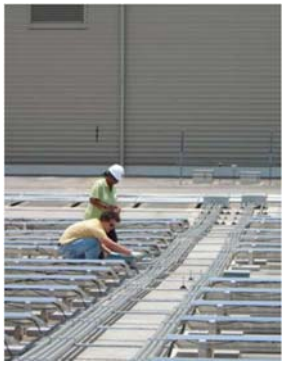
RFP Appendix A (Solar)

PACIFICORP

Solar Photovoltaic Renewable Resource Technical Specification

2018


Contents

Acronyms and Abbreviations

AC	alternating current
A	ampere
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing and Materials
CPT	control power transformer
DC	direct current
EL	electroluminescence
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
kW	kilowatt
kWh	kilowatt hour
LPS	lightning protection system
MW	megawatt
MW_{AC}	megawatt alternating current
NEC	National Electric Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
O&M	operation and maintenance
PCB	polychlorinated biphenyl
PCC	Point of Common Coupling
PV	photovoltaic
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
SCADA	supervisory control and data acquisition
SCCR	short-circuit current rating
SPD	surge protection devices
SWPPP	Storm Water Pollution Prevention Plan

TÜV	Technischer Überwachungsverein
UL	Underwriters Laboratories, Inc.
V	Volt
V_{AC}	volts alternating current
V_{DC}	volts direct current
VDE	association for electrical, electronic, and information technologies

List of Appendices to Appendix A

A-1	Not Used
A-2	Interconnection Agreement
A-3	Permit-Matrix
A-4	Not used
A-5	Project One-line Drawing and Layout
A-6	Division of Responsibility
A-7	Owner Standards and Specifications
A-8	PVSYST Performance Summary Report
A-9	Product Data Input Supply Forms
A-10	Not Used

Reference PacifiCorp Standards

RFP Appendix A-7 contains the following Owner standards that apply to this specification:

01. Attachment 1A Project Document Formatting and Requirements.
02. Attachment 1B Project Document Deliverables.
03. a) Computer Aided Design (PacifiCorp Energy) General AutoCAD/Drafting Standards (Specification DCAP876).
03. b) Renewable Resources: Engineering Procedures/CAD Standards, Volume 8 Consultant Drafting Procedures and Standards (For Engineering Drawings)
04. 04.1 Substation Equipment Power Transformers, ZS-001 and b) 04.2 Two-Winding Distribution Transformer, ZS-102.
05. Material Specification ZS 061, Electrical Equipment-Insulating Oil.
06. Material Specification ZS 065, Wind, Ice, and Seismic Withstand.
07. Material Specification ZS 066, Contaminated-Environment Protection.
08. Procedure SP-TRF-INST, Transformer Receiving, Installation and Testing.
09. Asset Management Form 006F, Meter and Relay Equipment Memorandum.
10. PacifiCorp Engineering Handbook, Part 6B.5 Fence Application and Construction.
11. PacifiCorp Engineering Handbook, Part 6B.6 Substation Grounding.
12. PacifiCorp Protective Relaying Standard, Document Number: GEN-ENG-RELAY-0001.
13. PacifiCorp Protective Relaying Standard, Arc Flash Hazard Standard, Document: GEN-ENG-RELAY-0002.
14. PacifiCorp Protective Relaying Standard, “Relay Current Transformer (CT) & Potential Transformer (PT) Insulation Integrity Test,” Document: GEN-ENG-RELAY-0003.
15. PacifiCorp Protective Relaying Standard, “Thermal Plant Protective Relay Maintenance and Testing-PRC-005,” Document: GEN-ENG-RELAY-1003.
16. PacifiCorp Protective Relaying Standard, “Relay Testing & Commissioning Checklist.”
17. PacifiCorp Protective Relaying Standard, “Relay Installation Procedure,” Document: GPCP-EQPMNT-INST.
18. PacifiCorp Protective Relaying Standard, “Current Transformer Installation Procedure (Relay),” Document: GPCP-CT-INST.
19. PacifiCorp Protective Relaying Standard, “Current Transformer Installation Form (Relay),” Document: GPCP-CT-INST.
20. PacifiCorp Substation High-Voltage Warning Signs, SG-001.

21. Specification for Substation Equipment Installation Testing and Commissioning.

22. SV002 Bird and Animal Protection-General Installation Instructions

23. SV251 Bird and Animal Protection for Miscellaneous Equipment

24. TD051 Danger Sign

OTHER RELEVANT DOCUMENTS

PacifiCorp "Open Access Transmission Tariff". FERC Electric Tariff

Technical Specification

This is Appendix A – "Solar Photovoltaic Renewable Resources 2018 – Technical Specification", which will subsequently become a contract document, as a supplement to the TURNKEY ENGINEERING, PROCUREMENT AND CONSTRUCTION AGREEMENT ("The Agreement"). Capitalized terms used and not defined herein have the meanings given in the Agreement unless the context requires otherwise.

A-1 Introduction and Contractor Responsibilities

Contractor shall provide all required services and materials for the successful completion of the Plant. Contractor's responsibilities shall include environmental permitting, design, engineering, procurement of equipment, Site preparation work, foundations, installation of all equipment, bulk material and commodities supply, and Site finishing work. Contractor also shall deliver project management, construction management, commissioning and startup, and testing of work, all as described in this document including all referenced appendices and standards which will subsequently become a contract document.

Contractor shall construct all roads, foundations, electrical systems, control systems, monitoring systems, communications, ancillary structures, storage facilities, security systems, and fencing, and shall erect and commission and start-up the photovoltaic (PV) System in the locations and orientations set forth in the Site plan and Site layout drawings and in accordance with this document, and all related specifications that relate thereto.

Installation of the PV System shall be by a recognized, experienced Contractor in accordance with federal, state, local, and utility specifications and requirements and in accordance with the relevant state energy office. The electrical installation of the PV System shall be performed in accordance with the same requirements. The Work shall be performed by an electrical contractor licensed in the state where the project will be constructed. The work shall be performed by a licensed Contractor approved by the relevant State authority. Solar PV Contractors must hold a current certificate by the North American Board of Certified Energy Practitioners (NABCEP). Contractor shall provide comprehensive onsite construction management for the Plant and shall commission and start-up the Plant. Contractor shall

manage, supervise, inspect, and furnish all labor, equipment, materials, temporary structures, temporary utilities, products, and services related to the foregoing, all on a turnkey basis.

These specifications are intended for use by Contractors providing a Solar PV Plant to be owned by PacifiCorp. The PV Plant shall be designed, built, commissioned, and started-up by the Contractor based on these PV Specifications, and all other PacifiCorp requirements including its interconnections for connecting to the transmission or distribution system. Upon completion of the quality assurance/quality control (QA/QC) procedures and Plant Acceptance the PV Plant shall be turned over for care and custody by PacifiCorp. Contractor shall perform the Work in accordance with the following:

a. In a manner that is sufficient, complete, and adequate in all respects necessary for the Plant to successfully achieve Final Acceptance by the Guaranteed Final Acceptance Date.

b. In conformance with the professional standards, skill, expertise, and diligence of design and construction of professionals regularly involved in utility-grade, utility-scale, grid-connected solar PV power projects in the United States.

c. In compliance with the terms of the contract documents, the operating guidelines, the Utility's interconnection requirements (**RFP Appendix A-2 – Interconnection Agreement**), and all applicable laws, standards, and permits including PacifiCorp's "Access Transmission Tariff", FERC Electric Tariff.

d. Approved as to form, use, and content by all government authorities and private entities authorized to administer or enforce any building, electrical, or construction code or standard whose approval of the final design of the Plant, or any portion thereof, is necessary for the construction, operation, or interconnection of the Plant.

A-1.1 Performance Characterization

The predicted PV system performance estimate must be provided in **RFP Appendix A-8** and is based on the performance characterization data in **RFP Appendix C-1** or **C-2**. The predicted PV system performance information that is to be provided shall include the PVSyst report, the 12X24 output in an Excel format, and an hourly profile 8760 output in an Excel format.

A-1.2 Permitting

Contractor shall apply for and obtain all permits and authorizations necessary for construction and to support operations of the Plant, as per the attached permitting matrix (**RFP Appendix A-3**). Copies of all applicable permits will be provided to Owner within 5 business days after they are obtained or completed.

A-1.3 Construction and Installation

Prior to beginning construction, Contractor shall provide a comprehensive onsite construction management plan for the construction of the Plant in accordance with all applicable laws and policies and Health, Safety, and Environmental Plans of the Contractor. No later than 15 days prior to initial Site mobilization, Contractor shall prepare and submit such Plans to Owner. Contractor shall also provide Owner with an evaluation and appropriate

documentation of the safety record for any licensed Subcontractor that will be performing work on the Plant.

Contractor shall assemble, construct, and install with its own labor forces and/or with Subcontractors labor, tools, and equipment necessary to complete the Plant, including the following Works:

- Site preparation, including but not limited to drainage required by the civil engineering plan, and remove excess debris
- Coordination with Owner when trenching is performed
- Direct current (DC) cabling and combiner and junction boxes
- Alternating current (AC) trenching and cabling
- Inverters, switchgear, and transformers and accompanying supports and/or concrete pads
- All equipment from the DC solar array up to and including the point of interconnection with the electric utility system
- Perimeter security fencing, access gates, and security systems (described in section A-3.9 Security)
- Security lighting
- Installation of the monitoring system, meteorological station(s), and revenue grade metering

Contractor shall provide all utilities necessary during construction, including but not limited to electricity, water, toilets, fuel and communications. Contractor shall be responsible for all costs associated with construction power. The following sections and associated appendices describe the scope of work and technical specification for the Plant.

A-2 Site and Plant Description

Contractor shall, at its own cost and expense, design, engineer, procure, construct, test, permit, and start up a utility scale PV solar system with a design output as stated in its proposal.

Except as otherwise expressly provided in the Agreement, Owner is not responsible for providing any material, labor, or services of any kind during Contractor's execution of the Work. Contractor is fully responsible for all development, permitting, engineering, procurement, construction, interconnection coordination, and startup and testing activities, and shall deliver a complete, operational, and reliable turnkey Plant to Owner. Contractor shall provide electrical and structural engineered drawings stamped by an engineer certified in the state where the project will be constructed, materials and equipment, installation of PV modules, installation of electrical systems including inverters, electrical connection to the existing electrical infrastructure, and construction of mounting structures on which the PV modules are installed. Contractor shall provide comprehensive onsite construction management for the Plant and shall commission the Plant. Contractor shall manage, supervise, inspect, and furnish all labor, equipment, materials, temporary structures, temporary utilities, products, and services related to the foregoing, all on a turnkey basis.

A-3 Design and Engineering

Contractor shall design and engineer the Plant in accordance with prudent utility practices, with the professional standards, skill, expertise, and diligence of design and construction of professionals regularly involved in utility-grade, utility-scale, grid-connected solar PV power projects for public utilities in the United States. The design must conform to the requirements and conditions of all applicable permits, codes and standards, and laws, and it must be in compliance with the operating guidelines, and meet the Owner specifications.

Contractor is responsible for all engineering for the Plant. All design drawings, specifications, and calculations shall be signed by a professional engineer-of-record in the state where the project will be constructed. The Agreement provides for submission to Owner of complete design drawings, data, and documents for review and comment. These engineered design drawings, data, and documents must be submitted to Owner for review and comment before construction is to begin.

Contractor is responsible for ensuring that all components are installed above the 100-year flood plain (e.g., inverter stations, substation, supervisory control and data acquisition [SCADA] system, Security System, control building, PV modules, tracker motors, switchgear, transformers, combiner boxes, etc.). The Contractor is responsible for ensuring that all PV modules and combiner boxes are installed above the maximum snow height.

Any third-party study or independent engineering reviews (e.g., the geotechnical study and the corrosion study) shall be provided to Owner.

A-3.1 Engineering Design Package

Based on the review of the Plant Site and infrastructure, Contractor shall design (or have designed by consulting engineers) a Plant (including all layout, civil, electrical, and structural components) that will produce the required electricity and that is capable of being operated in a safe, normal, reliable, and continuous manner as required by the contract documents at all operating conditions and modes specified below. The system design shall comply with all applicable laws and regulations and applicable permits. Owner may utilize a third-party or independent engineering consultant to perform technical reviews. Studies prepared by the Contractor's third-party consultants shall be provided to the Owner for review.

The Engineering Design Package shall include all items required in **Appendix A-7.2 Attachment 1B – Project Document Deliverables**, and shall include:

- Studies related to the project, such as the geotechnical engineering report and the lightning protection study
- Schematic and preliminary designs
- Design calculations
- All drawings including mechanical, electrical, structural, civil, and construction drawings (Site plans, schematic single lines, wiring diagrams and detail drawings). Drawings shall follow **Appendix A-7.3.b) Renewable Resources Drafting Procedures and Standards**.
- Project schedule

- Product description information
- Bill of Materials
- Equipment details, descriptions, and specifications
- Commissioning and start-up plan
- Full power test plan (capacity test)
- Layout of equipment
- GIS Shapefiles of all project equipment (transformers, junction boxes, overhead line poles, access roads, etc.)

The Engineering Design Package shall be provided prior to commencement of construction.

A-3.2 Site Layout, Maps, Line Drawings

Prior to beginning construction or procuring equipment, Contractor shall submit to Owner Site layout design drawings, data, and documents for review. The design shall include a vehicle access road to provide maintenance, cleaning, and public safety access with a 30-year service life (assuming regular maintenance) that shall comply with state and local county surface requirements.

The contractor shall plan and execute construction of earthwork methods and culverts (or other water control devices) to control surface drainage from cuts and fills and prevent erosion and sedimentation in compliance with the Storm Water Pollution Prevention Plan (SWPPP).

A-3.3 Structural Engineering

Contractor shall supply or design the PV arrays' mounting systems, foundations, and piers, as well as any equipment pads and buildings on the Site. The designs of these components shall be based on the requirements of applicable codes, standards, and permits, and the information/specifications provided by the module, inverter, transformer, switchgear, racking/tracking structures, and all other vendors.

A-3.3.1 Geotechnical Analysis

Geotechnical analysis shall be provided by Contractor and performed by a qualified geotechnical engineering firm employing a licensed Professional Engineer. The results of the analysis shall be used when designing the foundations for the structures on the Site.

At a minimum, the following should be included in the analysis:

a. Review publicly available geotechnical information and reports. This may include soils and geologic maps and literature, photographs, hydrogeology reports, groundwater reports, and water well data.

b. Coordination and mobilization of the geotechnical services team for subsurface exploration of the Site. This should include working with the local utilities to mark any existing underground utilities (such as cables, gas lines, piping, etc.) in advance of mobilization.

c. Study the Site to determine the presence of faults, ground fissures, slope instability on the Site or adjacent lands, and other potential geologic hazards that could affect the structural design, construction, and long-term operation of the Plant.

d. Drilling or digging of exploratory borings and pits. The amount and depth shall be determined by the Contractor's geotechnical engineering firm.

e. Performance of cone penetration tests. The amount and depth shall be determined by the Contractor's geotechnical engineering firm.

f. Laboratory testing of collected soil samples from the borings and test pits. An evaluation of the in-place moisture content and dry density, gradation, plasticity, consolidation characteristics, collapse potential, expansivity, shear strength, soil resistivity for the purposes of determining cable ampacity, chloride content, sodium sulfate content, and solubility potential (total salts) should be conducted.

g. Analyze the corrosivity of the soil. Include a recommendation for the type of cement to be used in any concrete foundations. Also include recommendations for corrosion protection for underground steel, including rigid metal conduit (such as the need for polyvinyl chloride [PVC] coatings).

A detailed geotechnical report shall be provided outlining the tasks performed and the results of the testing. Included in the report should be any recommendations for the foundation designs, structural support designs, corrosion protection for both underground steel and concrete, pile drive frequency, minimum pile size, and any geologic conditions that may prevent the development of the project. Specifically, an opinion on the viability of driven piles as the PV racking supports should be provided.

A-3.3.2 Environmental Loads

All structures on the Site shall to be designed using environmental loads as specified in the American Society of Civil Engineers (ASCE) 7-16 (year 2016) code book *Minimum Design Loads for Buildings and Other Structures.* These include wind loads (Chapter 6), snow loads (Chapter 7), rain loads (Chapter 8), ice loads (Chapter 10), and earthquake loads (Chapter 11). Each structure on Site shall be grouped in Occupancy Category II as defined in Table 1-1 of ASCE 7 - 2016. The corresponding importance factor shall be used for each load calculation.

A-3.3.3 Racking/Tracking Foundations and Supports

All foundations and supports must be designed using the calculated environmental loads discussed above and soil properties provided in the geotechnical report. Foundations and supports shall meet the recommendations found in the geotechnical report. Foundations and supports shall be designed for a minimum 30-year lifetime, including all environmental factors and corrosion. Foundations and supports should be designed to withstand the impacts and contact pressure from the installation method (such as a vibratory hammer). Any damage to corrosion protection coatings during installation should be repaired. Foundations and supports, including any field-applied modifications (e.g., holes drilled), shall meet the requirements in section A-3.3.5 Corrosion Protection.

A-3.3.4 Equipment Pads

All equipment pads shall be located such that adequate personnel access is provided to such equipment. A minimum of 4 feet (or 1.5 meters) horizontal clearance from obstructions that would otherwise limit access to the equipment on the pad shall be provided around all equipment pads. The pads shall be sized sufficiently to allow safety and adequate working space around the equipment. The inverter stations, switchgear, substation (if applicable), and other buildings shall be elevated above the Federal Emergency Management Agency 100-year flood plain. The slope of the earthwork around the inverter stations and other equipment shall allow safe and ergonomic access to the equipment.

A-3.3.5 Corrosion Protection

Corrosion protection shall be utilized on the structures of the Plant. The type and amount shall depend on the selected materials of construction and conditions at the Site. A study of these conditions along with recommendations from the geotechnical report shall be used to design the corrosion protection.

The corrosion protection study shall be performed by a qualified corrosion expert and documented with references and calculations showing that the foundations, supports, racking, fasteners, and conduit shall meet a 30-year design life in aboveground and belowground conditions. If galvanized materials are used, field-applied zinc coatings shall meet American Society for Testing and Materials (ASTM) A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings. This standard contains minimum requirements for the material, surface preparation, and application process. For example, repairs to damage due to vibratory pile driving shall conform to ASTM A780.

It is preferred that all holes in structural members requiring galvanization shall have the holes drilled before the galvanization is applied. Should holes be drilled in the field, galvanizing shall be applied to the exposed steel as specified in ASTM A780. All field welds shall have a field-applied galvanization as specified in ASTM A780. For example, if torque tubes with a 3-mil (0.003-inch) hot-dip galvanization are to be welded in the field, a field-applied coating, such as hot stick repair, shall meet or exceed the original 3-mil coating thickness of the torque tube per ASTM A780 requirements.

Only steel bolts with pre-applied corrosion inhibitors or stainless-steel bolts and fasteners shall be allowed in the entire mounting structure.

A-3.3.6 Single Axis Tracking Structures

In the event a tracking system is utilized, the system shall be designed using the environmental loads and the Occupancy Category as discussed in section A-3.3.2 Environmental Loads. The torque tubes, attachments, module mounting brackets, fastening hardware, foundations, and supports shall have a 30-year design life. Equipment shall have corrosion protection coatings as discussed in section A-3.3.5 Corrosion Protection.

A common feature of many trackers is the “stow” option during high winds. This feature will change the tracker’s tilt to a more favorable angle to decrease the wind loads on the racking, supports, and foundations during high wind conditions. If a “stow” is required to meet design wind loads, a backup energy source (e.g., a backup emergency battery system) shall be installed on the Site to ensure that the tracker shall be able to move into the stow position if

the power from the grid is interrupted during high wind conditions in excess of the vendor's design limit or the foundation design limit.

A-3.4 Civil Engineering

Contractor shall design all systems in accordance with applicable codes and standards. Contractor shall design necessary road improvements to meet state and local transportation codes, standards, conditional use permit stipulations and conditions, and requirements presented by construction equipment, delivery vehicles, and operation and maintenance traffic. Contractor shall perform required Site preparation, to include earthworks, SWPPP, and erosion control. Contractor shall attempt to minimize earthwork and vegetation disruption for the installation of the Plant to the extent it is compliant with the use permits; however, site grading and surfacing shall be designed to control vegetation to minimize fire danger and provide the ability to operate and maintain the Plant. Any land contours that may affect PV electrical generation should be included in the PV system performance estimate. If required, Contractor shall import engineered fill to slope the Site and prevent accumulation of standing water. Any direct burial cabling shall be protected with adequate bedding materials to ensure long-term cable integrity. Dust control shall be maintained in accordance with state and county requirements until Final Acceptance is achieved. Contractor shall provide other Site maintenance as needed during construction. Contractor shall coordinate interaction between Owner and any permitting authorities regarding the Work.

A-3.4.1 Human Access

Contractor shall make access to all equipment safe and reasonably ergonomic for maintenance staff. For example, if an inverter pad is elevated, the earthwork surrounding the concrete pad shall have a safe approach slope.

A-3.4.2 Erosion Control

Contractor shall submit a location-specific erosion control plan for local jurisdiction approval prior to construction.

All areas of temporary soil disturbance are to be graded, if necessary, and re-vegetated in a timely manner to limit erosion as required by the local jurisdiction. A weed management plan for site reclamation shall be developed and submitted to Owner for review prior to construction.

A-3.4.3 Grading and Drainage

The grading and drainage plan shall be designed and installed in accordance with local code and permit requirements. All structures required for the drainage plan, if any, shall comply with state standard specifications for drainage facilities.

A-3.4.4 Dust Control

Contractor shall apply dust control materials to minimize raising dust from construction operations and traffic, including haul routes, using only dust control mixtures approved by the local jurisdictions.

A-3.4.5 Fire Prevention and Protection

As part of its Safety Plan, the Contractor shall include a fire prevention and response plan.

The Contractor shall perform all work in a fire-safe manner.

The Contractor shall comply with all state, federal, and local fire prevention regulations.

A-3.5 Roads and Construction Access

A-3.5.1 Construction Access

Contractor shall abide by all load limits established by the applicable Department of Transportation (DOT) for the relevant state where the Plant is built.

Contractor shall be responsible for providing, operating, and maintaining equipment, services, and personnel with traffic control and protective devices, meeting the requirements of the *Manual of Uniform Traffic Code Devices* as required, to allow traffic flow on haul routes and onsite access roads in a safe manner. Contractor shall be responsible for any costs to comply.

Contractor is responsible for construction of temporary access around areas of excavation and other construction activity, if necessary and as required.

A-3.5.2 Onsite Roads

Contractor shall provide a minimum setback of 20 feet between the perimeter fence line and any equipment or as directed by local authorities if more distance is required. This setback space may be used as a perimeter road.

For interior service roads as necessary, Contractor shall allow a minimum road width of 16 feet between PV array blocks. Pathways between rows of modules and circuit blocks may be narrower but designed with consideration of procedures required for accessing all modules and array equipment for maintenance and repairs. Interior roads (as needed) shall be 16 feet wide. Pathways between rows of modules and circuit blocks may be less. Road surfacing shall meet local fire and emergency vehicle access requirements.

Roads shall have a minimum 30-foot inside radius, unless otherwise instructed by state or local requirements. A smaller turning radius may be approved with written approval from the Owner.

A-3.5.3 Site Access Roads

The Site access road, if not currently in place, shall be designed and installed by the Contractor. If the Site access road does exist, then it is to be improved by the Contractor to a 20-foot gravel road. This design shall be based on sufficient soils and subsurface investigation by a qualified professional to ensure that the constructed road will meet its intended purpose. The design life of the access road shall be 30 years (assuming annual maintenance). The Site access road shall be a gravel road sufficient to satisfy the loading requirements of the equipment vendors and to provide all-weather access for operation and maintenance of the Plant. Site access roadway design shall comply with local permit requirements.

Temporary construction roads and staging areas not connected to permanent roads (if any) shall be restored by Contractor in accordance with permit requirements.

A-3.6 Earthwork

A-3.6.1 General

Earthwork includes, but is not limited to, the following:

- Trench excavation (including rock excavation) and backfill for underground utilities
- Excavation and backfill (including rock excavation) for foundations
- Installation of granular fill and surfacing around concrete structures, drainage facilities, towers, and related Site structures, and within roadways
- Finish grading around all concrete pads (e.g., an inverter pad) shall have a safe approach slope leading to the top of the pad or to a small step up not to exceed 8 inches in height

Contractor shall make its own estimate of the types and extent of the various materials to be encountered or required to accomplish the Work.

Contractor shall utilize sustainable practices where practical, such as recycling shipping containers, pallets, etc. All materials that are not practicably recyclable shall be disposed of in an approved landfill. Contractor shall clean up any spill or contamination that may occur on Site in accordance with approved standard procedures.

A-3.6.2 Excavation

Contractor shall be responsible for making all excavations in a safe manner and consistent with the requirements of the Occupational Safety and Health Administration.

Contractor shall provide adequate measures to retain excavation side slopes to ensure that structures, equipment, and persons working in or near the excavation are protected.

Contractor shall protect all above grade and below grade utilities.

A-3.6.3 Construction Signage

Contractor shall provide temporary signage for local traffic control in accordance with state DOT or local county requirements and in accordance with the Agreement.

A-3.6.4 Fencing

Contractor shall utilize temporary fencing whenever an existing fence is removed and as necessary to maintain security and prevent the movement of livestock and other natural wildlife. Contractor shall provide a minimum setback of 20 feet between the perimeter fence line and the solar panels and project substation. Additional setback may be required by other standards. Fencing shall meet PacifiCorp design standards of **Appendix A-7.10 - PacifiCorp Engineering Handbook, Part 6B.5 Fence Application and Construction.**

A-3.6.5 Site Finish Grade

Contractor shall leave the Site in a clean condition upon completion of the work. Efforts shall be made to restore area to a clean condition as soon as practical. Contractor shall remove all trash, debris, and stockpiles. The Site access roads shall be returned to a condition that meets the original specification by repairing road damage such as ruts, gouges, and weather damage that may have occurred during the course of construction.

The Site finish grade within the equipment footprint and in areas required for operation and maintenance of the Plant shall be fully stabilized in a manner that meets or exceeds local county requirements.

Provisions of the SWPPP for final storm water drainage shall be implemented.

Contractor shall seed and mulch all areas of the Plant Site that have been disturbed beyond the permanent portion of the Site and access road, per the SWPPP. It is preferred that the Contractor use low water, low maintenance plans for re-seeding.

A-3.7 Plant Design and State Requirements

Any technical requirements under any applicable state incentive program shall be met by the contractor. For example, any technical requirements under the state energy office incentive structure shall be met by the Contractor for the state where the Plant is built.

A-3.7.1 Electrical Engineering

Contractor shall provide all electrical engineering design services, meeting applicable codes and standards and the requirements of the interconnecting utility.

The engineering and design shall include the appropriate sizing and cabling (above and below ground) that will connect all applicable equipment to the point of interconnection. The Plant electrical system shall be designed for electrical system losses on the DC wiring system to be no more than 2 percent and losses on the AC wiring system no more than 2 percent. In the event the Contractor proposes a direct current (V_{DC}) system greater than 1,000 Volts, then the Contractor is responsible for determining if the authority having jurisdiction will allow use of same and to design accordingly. All DC disconnects at the inverter (s) and combiner boxes shall include a visible gap when in the open position.

All protection equipment used throughout the system shall be sized and specified to reduce damage to all components to the utility interconnection point in the event of electrical failure.

The above ground portion of the electrical systems shall be neatly routed to facilitate access, troubleshooting, maintenance, etc.

Trench depth for electrical wires shall be as follows:

- Bottom of trench ~ 3.5 feet typical for DC trench
- Bottom of trench ~ 4 feet below finish grade for AC trench (28 kV)
- Bottom of trench ~ 5 feet below finish grade if both DC and AC (28 kV) in same space

The electrical design shall include the design of equipment grounding and lightning and surge protection for the entire Plant Site. Contractor shall provide a comprehensive surge protection system and provide a lightning risk assessment. The results of the lightning risk assessment and consultation with PacifiCorp will be the basis for determining the extent of the lightning protection system (LPS) that is required.

An arc flash study shall be performed per **Appendix A-7.13 - PacifiCorp Generation Engineering New Generation Plant Construction Standard, Arc Flash Hazard Standard**.

Contractor shall design and specify all communications hardware and software required for system protection and remote monitoring and control. All monitoring and communication supplemental equipment and cabling shall be designed and specified by Contractor, subject to Owner review.

The power delivered to the grid must at all times meet the interconnect requirements for power factor. A one-line drawing is required illustrating the power factor control strategy.

A-3.8 Communication System

Contractor shall procure and install a SCADA system as required in the Interconnection Agreement.

Contractor shall install communications systems as required by the Interconnection Agreement.

Contractor shall install communications systems as required in Section A-3.9 Security.

Contractor shall supply all equipment necessary to connect to Transmission Provider's fiberoptic cable for each of the communications described in this section.

A-3.8.1 Communications System Testing and Warranty

Contractor shall test the installed communication system to demonstrate its ability to meet the requirements of its intended use. Testing shall be performed when the final system interconnections have been made.

A-3.9 Security

Contractor shall provide a security system for the Plant. The security system around the perimeter shall include a 7-foot-high chain link fence with 1-foot top guard (total 8-foot high) of three strands of nine-gage barbed wire. The perimeter fence shall include three locked gates: two with a width of 20 feet for vehicles and one pedestrian entrance with a width of 4 feet. Fencing shall meet guidelines in section A-3.6.4 Fencing. Contractor shall utilize temporary fencing whenever an existing fence is removed and as necessary to maintain security and prevent the movement of livestock and local wildlife.

Perimeter signage shall be provided by Owner and installed by Contractor in accordance with Owner standards. Signage shall be installed every 65 feet along the perimeter fence and on all gates. Signage shall be installed five feet above ground level.

Signage that will be provided by the Owner will include the following:

Warning! Hazardous Voltage Inside Keep Out

English SI# 7999852

Spanish SI# 7999854

No Trespassing

SI# 8252306

Mounting Hardware

SI# 7999092

The Contractor shall be responsible for security during construction.

Contractor shall contract with AVTEC SYSTEMS INTEGRATOR, A DIVISION OF CACHE VALLEY ELECTRIC, (Security Sub-Contractor), to provide and install the necessary security equipment. Contact:

Avtec – System Integrator
Michael Petric
(801) 908-4191
michael.petric@cve.com

This equipment may include, but is not limited to:

a. LED Spot or LED flood lights.

b. Security cameras located such that they are capable of adequate identification of intruders covering the perimeter of the Site. Cameras shall be placed at a height that permits line-of-sight access to the property and minimizes shading onto the PV array.

c. Cameras with a control and detection system that assists in the detection and identification of intruders.

d. Network - Digital Video Recorders used to record video that could be used for evidence in the event of theft or vandalism.

e. Contractor shall negotiate with the Security Sub-Contractor to identify the scope of work that will be performed by the Security Sub-Contractor, to ensure that a complete and operational security system as described by the Security Sub-Contractor is provided. The Security Sub-Contractor shall provide to the Contractor the security system design, which will indicate the location of cameras, DVRs, security lighting and any security communications equipment, based on the Contractor's overall System design. The work that may be provided by the Security Sub-Contractor may include the furnishing and installation of wiring, cabling, labor, tools, equipment, and ancillary materials required for a complete and operational security system. At minimum, it is expected the Security Sub-Contractor will provide the following equipment: cameras, network DVRs, and any specialized security communications equipment.

f. Contractor shall be responsible for the furnishing and installation of all necessary conduit, 120 Volt alternating current (V_{ac}) power extensions for all Security related equipment. Contractor to allocate a minimum or (3) three each – 1" conduits from each Inverter Pad.

g. Contractor shall provide a free-standing weather proof enclosure with adequate space required for Security Control Equipment as specified by the Security Sub-Contractor. Contractor may also install the solar facility SCADA equipment, in accordance with Section A-4.12, within the same enclosure.

h. Installation of telephone lines, and/or cellular modem(s), and/or local area network for the interconnectivity of all related Security System Equipment.

i. Contractor shall provide fiber optic cable for Security System Communications. Fiber optic cable shall consist of a minimum of (4) four fiber strands between each inverter pad. Security fiber strands provided can be included in the fiber optic cabling that is provided as part of the SCADA Communications System.

j. The system shall be complete, tested, and fully operational. Prior to construction, Contractor shall provide the following:

    i. Descriptive statement and single-line block diagram to show how all related equipment will interface and operate as a complete system.

    ii. Product data: manufacturer's technical data sheets on each product to be used.

    iii. Drawings, including plans, elevations, equipment mounting heights, and dimensions required to show devices' locations and demonstrate accessibility compliance in accordance with referenced documents.

    iv. Detailed schematic wiring diagrams for all system devices; wiring information shall include cable type, conductor routings, quantities, and connection details at devices.

    v. Manufacturer's user's manuals for operations, administration, installation, and maintenance.

A-3.9.1 Security System Installation

All system components and appurtenances shall be installed in accordance with the manufacturer's specifications, referenced practices, guidelines, and applicable codes. All necessary interconnections, services, and adjustments shall be furnished as required for a complete and operable system as specified. Control signal, communications, and data transmission line grounding shall be installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.

All security system wiring shall be installed in dedicated conduit throughout. Cable shall not be pulled into conduits or placed in raceways, compartments, outlet boxes, junction boxes, or similar fittings with other wiring. All low-voltage wiring outside the control console, cabinets, boxes, and similar enclosures shall be plenum rated where required by code.

All wiring conductors connected to terminal strips shall be individually numbered and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as identified and shown on the drawings.

A-4 Equipment

A-4.1 Equipment Supply

As described in detail throughout this document, Contractor shall purchase and furnish to the Site all material required to complete the Plant, including the following material:

- Miscellaneous steel
- Support steel posts
- Components (nuts, bolts, clamps, etc.)
- PV modules
- Fixed tilt racking or single axis tracker equipment (as applicable) and components
- DC cabling and combiner boxes
- DC junction boxes
- AC cabling
- Power centers, including inverters
- Electrical switchgear
- Transformers
- Meteorological station
- Snow Monitoring System
- Remotely accessible data acquisition system
- All materials related to drainage required by the civil engineering plan
- All electrical conduit and junction boxes
- Concrete equipment pads
- Fencing, gates, lighting, security cameras, and security camera recording equipment
- Communications structure (if required)

Each item of equipment to be supplied by Contractor shall be subject to inspection and testing during and upon completion of its fabrication and installation as per PacifiCorp Facility Connection (Interconnection) Requirements for Distribution Systems (34.5 kilovolts and below).

Contractor shall provide the manufacturer's flash test data for all modules to Owner upon procurement of modules.

Prior to the arrival of equipment and materials at the Site, the Contractor shall install a fenced, secured area and provide security for the storage of such equipment and materials. Contractor shall notify Owner of the location and layout of intended staging areas, parking areas, storage areas, office areas, workshops, and other temporary facilities. Temporary construction roads and staging areas not converted to permanent roads (if any) shall be restored in accordance with all permit requirements.

Contractor shall be responsible for receiving and storing all freight at the Site in a secure manner.

Installed equipment and materials shall be new, of good quality and suitable grade for the intended purpose, and not a lower grade or quality than specified in the design and engineering plans or in manufacturers' recommendations. Where applicable, utility-grade

equipment shall be used. Commercial- or residential-grade equipment shall not be acceptable. No equipment shall utilize polychlorinated biphenyls (PCBs).

If Contractor proposes to use equipment that is non-utility grade, it is the responsibility of Contractor to identify the equipment and report it to PacifiCorp for approval. It is the responsibility of Contractor to identify any equipment using SF_6 gas. It is the responsibility of Contractor to identify any proposed batteries and provide quantities and associated data sheets. It is the responsibility of Contractor to provide data sheets and quantities on any proposed chemicals used on the Plant. Contractor shall provide a list of all major equipment to be purchased, constructed, and installed as part of the Plant. The list shall identify both the items and quantities.

A-4.2 Signage and Labeling

Permanent naming placards should be placed on all equipment, including inverters, combiner boxes, transformers, and others according to the NEC and PacifiCorp specifications. Naming on placards and/or tags shall match drawing naming convention. Security signage shall be in accordance with A-3.9 Security. All signage must meet current industry standards. Placards and signs shall have a life span of 20 years.

All cables shall be labelled to meet applicable codes and standards. All cables shall have a label affixed to the outer jacket with a Brady or equivalent cable marker at each termination of a type accepted by Owner before and installation. Labelling will match the point to point drawings. A method for ensuring labeling is complete must be included in the Contractor's QC Inspection Point Program.

A-4.3 Grounding and Bonding

Contractor shall provide detailed information (such as ground-grid drawings and calculations) for all proposed Plant grounding. Contractor is responsible for designing and providing the Plant system grounding and equipment grounding. The Plant grounding design shall be done in accordance with Institute of Electrical and Electronics Engineers (IEEE) standards for generating stations. Substation grounding shall be done in accordance with IEEE standards for substation grounding. All grounding designs shall be reviewed by Owner prior to Contractor commencing work.

All ground conductors shall be stranded copper and may be bare if exposed. Ground conductors in conduits shall be green-insulated. Ground lugs shall be mechanical and rated aluminum to copper. All below grade connections shall be exothermic welds. Step-up transformers and inverters and the Plant switchgear shall be bonded to the ground ring at opposing corners of the equipment. Mounting structures shall be grounded in a manner that is sized for maximum available short-circuit current and lightning current (if required).

Contractor shall submit to Owner grounding and lightning calculations for assurance of safe step and touch potentials on the Site, in accordance with Owner's standards. Contractor shall conduct a ground resistivity test, with opportunity for witness by Owner as provided in the Agreement, to verify that the grounding system meets minimum requirements for the overall grounding scheme. Interior fencing (including without limitation internal fences around interconnection equipment and inverters) shall be installed and grounded and substation grounding shall be done in accordance with PacifiCorp Engineering Handbook Parts 6B.5

and 6B.6. Fencing around the perimeter of the overall Plant Site shall not need to meet the aforementioned Handbook standards but shall be grounded in accordance with local codes. Perimeter fences shall not be shared with the substation fence and shall be at least 30 feet from the fence around the interconnection equipment. A ground grid meeting the requirements of IEEE 80 shall be installed in the area of the interconnection equipment.

A-4.4 Surge and Lightning Protection

Contractor shall provide a lightning risk assessment performed to industry standards by a certified lightning protection professional, as outlined in section A-4.4.2 External Lightning Protection System (LPS). The results of this assessment, in consultation with Owner, shall be the basis for determining the requirements and extent of the facility LPS and a surge protection system that provides protection of the PV panels, DC power circuit, inverters, measurement control and communications systems, and other major electrical equipment.

A-4.4.1 Surge Protection

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 (A-3.7.1 Electrical Engineering) 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 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:

Underwriters Laboratories, Inc. (UL) Standard 1449 3rd edition.

IEEE Guideline C62.41.1-2002

IEEE Guideline C62.41.2-2002

IEEE Standard C62.42.0 -2016

IEEE Standard C62.45-2002

IEEE Standard 1100-2005

SPDs for PV DC Power Circuits

SPDs applied on PV DC power circuits shall meet all the requirements listed above in this general section and shall be specifically designed for and labeled to UL 1449 3rd edition and UL’s Certification Requirement Decision for PV DC application. DC PV SPDs shall be rated

for a short-circuit withstand capacity (I_{SCWPV}) of not less than 1,000 amperes (A). The SPDs must be specifically designed to be able to disconnect themselves from an energized DC circuit by means of an internal integral fused circuit and do so without damage caused by faulting arcs. SPDs must be selected for the voltage system that they are to be applied (such as 600; 1,000; 1,200; or 1,500 V_{DC}). SPDs shall be from an equipment manufacturer regarded as a Tier 1 Supplier. Surge Suppression, Inc. of Destin, Florida is the preferred manufacturer of any required SPDs.

SPDs Applied on AC Power Circuits

SPDs applied on AC systems must meet all the requirements listed above in this general section and must be specifically designed for and compliant to UL 1449 3rd edition. SPDs must be selected for the system voltage where they are to be applied. SPDs are to have a short-circuit current rating (SCCR) higher than the short circuit availability where they are installed, therefore not requiring external fusing. SCCR of 200,000 A is ideal. SPDs shall be from an equipment manufacturer regarded as a Tier 1 Supplier. Surge Suppression, Inc. of Destin, Florida is the preferred manufacturer of any required SPDs.

SPDs for Measurement, Control, Instrumentation, and Communications Circuits

All critical non-power circuits are to be protected with appropriate DIN rail-mounted pluggable surge protection for the system they are applied. Surge protection bases are to permit signal continuity even if the SPD module is removed from the base. SPDs shall be from an equipment manufacturer regarded as a Tier 1 Supplier. Surge Suppression, Inc. of Destin, Florida is the preferred manufacturer of any required SPDs.

A-4.4.2 External Lightning Protection System (LPS)

Based on the findings of the lightning risk assessment and/or the discretion of the Owner, an external LPS may be required to be installed. If so, Contractor shall provide a LPS to protect the overall plant from direct lightning strikes to any portion of it, including, but not limited to, solar panels, inverters, outside cabinets, and buildings housing electrical equipment. The LPS shall consist of air terminals of proper height and spacing (using the rolling sphere method), properly rated and properly designed and placed down-conductors to assure safety of personnel during discharges, and a properly designed and installed ground system.

The systems shall be designed in accordance with the latest globally recognized standards for such designs, which are either International Electrotechnical Commission (IEC) 62305-1 and IEC 62305-3, or NFPA 780.

Grounding systems shall be in compliance with IEEE Standard 142-1982, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

Designs are to be provided by a recognized expert LPS design firm, supplier, or professional engineering firm, and are to be submitted to the Owner.

All components of the LPS shall be in compliance with the selected system design standard chosen.

Careful consideration must be given to the design and placement of all air terminals so as to have no shadowing effect on PV panels.

A-4.5 Photovoltaic Modules

The PV modules shall:

a. Meet IEC 61215 (crystalline silicon PV modules) or IEC 61646 (thin film PV modules).

b. Meet IEC 61730: Photovoltaic Module Safety Qualification.

c. Meet IEC 61701: Salt Mist Corrosion Testing of Photovoltaic Modules; Severity 6.

d. Be listed to UL standard 1703 for the voltage specified.

e. Include all known and future duties, tariffs, export tariffs, customs, demurrage, and shipping costs.

f. Be from an equipment manufacturer regarded as a Tier 1 Supplier.

g. Module supplier should provide a bankability report from an independent engineer.

h. Manufacturer should provide an established track record of installed systems throughout the United States.

i. Demonstrate workmanship quality through a third-party factory audit or testing score such as VDE Quality Tested certificate, or Solarbuyer's Independent Quality Assessment overall rating of "Good" or better with zero critical findings.

j. Demonstrate a 25-year rated lifetime via long-term outdoor testing and/or accelerated lifetime laboratory testing. Testing such as Thresher testing, DNV-GL's "PV Module Reliability Scorecard," Atlas 25+ PV Module Durability Testing (Desert Climate Classification preferred), 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 expected life.

k. Demonstrate that damp heat testing is performed at proposed design voltage (e.g., 1,500 V_{DC}).

l. Demonstrate proposed module is Potential Induced Degradation (PID) free.

m. Be only factory "firsts" meeting all QA/QC requirements. No "seconds," or modules not meeting all quality control requirements shall be allowed.

n. Demonstrate manufacturing quality by electroluminescence (EL) testing of every module for defects.

o. Acceptable PV module vendors are:

- Canadian Solar
- First Solar
- Hanwha Q CELLS
- JA Solar
- Jinko Solar
- Kyocera
- LG

- LONGi Solar
- Mission Solar
- Panasonic
- Phono Solar
- REC Solar
- Renesola
- Sanyo
- Solar Frontier
- SolarOne
- SolarWorld
- SunPower
- Trina

p. 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 shown in Figure 1. 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.

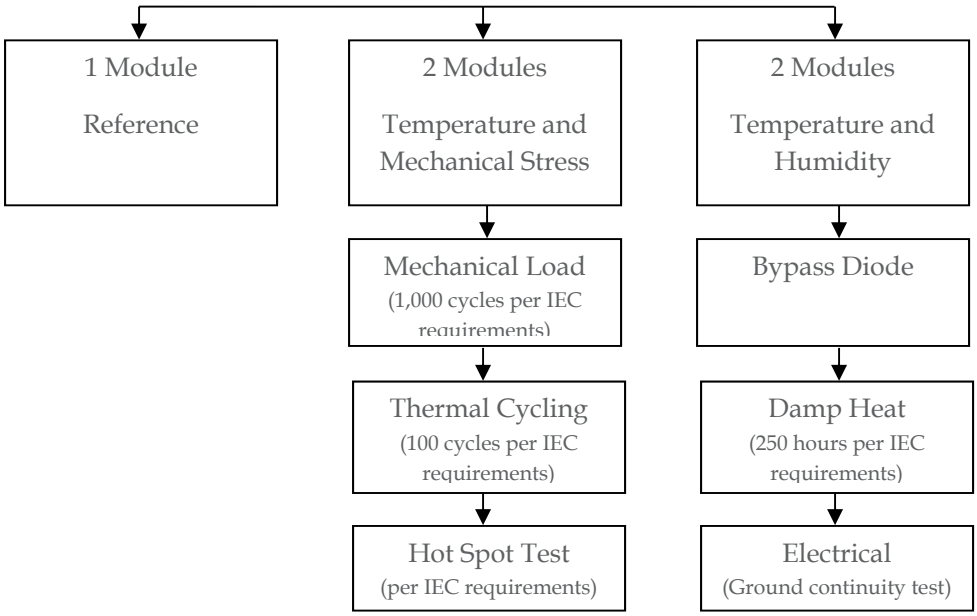


Figure 1: Module Manufacturing and Batch Quality Assurance

Note that the Owner, at its sole discretion, may randomly select up to 20 PV modules shipped to the Plant for delivery to a third party for quality verification testing. The costs of such verification testing will be the responsibility of Owner. Owner reserves the right to refuse the

Bidder's proposed module if the independent tests indicate performance, workmanship, batch quality, or reliability issues.

PV module manufacturer shall:

- Be ISO 9001 certified (alternatively, ISO 62941)
- Be ISO 14001 certified
- Have a minimum of 5 years' experience manufacturing PV modules

A-4.6 Step-Up Transformers

Transformers shall meet transformer efficiency standards set forth in the most recent version of the U.S. Department of Energy "Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule." Transformers shall be rated for inverter source operation and the environment in which they will operate. The transformer shall be supplied with a no-load tap changer with high-voltage taps capable of operating at 2.5 percent above and below nominal voltage at full rating. The transformer shall be supplied with a fused disconnect switch on the transformer high-voltage side to isolate the transformer in case of an internal fault. The switch/transformer configuration shall be designed for loop feed. Transformers shall be either dry-type, biodegradable fluid, or less-flammable oil insulating fluid. Enclosure finish shall be a top powder coat that is designed for a 25-year service life. Contractor shall provide and install step-up transformers as provided in the Agreement. Owner shall reserve the right to attend factory witness testing of step-up transformers.

Contractor that interconnects to the PacifiCorp system shall provide equipment and perform the work in compliance with the requirements of the **RFP Appendix A-2 - Interconnection Agreement, RFP Appendix A-7.04 - Two-Winding Distribution Transformer, Inverter Step-Up Liquid-Immersed (Pad Mounted, Compartmental Type) ZS-002**, and other applicable standards and specifications listed in **Appendix A-7 – Owner Standards and Specifications**.

A-4.7 Inverters

The inverter units shall be utilized for inverting the DC input from the Plant to AC output. Contractor may use large-scale, central inverter or string inverter design strategies. However, either design shall be capable of operating under all required federal, state, and local standards and codes, and be capable of providing all the required grid support.

Inverters shall be calibrated and set so that the AC output, after inverter clipping and losses between the inverter to the meter, shall not exceed the Plant AC capacity at the meter. Contractor shall supply and install inverters, transformer pads, and wiring/cabling to this equipment in accordance with National Electrical Code (NEC) standards. Contractor will tie into the existing medium-voltage distribution system, connecting the system to the new generation facilities via medium-voltage transformers.

Inverters selected for this project shall:

a. Be UL listed to 1741 (Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources).

b. Comply with IEEE 1547-2018, including testing to IEEE 1547.1 and IEEE C62.45. Regulatory standards compliance shall also include IEEE C62.41.2 and CSA107.1-01.1. Inverters shall have voltage and frequency ride-through functionalities, as well as be capable of actively regulating voltage levels by providing adjustable active and reactive power. The inverters/plant controllers shall have the capability of reducing their active power during certain pre-determined conditions, as specified in the Interconnection Agreement. The inverter shall have the capability to meet the following:

Ride-through region for voltage and voltage trip settings

Voltage at Point of Common Coupling (% Nominal Voltage)	Ride-Through Until (s)	Operating Mode	Maximum Trip Time (s)
>120			0.16
110- 120	12	Momentary Cessation	13
88 - 110	Continuous Operation	Continuous Operation	Continuous Operation
70 - 88	20	Mandatory Operation	21
50 - 70	10	Mandatory Operation	11
0 -50	1	Momentary Cessation	1.5

Default Interconnection System Response to Abnormal Frequencies

System Frequency Default Settings	Range of Adjustability (Hz)	Default Clearing Time (s)	Range of Adjustability (s)	Ride Through until (s)	Ride Through Operational Mode
f > 62	62 - 64	0.16	0 - 300	No Ride through	Not Applicable
60.5 - 62	60 - 62	300	0 - 300	299	Mandatory Operation
58.5 - 60.5	indefinite				
57.0 - 58.5	57 - 60	300	0 - 600	299	Mandatory Operation
< 57.0	53 - 57	0.16	0 - 5	No Ride through	Not Applicable

Notwithstanding the above, the inverter and associated system shall meet all requirements specified in the Interconnection Agreement. Contractor shall notify Owner at least two

weeks prior to factory acceptance tests that will be performed to demonstrate these capabilities. Owner, or its representative, shall have the opportunity to witness factory acceptance tests.

The inverter and associated equipment shall meet all standards for operating on the transmission or distribution systems including all aspects of dynamic grid support noted in A-4.7 b. above and the additional requirement for providing Primary Frequency Response as dictated by FERC and included in the PacifiCorp interconnection standards for Small and Large Generators.

Inverter shall be capable of providing voltage droop control.

c. Carry a minimum 5-year standard warranty with options for at least a 20-year extended warranty.

d. Be designed for a 30-year lifetime, assuming regular maintenance (including replacement of inverter components).

e. Have a maximum harmonic distortion less than 3 percent of total harmonic distortion at rated power output.

f. Have an efficiency greater than 98 percent without medium-voltage step-up transformer according to the California Energy Commission (CEC) test procedures for peak efficiency.

g. Be capable of rated output at 50º C or higher.

h. Incorporate a no-load, two-pole, lockable disconnect switch or fusible disconnect for main DC power disconnect for maintenance personnel safety with visible gap between contactors when in the open condition. DC load break switches should be installed at the combiner boxes and at the inverters (located as close to the array as possible). Be equipped with lightning protection.

Skid-mounted package units containing all equipment including DC switches, master fuse boxes, inverters, step-up transformers, and other power conditioning system equipment are preferred. Skid-mounted package units with integrated steps, side rails, and other safety features are preferred. The inverter manufacturer must approve all structures that contain inverters, especially as it relates to ventilation and temperature.

Inverters located outdoors shall be enclosed in lockable enclosures with a minimum rating of National Electrical Manufacturers Association (NEMA) 3R and with coatings in accordance with section A-3.3.5 Corrosion Protection. Any sensitive electronic equipment associated with, or part of, the inverter shall be installed in a NEMA 4 rated enclosure.

To the extent practicable, inverters should be mounted/oriented in such a way to avoid the effects of the sun (for example, facing the LCD display north to reduce sun exposure). If an LCD screen will be exposed to direct sunlight, a shade canopy shall be installed to provide shading for the screen.

Enclosure must have a door interlock system to prohibit the door(s) from being opened while energized.

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 the vendor shall furnish an external on/off (start/stop) switch.

Inverters shall employ a maximum power point tracking scheme to optimize inverter efficiency over the entire range of PV panel output for the given Site design conditions.

Inverters shall be equipped with all hardware for data collection and communication to the central SCADA server.

Inverter shall be equipped for direct external communication and control to Owner. If communications to Transmission Provider's SCADA system is required by the Interconnection Agreement, then inverter communications and all available inverter controls shall be provided to the Transmission Provider over Transmission Provider's telecommunication network (see **RFP Appendix A-2**).

Inverter shall include a fused, and disconnectable control power transformer (CPT).

Plant design for inverters rated to 1,500 or 1,000 V_{DC} shall comply with NEC Articles 690 and 490, and all other requirements applicable to installations rated over 600 volts (V).

Buildings, storage facilities, and enclosures shall be provided to the extent that protection is needed; the environment needs to be maintained for the long-term reliability, availability, and operation of the equipment; or that it is required by law or the Interconnection Agreement.

Inverter manufacturer shall:

a) Be certified to ISO 9001 and ISO 14001 standards.

b) Be regarded as a Tier 1 Supplier.

c) Shall have supplied a minimum of 100 MW capacity in utility-scale projects located in North America.

Acceptable inverter vendors include the following firms:

- Huawei
- Sungrow
- SMA
- TIMEIC
- ABB
- TBEA
- Schneider Electric
- Power Electronics
- SolarEdge
- Yaskawa-Solectria Solar
- General Electric (GE)

- Ingeteam
- Kaco New Energy
- Enphase

A-4.8 Fixed Tilt Racking Structure

The fixed tilt racking system (if applicable) shall include the racking structure and all module mounting hardware. The racking vendor may supply the supports if desired, or the supports may be provided by a third party. The rack's azimuth and tilt angle shall be specified on the engineering drawings.

The racking system shall be designed using the environmental loads and the Occupancy Category as discussed above in section A-3.3.2 Environmental Loads. The racking structures, support attachments, module mounting brackets, fastening hardware, and supports (if applicable) shall have a 30-year design lifetime. Equipment shall have corrosion protection coatings as discussed in section A-3.3.5 Corrosion Protection.

If the racking structure is a component of the solar array grounding and bonding strategy, the racking system shall meet UL 2703. Manufacturers' directions pertaining to grounding and bonding shall be followed.

Fixed tilt racking vendors under consideration shall have installed a minimum of 100 megawatts (MW) capacity in utility-scale projects.

A-4.9 Single Axis Tracking Structure

The single axis tracking system (if applicable) shall include the racking structure, mounting hardware, drive motor(s), and controller system. Additionally, any equipment required for the safe operation and wind stow (if applicable) should be included in the bid. The vendor may supply the supports if desired, or the supports may be provided by a third party. The trackers shall be oriented on a north-south axis and shall automatically track the path of the sun each day. All control equipment enclosures shall be rated NEMA 4.

Flexible cords or cables, where connected to moving parts of PV tracking arrays shall follow National Electrical Code 690.31 (E) pertaining to the number of strands required in flexible cabling, keeping in mind that this is a minimum standard and the number of strands may be significantly higher than Table 690.31 (E).

If the tracking structure is a component of the solar array grounding and bonding strategy, the tracking system shall meet UL 2703. Manufacturers' directions pertaining to grounding and bonding shall be followed.

Self-powered tracking systems shall be UL 3703 listed.

The tracking system shall be designed using the environmental loads and the Occupancy Category as discussed in section A-3.3.2 Environmental Loads of this specification. The torque tubes, support attachments, module mounting brackets, all fastening hardware, and supports (if applicable) shall have a 30-year design lifetime. Equipment shall have corrosion protection coatings as discussed in section A-3.3.5 Corrosion Protection. PV modules may be either 60-cell or 72-cell modules. Modules shall be oriented as modeled in Contractor PVsyst or other modeling tool used by the Contractor for System design.

As discussed in section A-3.3.6 Single Axis Tracking Structures, many trackers feature a "stow" option. If this feature is required for the racking, supports, and foundations to satisfy the design wind loads, a backup energy source shall be installed on the Site to ensure the tracker will be able to move into stow position during winds in excess of the supplier's design wind speed if the power from the grid is interrupted. Owner does not require the backup energy source if the stow feature is not needed. Contractor shall design the PV arrays' mounting systems, foundations, and piers as provided in the Agreement. The design shall be based upon standard industry practice, including the requirements of applicable codes, standards, and permits, as well as the information and specifications provided by the module, inverter, transformer, switchgear, racking, and all other vendors.

Single axis tracking vendors under consideration shall have installed a minimum of 100 MW of capacity in utility-scale projects.

A-4.10 Direct Current Fused Combiner Boxes

Combiner boxes shall be rated for maximum system voltage and maximum system continuous and short-circuit currents.

Design should follow combiner box manufacturer instructions pertaining to temperature rating of output conductor in order to use 90º F conductor rating, combiner box manufacturer must certify box assembly as 90º F rated.

Enclosures shall be rated NEMA 4 and shall have integral key lock or provisions for padlocking.

DC inputs shall be fused with finger safe fuse holders for all hot conductors

Fuses shall have blown fuse indication.

Combiner box output shall have a means to be externally disconnected.

If the combiner box has a lightning protection device, the device should include a visual trip indicator.

A-4.11 Meteorological Stations

Contractor shall provide complete solar meteorological weather stations for the Plant per the requirements of IEC 61724 -1 "Photovoltaic System Performance – Part 1: Monitoring" for Class A monitoring. The quality and quantity of stations will be as per Class A.

The required minimum measurements shall be as follows to meet Class A:

- Global horizontal irradiance (measured by two instruments)
- Plane of array irradiance (in the plane of the tracker if used)
- Ambient air temperature and relative humidity
- Cell temperature on a single solar module in the array
- Wind speed and direction (measured at 2 and 10 meters)
- Precipitation (rainfall)
- PV module soiling and back of module temperature sensor

Below is a list of the general features the monitoring station shall include and other provisions the design shall accommodate:

- Equipment calibration certificates
- Summary of common calibration recertification timelines
- Functional specifications for the measurement devices
- Electrical schematic and mechanical installation drawings, proposed commissioning plan (flow chart) and site troubleshooting and problem resolution protocol (flow chart) for the monitoring systems
- O&M manual that includes an overall description of the monitoring system, the routine O&M plan and schedule of maintenance events and procedures
- Equipment and installation warranties

A-4.12 Supervisory Control and Data Acquisition

Contractor shall supply and install an Owner-approved monitoring hardware and software package, including interconnection communications. The monitoring system must be selected to provide its 5-year Commercial Solar Monitoring Equipment and Service Package for the Plant. SCADA pricing shall include hardware and software (including all software subscriptions) for a minimum of 5 years. The monitoring system shall provide energy generation data, historical data, solar insolation attributes, and meteorological data. The system shall be configured to sample data at a rate of once per second, with 1-to-10 minute average intervals, and shall be configured to update the server at least once every 15 minutes. The system shall be configured to sample and store the 1-to-10 minute averaged interval data for a period of 24 months.

The Contractor shall supply a meteorological station that will provide current weather data as noted in section A-4.11 Meteorological Stations.

The monitoring system shall be capable of issuing alarms and notices to instantly alert the system manager and operation and maintenance (O&M) contractor to potential system problems and outages. The metering and monitoring system shall comply with the accuracy requirements and general standards set forth in IEC 61724.

The metering scheme shall be capable of reading the net electrical energy to the grid during daylight hours and the nighttime auxiliary loads when the Plant is in standby mode. The metering and monitoring system shall be compliant with Western Renewable Energy Generation Information System certification requirements for Renewable Energy Credit sales or trading per section A-4.13 Revenue Meter.

Data from the monitoring system can be accessed through the system's dashboard, which allows for public and administrator panel views. All electronics shall be enclosed in a NEMA 4 enclosure. This system may be housed in the same enclosure as the security equipment (see Section A-3.9). The data shall be collected at hardwired locations and transmitted wirelessly via a cellular modem to be provided and installed by Contractor. Contractor shall test the installed communications system to demonstrate its ability to meet the requirements of its intended use. Testing shall be done when the final system interconnections have been made.

Contractor shall furnish and install all materials and equipment necessary to complete the SCADA installation. The monitoring system shall be configured for automatic reporting of generation statistics required by Owner. The data shall be collected at the hardware locations and transmitted wirelessly via a wireless SCADA system to be provided and installed by Contractor. Points to be monitored by the SCADA system shall include, at a minimum:

- Meteorological station
  - Monitor and record all items in section A-4.11 Meteorological Stations
- Inverters
  - AC voltage
  - DC voltage
  - AC current
  - DC current
  - Kilowatts (kW)
  - Kilowatt hours (kWh)
- Metering
  - Monitor and store date from the Plant meter on an interval between 5 and 20 seconds
- Transformers
- Tracker control system integration, remote monitoring, and control
- Any buildings or shelters
- Plant switchgear

The following shall make up the SCADA calculated values list:

- Model versus actual performance in kW and kWh
- Day's energy in kWh
- Month's energy in kWh
- Year to date energy in kWh
- Total lifetime energy in kWh
- Plant performance ratio, current value
- Plant performance ratio, day's average
- Plant performance ratio, month's average
- Plant performance ratio, year to date average
- Plant performance ratio, since commissioning

All monitored plant electrical generation equipment (e.g., inverters, transformers, switchgear) shall be monitored to capture real time AC and DC electrical characteristics, including:

- Voltage
- Current
- Power
- Frequency
- Power factor

All monitored plant electrical generation equipment (e.g., inverters, transformers, switchgear) shall be monitored to capture all diagnostic information, including:

- Temperatures
- Alarms
- Status indicators
- Fault states

A-4.13 Revenue Meter

A bi-directional revenue grade meter shall be installed to measure the total Plant output at the switchgear for accurately metering energy (kWh) generated by the Plant. The revenue grade meter shall be American National Standards Institute C12.20 0.2% Class UL listed, ISO9001 certified, which is accepted by all authorities requiring revenue grade. The meter must have a display for easy reading of current power generation and lifetime generation and shall be compliant with Western Renewable Energy Generation Information System certification requirements for Renewable Energy Credit sales or trading.

This revenue meter will be supplied by the Transmission Provider. Contractor shall coordinate with the Transmission Provider for the installation of same.

A-4.14 Security Cameras and Related Equipment

The material furnished shall be in accordance with, but not limited to, the following codes and standards:

- NFPA 70 - National Electrical Code
- NFPA 101 - Life Safety Code
- UL 294 - Access Control Systems (if applicable)
- UL 1076 - Proprietary Burglar Alarm Units and Systems
- American with Disabilities Act - Public Law 101.336
- State Building Code

A-4.14.1 Security Equipment

General Requirements

All security system components shall be UL labeled.

Security System Components

Security system components may consist of LED spot or LED flood lights, cameras, alarms, network video recorders, communication lines, and all wiring required for all the components. The security system shall be sufficient to monitor and deter any theft or vandalism onsite. The security component supplier shall provide detailed specifications of each component.

The Security Sub-Contractor and Contractor shall coordinate with the SCADA design/instrumentation and control engineer to ensure sufficient bandwidth is available on the network to accommodate the proposed security system. Owner may elect to reduce the equipment needs based on the location of the Site and subsequent security requirements.

Surveillance cameras and pan/tilt/zoom (P/T/Z) drives shall meet the following minimum requirements. Surveillance cameras and P/T/Z drives shall be provided by the Security Sub-Contractor. Alternative solutions providing higher upgradeability and compatibility with future products are acceptable at no additional cost, subject to Owner's approval.

1. The P/T/Z unit shall meet the following design and performance specifications:
    a. The unit shall be microprocessor controlled with network / IP based programming via standard WEB based interface.
    b. Each pan/tilt drive unit shall operate as an independent unit with exclusive programming and setup data contained on each unit's nonvolatile memory.
    c. The unit shall be capable of 360-degree continuous pan rotation with a vertical unobstructed tilt of +36 to -85 degrees.
        a. Manual Control Speeds of: 0.1 degree to 40 degree per second (Pan), and 0.1 degree to 30 degree per second (Tilt)
        b. Preset Speeds of: 100 degree per second (Pan) and 30 degree per second (Tilt)
    d. The unit shall pan and tilt under manual control.
    e. The unit shall be capable of 16 learned tours And 256 configurable preset locations for Alarm Call-up configuration.
2. The camera shall meet the following specifications:
    a. The sensor type shall be 1/2-.8-inch Type Exmor CMOS Sensor.
    b. The camera shall provide a minimum of 1080p (1920x1080) resolution, at 30 Images per second (ips).
    c. Camera shall provide a minimum of 2 simultaneous video streams: Dual H.264 or H.264 and Scalable MJPEG.
    d. Camera shall allow for control and monitoring of video via IPv4 and IPv6 Networks.
3. The motorized lens shall meet the following design and performance specifications:
    a. The camera shall provide 16:9 Aspect Ratio and shall provide a 30X optical zoom and 12X Digital Zoom.
    b. The lens shall provide horizontal angle of view of 59.5 degrees (wide) to 2.1 degrees (telephoto).
    c. The lens shall feature an automatic focus with manual override.
    d. A step-down power transformer shall be provided for each camera. Transformers shall be rated 120/24 V_{AC} and shall have an adequate Volt-ampere rating for the load at 40 degrees C ambient air temperature. Individual Fuse Distribution shall be provided.

4. The camera and lens housings shall be weatherproof and part of an Integrated Optics Cartridge (IOC). The IOC shall accommodate specified camera and lens combinations. IOC shall be dry nitrogen filled to 10 psig, to protect Camera Sensor / Lens optics from condensation and corrosion.

5. Camera assembly shall be provided with integrated IR Illumination. IR Illumination Transmitters shall be integrated to the Pan / Tilt Assembly Housing so as to provide IR Illumination for areas being viewed by the camera.

    a. IR Illumination shall be provided for distances up to and including 330 feet from each camera location.

Video Wiring System

1. Description: 100-ohm, four-pair UTP, covered with a black PVC jacket.
    - Comply with ICEA S-90-661 for mechanical properties.
    - Comply with TIA/EIA-568-B.1 for performance specifications.
    - Comply with TIA/EIA-568-B.2, Category 6.
    - Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
        - Communications, Direct Burial Rated: Type F/UTP, complying with NFPA 262.
        - General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher. All terminations shall use TIA/EIA 568B wire termination color coding.
2. Power and/or Auxiliary Input/Output cable shall be multi-conductor twisted shielded cables selected for use with the specific equipment to be controlled for installation in concealed conduit system. Cables shall have outer jacket of PVC and shall be suitable for direct burial installation.

3. All cables and conductors that serve as control, sensor, low voltage power, or data conductors shall have surge protection circuits installed at each end that meet the IEEE C37.90.1 surge withstand capability test. Fuses shall not be used for surge protection.

Network Video Recorder and Multiplexor

1. The network video recorder (NVR) and multiplexer shall be provided as one integrated unit. The NVR shall be provided by the Security Sub-Contractor.

2. The NVR shall provide for live and playback viewing while the system continues to record new images. It shall be capable of time division, multiplexing multiple cameras and storing their digitized and compressed images on integral hard disk drives, and search and retrieval either locally at the unit or from a remote work station using a graphical user interface. It shall have Ethernet connectivity.

3. The NVR shall record video on an internal hard disk drive(s). It shall support multiple internal and external hard disk drives of minimum 500 gigabytes, or large enough to store up to 1 month of the camera recordings.
4. The NVR shall support archiving of images on an external archiving device. It shall support recording on portable / removable storage media.
5. The NVR viewing software shall provide the following displays as a minimum in live and playback mode: full-screen, sequencing, quad, 9-way, or 12-way. It shall allow the user to rearrange cameras in any multi-screen display, in both live and playback modes. The display options shall include but not limited to:
    a. Camera tilting
    b. Title display, per monitor
    c. Time and date, per monitor

A-4.14.2 Security Software

The Security Sub-Contractor shall provide a minimum of two software and database management licenses. Contractor shall provide two copies of the software on CDs for backup and a complete user manual. Software shall be Windows compatible. Contractor shall provide free software upgrades during the warranty period of the system as a minimum.

A-4.15 Wire, Cable, and Connectors

Contractor shall provide information about proposed wire, cable, and connectors, including all underground facilities. Cable shall be designed and installed for a service life of 30 years. Cable for DC feeders and PV panel interconnect shall be 2-kilovolt 90°C (wet or dry) power cable type USE-2 or RHH/RHW-2 with XLPE jacket and UL 1581, VW-1 rating or approved equal for intended use capable of meeting DC collection system design current requirements. Externally installed cables shall be sunlight and ultraviolet resistant, suitable for direct burial, and conform to NEC 300.5 Underground Installation, Table 300.5 Minimum Cover Requirements, rated to the maximum DC voltage of the Plant.

PV panel interconnect connectors shall be: (i) latching, polarized, and non-interchangeable with receptacles in other systems, and (ii) tap branch connectors with multi-contact termination connectors. Grounding member shall be first to make and last to break contact with mating connector and shall be rated for interrupting current without hazard to operator.

Cables shall be listed and identified as PV wire as stated in NEC Article 690. If a cable tray is utilized, there shall be no self-tapping screws, only a clamping mechanism to secure the top. All underground cable shall be mapped and identified along its entire run with hazard tape and tracing, 18 inches above the cable elevation and 18 inches below finish-grade elevation.

Galvanized, rigid metal conduit where underground cable is exposed above ground or stubbed up to junctions or poles shall be used. Rigid metal conduit shall be included in the corrosion mitigation plan and shall be designed for a 30-year life in the Site soils and conditions. All 90-degree bends shall be in long sweeps installed in accordance with standard utility practices. Underground cable shall be direct-buried a minimum of 3 feet below finish-

grade elevation. **No underground cable splicing shall be acceptable under any circumstance.** All cable splices shall be brought above ground and housed in a suitable enclosure or, if below grade, placed in a suitable vault that is clearly marked.

Cables shall be labeled in accordance with Section A-4.2 Signage and Labeling.

A-4.16 Plant Switchgear

Switchgear shall be located outdoors in a NEMA 4 lockable enclosure. Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays and the 120/240-V CPT shown in the one-line diagram(s). The protective relay system shall be specified, designed, and installed in accordance with interconnecting utility's requirements. Switchgear monitoring and communication hardware shall be included to meet the requirements of sections A-4.12 Supervisory Control and Data Acquisition and A-4.13 Revenue Meter, and the metering requirements of Owner. Relay current transformers shall be C400 accuracy class.

The CPT shall be fused and disconnectable. The CPT shall be sized and single-phase breakers shall be included to supply power to a 120-V convenience receptacle and an energy efficient light within the switchgear enclosure, switchgear heaters, and the 240/120-V_{AC} panelboard within the communications shelter (if applicable). The switchgear main breaker shall have vacuum fault interrupters and shall have provisions for bifurcation. Medium-voltage protective device selection and relaying should be based on the use of Schweitzer Electric Laboratories relays or approved other, as required and specified in the Interconnection Agreement.

In general, the interconnection design and components should meet the requirements of the interconnecting utility and the interconnection agreement (including the necessity of a grounding transformer if required).

A-4.17 Emergency Direct Current Battery System

The batteries and chargers location shall be specified in accordance with temperature and shading requirements, and the battery system shall meet the requirements set forth in the Interconnection Agreement. The battery system shall be sized: to provide DC power to trip, close, and recharge the switchyard 8 hours after a loss of power; recharge within 12 hours; and supply sufficient power to the SCADA and communications systems for 12 hours minimum. The battery sizing calculation shall be provided by Contractor to Owner.

A-5 Warranties

A-5.1 General Contractor Warranty

Contractor shall follow all material requirements of the warranties of the principal equipment suppliers using the procedures detailed in the manuals delivered upon completion of the Plant. All warranties shall be passed to PacifiCorp and shall be enforceable throughout the warranty period.

A-5.2 Solar Module Warranty

Provide the proposed module warranty duration, terms and conditions. At a minimum, solar module manufacturer shall provide a 25-year linear warranty on the solar modules with at least 80

percent of power output guaranteed at 25 years as more particularly described and provided in the module warranty to be provided by the Contractor. The solar module manufacturer shall confirm that the warranty applies on an "as installed basis," i.e., it will confirm the panels were installed according to its requirements and specifications for installation.

A-5.3 Racking and Tracking System Warranty

Provide the proposed tracker warranty duration, terms and conditions. The tracking manufacturer, if applicable, shall supply a 5-year warranty for the installed structure and a 5-year warranty on the motor, and the racking design shall be certified by both the tracking manufacturer and the solar module manufacturer such that all warranties apply on an "as installed" basis. An extended warranty for parts only (motorized drives) shall be provided for a period of 10 years by Contractor. The racking manufacturer, if applicable, shall supply a 10-year warranty for the installed structure, and the racking design shall be certified by both the racking manufacturer and the solar module manufacturer such that all warranties apply on an "as installed" basis.

The racking and tracking manufacturer shall supply a minimum five (5) years full parts and labor replacement warranty, as more particularly described and provided by the Contractor.

A-5.4 Inverter Warranty

Provide the proposed inverter warranty duration, terms and conditions. The inverter manufacturer shall provide a 5-year full parts and labor replacement warranty, as more particularly described and provided by the Contractor. A six to 10-year warranty also may be offered by the inverter manufacturer. The inverter manufacturer shall confirm its warranty on an "as installed basis."

A-5.5 Transformer Warranty

The transformer manufacturer shall provide a 5-year warranty for the transformers, as more particularly described and provided by the Contractor.

A-5.6 SCADA Monitoring System and Security Equipment Warranty

Provide the proposed SCADA Monitoring System warranty duration, terms and conditions. Provide the proposed security system warranty duration, terms and conditions. The SCADA and security equipment system manufacturers shall provide a 5-year full parts and labor replacement and software upgrade warranty, as more particularly described and provided by the Contractor.

A-5.7 Performance Warranty

This section not used.

A-6 Applicable Codes and Standards

The Plant's design, engineering, construction, interconnection, startup, and testing shall follow the applicable codes, standards, and publications that are in effect at the time of Plant initiation, and which are consistent with current utility industry standards. The codes and standards utilized shall be the latest editions in effect at the notice to proceed date.

Materials manufactured within the scope of Underwriters Laboratories shall conform to UL standards and have an applied UL listing mark. If no UL compliance is available, material and equipment shall be labeled or listed by a nationally recognized testing laboratory.

Where codes do not govern specific features of the equipment or system, Prudent Utility Practice, equipment manufacturer specifications, and standard industry standards shall apply.

Where local codes or ordinances will have an impact on the design, Owner and Contractor shall jointly address these with the local authorities having jurisdiction as provided in the Agreement.

A-7 Distribution or Transmission Interconnection

Contractor is responsible for the cost of designing, procuring equipment for, and installing all interconnection and metering facilities required to deliver the Plant's electrical output to the Point of Interconnection, in accordance with this Agreement and the Interconnection Agreement. Contractor shall be aware of the relevant interconnection requirements for Small Generators, (less than 20 MW), and Larger Generators, (Greater than 20 MW) and design, install and operate the PV Plant accordingly.

Contractor shall be fully responsible for working with and coordinating with the transmission provider to assure that the Plant is properly designed, constructed, and prepared to interconnect with the distribution system. Contractor shall provide the interconnection equipment and structures to the Point of Interconnection as shown on the detailed design drawings and specified in the Interconnection Agreement. Contractor shall coordinate its work on interconnection with the Owner and perform in accordance with any applicable requirements in the Interconnection Agreement. Contractor shall provide Owner and the transmission provider with at least 15 days advance written notice of the first test that involves either backfeed or delivering energy to PacifiCorp, and must be in compliance with the Interconnection Agreement.

A-8 Operations and Maintenance — Manuals and Training

A-8.1 Documentation

Contractor shall supply Owner with all manuals and/or handbooks (in printable electronic format) that provide, either in a single manual or handbook or collectively, complete operating and maintenance instructions (including inventories of spare parts and tools and parts lists with ordering instructions) for each major piece of equipment and system of the Plant. Each such manual and handbook shall comply with the requirements as set forth below and in RFP Appendix A-7.2 Attachment 1B Project Document Deliverables

A-8.1.1 Manuals

Contractor shall provide Owner with six (6) paper copies and one editable electronic copy of all manuals.

Hard copy manuals shall be on standard 8-1/2" x 11" paper. Drawings and schedules which are to be bound into the manual shall also be 8-1/2" x 11" or 11" x 17" folded. Each manual shall be assembled and bound in heavy-duty post binders designed for rough usage. Light duty and ring binders are not acceptable. Binder capacity shall not exceed four inches, nor shall material included exceed the designed binder capacity. If the material to be furnished exceeds this capacity rating, multiple volumes shall be furnished. Binders shall be sized to the material to be contained, and capacity should not be more than approximately one-half inch greater than the thickness of material within the binder. All documents, illustrations, specifications, equipment data sheets, drawings, operating and maintenance instructions shall be in the English language. Use of the English system of units on documents is preferred; if

the metric system of units is used, the drawing, data sheet, specification or illustration shall clearly indicate that the metric system of units is used. Each manual shall include a Table of Contents, front cover, side label and laminated index tabs and shall be of a consistent format.

The electronic copy of the manuals shall be organized in folders consistent with tabs in the paper manuals. Electronic copies of installation, operation and maintenance manuals shall be organized from the most general information in the top directory to the most specific information in the lowest level folder. The top level folders shall include a document containing a directory of the subfolders describing the contents of each and every subfolder. Electronic copies of Installation, Operation and Maintenance manuals shall be organized by project, system, subsystem, equipment and components. Manufacturers' or vendors' electronic manuals shall be delivered as individual files. Contractor shall not merge or combine manufacturer and vendor provided files containing manuals.

The manuals to be provided shall include:

1. Design Manuals

   Design manuals shall contain the following items:

   - Drawing List, Drawing and Specification Identification System, Units of Measurement and Formats
   - System List and Equipment Numbering System
   - List of applicable drawings
   - System design requirements
   - System and equipment descriptions
   - Equipment lists itemizing type, performance and technical requirements.
   - Overall performance data

2. Start Up, Operation and Shutdown Manual for the Plant, including comprehensive and complete procedures for checkout, startup and testing of the Project and will include as a minimum the following items:

   - Plant start-up and shutdown procedures
   - Startup schedule
   - Startup organization chart
   - Administrative procedures
   - Data sheets
   - Test procedures for all tests required for Mechanical and Electrical Completion and Final Acceptance.

- Turnover sequences and procedures
- Safety clearance procedure
- Work responsibility matrix

3. Installation, Operation, and Maintenance Manuals for the Equipment, including information typically supplied for equipment and/or systems such as the following items:
    - System or equipment startup and shutdown procedures
    - Description / design criteria of each item of equipment
    - Nameplate information and shop order numbers for each item of equipment and components thereof
    - Operating procedures and instructions for commissioning, startup, normal operation, shut down, standby and emergency conditions and special safety precautions for individual items of equipment or systems
    - List of any start-up prerequisites
    - Normal range of system variables
    - Operating limits and hazards for all equipment and systems including alarm and trip set points for all devices
    - Testing and checking requirements
    - Effect of loss of normal power
    - Tolerance of electrical supply frequency variation
    - Final performance and design data sheets, specifications and performance curves for all equipment including test data and test curves
    - Preventive maintenance schedule and maintenance instructions for equipment including standard and special safety precautions
    - Lubrication schedule showing requirements and specifications for lubricants for equipment
    - Dismantling and assembly procedures for equipment with associated tests and checks prior to returning equipment to service.
    - Detailed assembly drawings to complement assembly procedures mentioned above including parts lists and numbers for replacement ordering.
    - Setting and running clearances and tolerances
    - Cleaning procedures
    - Specifications for any gases, chemicals, solvents or lubricants
    - Drawing showing space provided for equipment maintenance for equipment and any fixed facilities for maintenance such as trolley beams, etc.

- Methods for trouble-shooting
- List of maintenance tools furnished with equipment
- Installation instructions, drawings and details
- Vendor drawings as appropriate
- Installation, storage and handling requirements.

The above requirements are a minimum; however, requirements which are clearly not applicable to specific items or components may be deleted, however, any additional information which is necessary for proper operation and care of the equipment shall be included.

A-8.2 Spare Parts

No later than 90 days after the Effective Date the Contractor shall provide to the Owner a recommended spare parts list, including quantities and prices if purchase with the contract, for the equipment and systems provided by the Contractor. The recommended spare parts list shall include all expendable items that may be required during the operation of the Project. Each of the spare parts shall be fully identified by reference to the spares list, part number, cost, and manufacturer drawing number. Contractor shall also identify spare parts that the Contractor recommends should be stocked locally to ensure prompt repair due to any failure that can be reasonably expected, taking into account the length of time required to obtain replacement parts.

The Contractor shall provide, receive, store locally, distribute and restock spare parts, materials, test equipment, instruments, tools, and consumables required for start-up and operation of the systems and equipment within its scope until **[Substantial Completion].**

If the Contractor, his suppliers, or sub suppliers cease manufacture of any of the spare parts, or if for any reason any spare part will become unavailable at any time during the life of the facility, the Contractor shall notify the Owner in writing at least 180 days prior to the unavailability of such spare parts. The Contractor shall provide the Owner the opportunity to purchase sufficient stock of spare parts to support the system for its expected life.

A-8.3 Tools and Equipment

Contractor shall provide all special tools, test instruments and computer programs, as applicable for maintenance and operation which are not normally or readily available. The Contractor shall submit a complete list of tools and equipment needed for erection/installation and maintenance and a list of special tools and equipment that will be provided, including prices. Special tools and equipment shall become the property of the Owner at the completion of the PV installation. The Owner reserves the right to purchase additional quantities of tools if desired.

A-9 Final Plant Completion

Following is the step-by-step procedure for orderly completion of the Plant:

1. Mechanical and Electrical Completion
2. Q/A Q/C testing
3. Commissioning and Start-up procedures and tests
4. Interim operating time
5. Capacity Test

- If Plant passes Capacity Test (Go to Final Acceptance and hand-over)

- If failed Capacity Test – allowable period for corrective measures for re-testing of Capacity Test

6. Substantial Completion
7. Final Completion and hand-over to PacifiCorp, or O&M team

Step 1 - Mechanical and Electrical Completion

Contractor shall achieve Mechanical and Electrical Completion and assure that the Plant has been synchronized with the PacifiCorp Interconnection Facility (in accordance with PacifiCorp's requirements) before conducting the Capacity Test. Mechanical and Electrical Completion shall mean:

a. Equipment for the Plant has been installed, including with the required connections and controls to produce electrical power.

b. All equipment related to the solar tracking system (if applicable) has been installed and checked for alignment, lubrication, and rotation.

c. All remaining electrical systems have been checked out and are ready for operation.

d. All electrical continuity and ground fault tests and all mechanical tests and calibrations have been completed.

e. All instrumentation is operational and has been calibrated in accordance with manufacturers' standards and guidelines and, where possible, loop checked.

A-10 Synchronization Procedures and Requirements

All testing shall be done in accordance with the Interconnection Agreement and all of the requirements to achieve electrical and mechanical completion of the plant.

A-11 Quality Assurance/Quality Control and Procedure for Plant Completion

A-11.1 Step 2 – Quality Assurance/Quality Control

Contractor shall submit to Owner a copy of its QA/QC plan for review not later than 45 days after contract execution for Owner review and comment. The Plant shall be managed in accordance with the program.

The QA/QC program shall include, but is not limited to, such procedures and systems as the following:

- Road construction
- Rebar and conduit placement
- Concrete placement and testing
- All wire insulation testing—Megger testing or very low frequency testing
- Mechanical system—trackers, mounting structures, tracker controls
- Factory testing of inverters and transformers by the manufacturer
- PV source open-circuit measurements—V_{OC} at combiner boxes
- Fuse tests
- Termination pull testing
- All visual inspections
- Grounding continuity testing
- Earth-ground resistivity testing
- PV module inspection and manufacturer documentation of factory test per the manufacturer's existing program
- Metering and instrumentation calibration testing
- Step-up transformer testing
- Inverter phase rotation and matching with utility
- Relay settings at the point of interconnection to Owner
- Verification of security camera system operations, including device points, sequences, and communications
- Other Contractor-prescribed procedures

All QA/QC testing procedures onsite shall be witnessed and documented by a qualified representative of Contractor. Owner shall observe and witness QA/QC as necessary and at its discretion. A qualified engineer of Contractor shall date and sign documentation indicating completion and acceptance of each onsite QA/QC test procedure.

A-11.2 Step 3 –Commissioning and Startup

Contractor shall provide the proposed commissioning and startup plan for the Plant at least 45 days prior to the proposed commissioning and startup dates. The plan shall follow procedures as dictated in IEC 62446-1.

Contractor shall coordinate with Owner to develop an acceptable commissioning plan that includes a checkout and startup procedure. This work will assure: that systems are activated in a manner that is safe for personnel as well as for the equipment, that Contractor work is complete and according to the contract documents, and that the systems perform as required by the contract documents and are ready to be turned over to Owner. As the construction and installation of the systems nears completion, Contractor shall prepare punch lists and conduct system walk-downs, sub-system and system checkouts, startups, testing, and turnovers.

The final approved Acceptance Test and Commissioning Procedures shall follow IEC 62446-1, and at minimum, include the following:

- Safety plan during startup and commissioning
- Review of all QA/QC testing on the DC and AC sides of inverters
- Detailed procedure for Plant startup, including switching sequencing
- Confirm testing and energizing inverters in conformance with manufacturer's recommended procedures; note operating voltages; and confirm inverter is performing as expected
- Under full sun conditions, and after at least 15 minutes of operation, taking and recording Plant operating data—such as but not limited to megawatts direct current, megawatts alternating current (MW_{AC}), V_{DC}, V_{AC}, I_{DC}, I_{AC}, Solar Radiation, etc.
- Testing the system control and monitoring system to verify that it is performing correctly
- Testing the communication system for offsite monitoring
- Testing the Plant metering and protective relaying to verify they meet utility requirements
- Detailed procedure for interface and initialization with the grid
- Documentation of successful startup and commissioning procedure
- Written notification submitted by Contractor to Owner that the completion of Acceptance Testing and Commissioning has occurred

Upon successful completion of energizing and startup, the Plant will be considered operable. The Plant will then move to the Interim Operating Period where Contractor shall make the Plant ready for Capacity Testing.

A-11.3 Step 4 – Interim Operating Period

Following successful completion of the startup and commissioning of the Plant, the Contractor shall have a maximum of 45 days to resolve any operating issues. The Owner-designated operating and maintenance team shall receive training regarding the Plant during

this period. After the successful execution of the Interim Operating Period, the Contractor shall perform a Capacity Test Procedure to verify the rated output for the Plant. Contractor is not required to use the maximum 45 days, rather it is an allowance of time.

A-11.3.1 Training

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

A-11.3.2 Operator Training

The Contractor shall provide the necessary training in proper operation of the PV system and related equipment. It is anticipated that this session will last 3-5 days. This session will be limited to a maximum of 20 people. Emphasis shall be placed on hands-on operating experience interspersed with the critical background as necessary, including switching procedures and emergency response training.

A-11.3.3 Maintenance Training

The Contractor shall provide necessary training in maintenance of the PV system and related equipment, providing maintenance by the Owner option is chosen. The maintenance training shall be scheduled after successful completion of the availability guarantee period. It is anticipated that maintenance training will last 3-5 days. This session will be limited to a maximum of 20 people. The maintenance training shall include, but not be limited to:

- normal maintenance methods
- repairs and replacement
- diagnostic procedures
- equipment calibration
- re-energization
- special tests
- special tools
- safety and grounding procedures

A-11.4 Step 5 – Capacity Test

Upon notification that the Plant is ready for field testing, the Contractor, in the presence of Owner-designated engineers or a third-party independent engineer, shall complete the Capacity Test. The Test will be performed under field environmental conditions (in the field irradiance, temperature, and measured capacity in MW_{AC}) according to the procedures described in IEC TS 61724-2 “Photovoltaic System Performance Part 2: Capacity Evaluation Method”. The metering and monitoring procedure for the Capacity Test shall conform to the IEC Standard “Photovoltaic Systems Performance – Part 1 Monitoring”. For the basis of the Capacity Test, that the inverter stations will be producing AC power at a power factor of 1.0.

Contractor shall submit its proposed plan to comply with the testing procedures 60 days prior to the date that Contractor anticipates the commencement of the test. The Contractor shall

include in the testing procedure the proposed reference conditions for the testing which will be reviewed and approved by the Owner and its engineers. The objective of the Capacity Test is for Contractor to demonstrate to Owner that the Plant has achieved the performance (in MW_{AC}) under the reference test conditions (irradiance, ambient temperature, wind, and other parameters used to define the capacity performance). Contractor's Capacity Test procedure submittal shall, at a minimum, include a listing of test instrumentation, calibration procedures, test duration, type of data collected and collection frequency, test data collection procedures, and test reporting conforming to IEC 61724 Parts 1 and 2.

The objective of the testing shall be for the Contractor to compare the actual measured capacity (MW_{ACTUAL}) to the contracted capacity ($MW_{CONTRACT}$) which are defined as follows:

MW_{ACTUAL} = The Plant capacity in MW_{AC} as measured resulting from the IEC 61724 capacity test at the reference test conditions.

$MW_{CONTRACT}$ = The Plant 'guaranteed contract capacity' by Contractor in MW_{AC} at reference test conditions. (Contractor bid)

Contractor shall submit preliminary results of the Capacity Test within 24 hours of the conclusion of the test. Upon Independent certifier's acceptance of the preliminary test results, Contractor shall submit to Owner a detailed test report within 10 business days of the completion of the Capacity Test. The test report shall consist of the following:

- Any agreed upon deviations to the test procedures
- Instrument calibration sheets/certificates
- Test data (manual and from the data acquisition system)
- Corrected test data
- Field notes
- Calculations
- Power factor at which test was taken
- Post-test uncertainty analysis
- Conclusion

If the rating falls below the guaranteed output, Contractor shall take measures to bring the Plant up to the required rating.

If Contractor chooses to take corrective measures to bring the power rating up to an acceptable level, then retesting may occur following notification to Owner in writing.

A-11.5 Step 6 – Substantial Completion

After the startup and commissioning is successfully demonstrated to Owner's satisfaction in accordance with **RFP Asset Purchase and Sale Agreement**, the Plant will be considered Substantially Complete. To demonstrate substantial completion, the Contractor shall:

a. Commission the completed system in accordance with the tests to verify that:

    i. The system is capable of being operated at all levels and operating modes in accordance with the operating guidelines, applicable laws, applicable standards,

applicable permits, prudent utility practices, and requirements of the contract documents.

ii. The Plant is functioning as expected within acceptable parameters and as designed at a nameplate capacity as per the final results of the Capacity Test.

b. Facilitate completion or execution of any incentive- or rebate-related documents or other documents required for any warranty to become effective or to be assigned to Owner.

c. Coordinate with PacifiCorp confirming that the facility has been installed per the Interconnection Agreement.

d. Cause the Plant and all items of equipment and improvements at the Plant to be designed, manufactured, installed, calibrated, and tested where applicable in accordance with the published standards (as of the dates specified) listed in this Technical Specification; Contractor shall notify Owner of any standards of such organizations that are inconsistent with each other and advise Owner of the manner in which it intends to resolve such inconsistency in accordance with the published standard.

e. Acceptance testing of security system shall include verifying that each device point and sequence is operating correctly.

f. Provide Owner a startup manual in conformance with section A-8.1.1 as part of the plant startup procedures.

g. Provide Owner with all training and documentation as required to satisfy the requirements for Substantial Completion as listed in **Appendix A-7.2 - Attachment 1B Project Document Deliverables**.

h. Within 45 days prior to Substantial Completion Contractor shall complete training of Owner in the operation and recommended maintenance of the Plant.

A-11.6 Step 7 – Final Completion

After Substantial Completion, Contractor shall complete all punch-list items; demobilize; clean and clear the Site; submit all as-built drawings; O&M manuals, and spare parts lists; complete all training; deliver all spare parts onsite; and transfer all permits to Owner. Prior to submitting its request for a Final Acceptance Certificate, Contractor shall perform the following tasks without limitation:

a. Identify punch-list items and provide timeline for completion. Following the Final Acceptance Date, Contractor shall complete the items on the punch-list in accordance with the standards described herein, and as quickly as reasonably practical. Contractor shall coordinate with Owner regarding continued Site access.

b. Conduct a final clean-up of the Site.

c. Remove all its equipment from the Site (other than equipment, supplies, and materials necessary or useful to the operation or maintenance of the Plant, and equipment, supplies, and materials directed by Owner to remain at the Site until completion of the Plant).

d. Tear down and remove all temporary structures on the Site built by Contractor or its Subcontractors and restore such areas to a condition consistent with that of a newly constructed solar PV power plant, except as required by any provision of this Agreement.

e. Remove all waste, rubbish, and hazardous material from and around the Site and disposed in accordance with all state, federal, and local regulations.

f. Provide Owner with copies of all O&M manuals and warranties for the Plant.

g. Provide final as-built documents upon completion.

h. Complete all performance testing in accordance with the Capacity Test.

i. Meet all requirements listed below**.**

A-11.6.1 Requirements for Final Completion.

Final Completion of the Work shall be deemed to have occurred only if all of the following have occurred:

(a) Contractor has achieved Substantial Completion in accordance with Article 14;

(b) Owner has received final "as-built" drawings in accordance with the terms of this Contract;

(c) the Punchlist Items have been completed to the reasonable satisfaction of Owner;

(d) Contractor has delivered the Final Release and Waiver of Liens and Claims in accordance with Section 7.6 and has delivered such other documents and certificates as Owner has reasonably requested to ensure compliance with all Applicable Laws;

(e) Contractor has paid Owner all amounts due hereunder and not in dispute; and

(f) Contractor has delivered to Owner a Notice of Final Completion stating that all the preceding conditions in this Section 15.4 have been satisfied.

A-11.6.2 Procedures for Final Completion.

When Contractor believes that it has achieved Final Completion, it shall deliver to Owner a Notice of Final Completion. Such Notice shall contain a report in a form reasonably acceptable to Owner, and with sufficient detail to enable Owner to determine that Contractor has achieved Final Completion. Owner shall, within twenty (20) Days following receipt of such Notice, either: (a) approve Contractor's Notice of Final Completion, indicating Owner's acceptance of the achievement of Final Completion; or (b) if reasonable cause exists for doing so, notify Contractor in writing that Final Completion has not been achieved, stating in detail the reasons therefor. If Owner delivers the Notice under the preceding clause (b), Contractor promptly shall take such actions, including the performance of additional Work, to achieve Final Completion, and upon completion of such actions, shall issue to Owner a revised Notice of Final

Completion pursuant to this Section 15.5. Such procedure shall be repeated as necessary until Final Completion has been achieved. If Owner fails to respond to Contractor's submitted Notice of Final Completion within the time set forth above, Owner shall be deemed to have approved Contractor's Notice of Final Completion. For all purposes of this Agreement, the Final Completion Date shall be the date on which Contractor delivers to Owner the Notice of Final Completion that Owner ultimately accepts or is deemed to have accepted (or pursuant to a later determination under the dispute resolution procedures, should have accepted). Any disputes regarding the existence or correction of any such alleged deficiencies shall be resolved pursuant to Article 35. Contract shall cause Final Completion to occur no later than sixty days following the Substantial Completion Date.