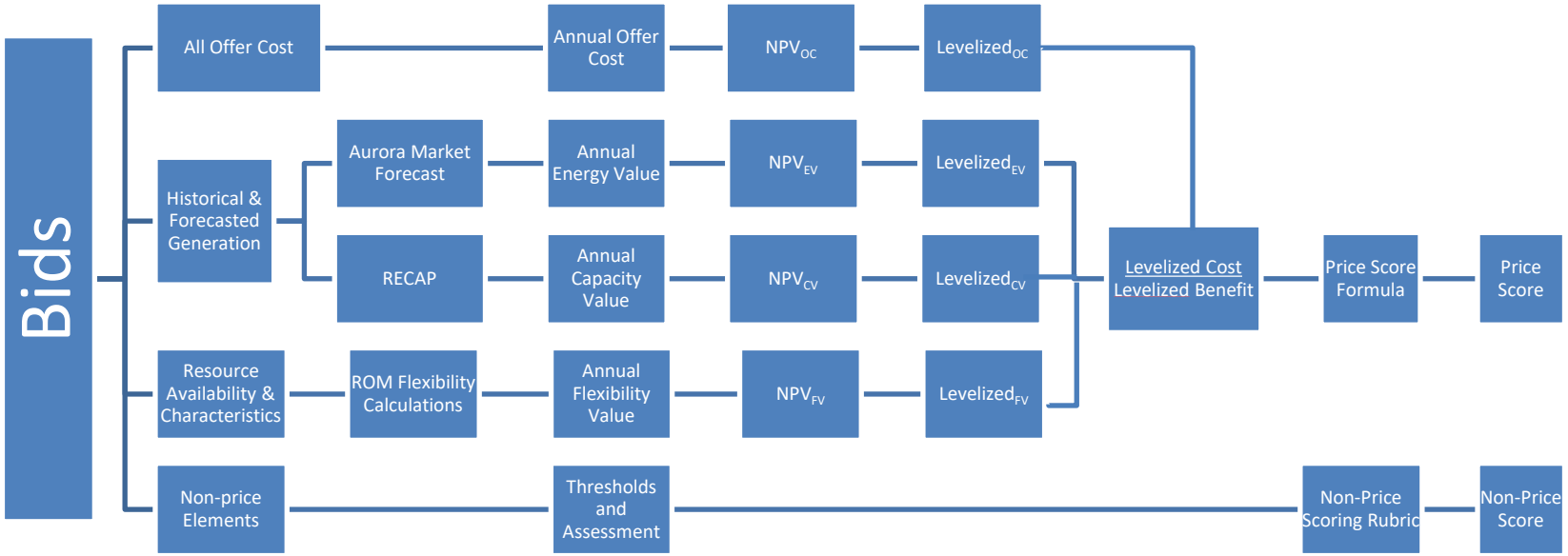
Portfolio Term and Size Normalization

For portfolio analysis, resources will be term and size normalized to match the energy target identified:

- To term normalize for resources with shorter duration (e.g. PPA for 20 years), we will fill with the real levelized cost of an appropriate specific resource of like size for the remaining planning horizon.
- To size normalize, any difference in size between the offers' total energy and the targeted energy need will be effectively filled in by the remaining specific fill resource.
- The specific resource used to size and term normalize reflects the cost and performance of new resources informed by the initial short list.

Filling with costs associated with new resources will correctly account for the risks associated with the energy target identified in Commission Order No. 18-044. We will calculate a total portfolio cost based on the AURORA dispatch of the candidate portfolios across futures including the reference case of carbon price, natural gas price, and hydro availability. In addition, we will calculate risk as the standard of deviation of the total portfolio present value net cost of candidate portfolios across the futures. Candidate portfolios will be ranked in order of increasing costs and risks. After the initial analysis, portfolio results will be stress-tested under multiple energy targets and qualifying facility planning scenarios.

## Exhibit E – Scoring Process Flow



# 19 Appendix I – Required Bid Information

# REQUIRED BID INFORMATION

***INTENTIONALLY BLANK:***
***TO BE POSTED ON PROCUREMENT WEBSITE***

# 20 Appendix J – Benchmark Bid Information

# APPENDIX J

## Portland General Electric's Company Owned Self-Build (Benchmark Resource)

**Proposed 2018 RFP Company Benchmark Resource**

- PGE intends to submit one (1) individual wind Benchmark Resource to satisfy approximately 300 MW of targeted wind resources.
- The Benchmark Resource would be a greenfield wind resource constructed in Eastern Oregon.
- The Benchmark Resource would be built on property that PGE intends to acquire the rights to develop.
- The Benchmark Resource would be 100% PTC qualified with an expected on-line date in 2020.
- The Benchmark Resource would be constructed in compliance with PGE's wind farm specifications and technical standards.