**SPECIFICATION SECTION 48 14 00 PHOTOVOLTAIC SYSTEM**

**PART 1 -GENERAL**

## RELATED DOCUMENTS

### The Contract and any design-build bridging documents.

### Section 26 00 00 General Electrical Specifications

### Section 05 90 02 Solar PV Canopy Structures Specification

### Section 05 90 04 Solar PV Roof-Mount Structures Specification

### Other relevant Judicial Council Specifications

*NOTE: Where this specification and other specifications or bridging-documents are in conflict, the more stringent shall apply. Contractor shall identify conflicts and confirm recommended equipment or procedures with the Judicial Council.*

## CODES & REFERENCES

### The design and installation shall conform to all requirements as defined by the applicable codes, laws, rules, regulations and standards of applicable code enforcing authorities (Latest Edition unless otherwise noted). The following are key standards that shall be followed. The Architect/Engineer of Record and Contractor shall ensure all applicable codes are followed:

#### ASTM International (ASTM) ([www.astm.org](http://www.astm.org)), including:

##### E3010, Standard Practice for Installation, Commissioning, Operation, and Maintenance Process (ICOMP) of Photovoltaic Arrays

#### American National Standards Institute (ANSI)

#### California Building Code (CBC), with State of California Amendments

#### California Energy Commission Title 24 Building Energy Efficiency Requirements

#### California Department of Forestry and Fire Protection, Office of the State Fire Marshal – Solar Photovoltaic Installation Guidelines

#### Institute of Electrical and Electronics Engineers (IEEE)

#### International Electrotechnical Commission (IEC), including:

##### 62446-1 Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance. Part 1: Grid connected systems – Documentation, commissioning tests and inspection

#### International Electrical Testing Association (NETA)

#### Local Fire Permit Requirements

#### National Electrical Manufacturers Association (NEMA)

#### National Fire Protection Association (NFPA), National & California Electrical Code

#### Underwriters Laboratory (UL), including:

##### UL 2703 – Standard for Mounting Systems, Mounting Devices, Clamping/Retention Devices, and Ground Lugs for use with Flat-Plate Photovoltaic Modules.

#### Utility company standards and requirements

#### For projects under the Purview of the Division of the State Architect (DSA)

##### DSA IR-16-8 (most recent) Guidelines

##### DSA PL-07-02 (most recent) Guidelines

#### Judicial Council Specifications and Requirements

#### All other applicable Codes and Ordinances

## GENERAL

### "Judicial Council" shall refer to Judicial Council of the State of California, owner of the site(s) where project will be located, regardless of system ownership, and include any representative of the site Judicial Council, such as independent engineers, consultants or inspectors. "Contract" refers to the design-build and/or construction contract and any associated design-build bridging documents, inclusive of requirements outlined in the request for proposals (RFP). "Contractor" refers to the entity performing the work, inclusive of Engineer(s) and Architect(s) of Record for design-build contracts, post construction system operator, and financier. This is a design-build project and includes the design and construction of complete Photovoltaic Systems (PV), including all AC, DC and balance of system components. The design and installation shall conform to all requirements as defined by the applicable codes, laws, rules, regulations and standards as specified in the Contract.

### The Contractor shall include all items and all work reasonable required to complete the System in accordance with the Agreement. If the Contractor is in doubt as to the intent of any portion of these specifications, or necessary information is omitted, the Contractor shall notify the Judicial Council in writing for clarifications or corrections to be provided by addendum.

### All design documents, cut sheets, shop drawings, and technical specifications shall be submitted, reviewed and accepted by the Judicial Council per the guidelines specified in the Contract and any bridging documents.

## WORK INCLUDED

### The work shall include the design, engineering, materials, labor, equipment, installation, testing, services, and incidentals necessary to install complete Photovoltaic (PV) Systems in conformity with the Contract, applicable codes and professionally recognized standards.

### PV systems shall consist of arrays of framed photovoltaic modules, mounting hardware, terminal boxes, combiner boxes, quick-connect electrical connectors, DC wiring, DC disconnects, utility interactive inverters, AC disconnects, AC feeders, transformers, AC circuit breakers, AC panel boards / switchgear, complete data acquisition and monitoring systems, monitoring and data services for the term of contract, and any other equipment described or inferable from the Contract.

### The PV systems shall be utility grid connected as net energy metering (NEM or NEM-A) or RES-BCT project. The Contractor shall be responsible for all interconnection coordination during design and construction, including review of any previous interconnect applications, utility company coordination, revisions to interconnect applications as-needed, inspections, permits, and final approval for the complete interconnection of the PV systems with the utility company grid, including bi-directional utility meters at each location. The Contractor shall ensure that the design and construction does not void any tariff grandfathering achieved by the initial interconnect applications submitted with the utility.

### The Contractor shall ensure adequate clearance and equipment space within the allotted areas and existing building and site conditions. All equipment and sizes / clearances shall be coordinated with the Judicial Council prior to rough-in.

### The Contractor shall provide for the disconnection, disposition, and proper disposal of all existing equipment to be replaced.

## QUALITY ASSURANCE

### All equipment shall be listed to Underwriters’ Laboratories (UL) standards as applicable.

### Installer Qualifications – The installing contractor shall be familiar with the equipment to be installed and have the necessary training to install in the equipment, inclusive of a California Class A or Class B and C-10.

## MATERIALS, DELIVERY, STORAGE, AND HANDLING

### All materials shall be delivered new, undamaged and without defects.

### All equipment and panels shall be handled with care so as not to damage the delivered products. All equipment shall be installed in new and neat condition.

### Appropriate protective clothing shall be worn when handling the equipment.

### Where PV systems will be installed on a roof or overhead, all materials stored on the roof shall be distributed so as not to overload the roof at any point. All materials stored on roof shall follow the guidelines of the roofing system manufacturer including protection boards, pallets and/or mats to prevent damage to the roof system and insulation assemblies. All roof top construction, construction related traffic and staging areas shall have protection boards in place to prevent damage to the roofing system and insulation assemblies.

# PRODUCTS

## ACCEPTABLE MANUFACTURERS

### Acceptable system manufacturers/vendors shall be as specified in other sections of the Contract. Manufacturers shall provide their latest line of equipment, meeting all current industry standards, utility requirements and criteria set forth in the Contract. The Judicial Council seeks equipment from proven, industry leading manufacturers in solid financial standing, producing “tier-one” financeable equipment.

### Contractor proprietary products shall have an ICC report or a testing report stamped and signed by a licensed California engineer.

## EQUIPMENT AND MATERIALS

### PV MODULES SHALL MEET THE FOLLOWING:

#### Module manufacturer that has produced no less than 250MW of modules in the prior year.

#### Modules are from a field-tested product line that has been commercially available for no less than three years.

#### Module manufacturer shall provide a 25-year warranty on the solar modules with at least 80 percent power output guaranteed at 25 years. The solar module manufacturer shall confirm that the warranty applies on an “as installed basis,” i.e., the warranty will confirm the panels were installed according to its requirements and specifications for installation.

#### Have a minimum 25-year design life, designed for normal, unattended operation.

#### UL 1703 listed.

#### UL listed for the specified voltage (typically 1000 V-DC).

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

#### Meet California SB1 Guidelines for Eligibility.

### INVERTERS SHALL MEET THE FOLLOWING:

#### String-type inverters.

#### Integrated AC and DC disconnects

#### Include a 10-year warranty.

#### Manufacturer produced no less than 250 MW of inverters in the prior fiscal year.

#### Field-tested product line that has been commercially available for no less than 2 fiscal years.

#### Comply with the following:

##### UL 1741 listed, inclusive of UL 1741-SA requirements.

##### IEEE 1547, including testing to IEEE 1547.1 and IEEE C62.45.

##### IEEE C62.41.2 and CSA107.1-01.1.

##### California Rule 21, CEC approved and utility line interactive type.

#### Incorporate disconnect switch for main DC power disconnect in compliance with applicable codes and utility requirements.

#### Sized as required to support the PV module production load within the rating of the equipment, together with all other components. Sizing shall not exceed 1.35 DC:AC ratio without approval by Judicial Council.

#### Meet the following requirements:

##### Nominal AC Voltage (Three-phase, + 10%): 208, 240, or 480 VAC (as required per site)

##### Nominal AC Frequency (+ 0.5 Hz): 60 Hz

##### Line Power Factor (Above 20% rated power): >0.99

##### AC Current Distortion (At rated power): <5% THD

##### Maximum Open Circuit Voltage DC: 1,000 VDC

##### Maximum Ripple Current (% of rated current): <5%

##### Minimum Inverter Efficiency: >96%

##### Temperature Range Ambient: -4º F to 122º F (-20º C to 50º C)

##### Enclosure Environmental Rating (minimum): NEMA 3R (NEMA 4X within 5 miles of a marine environment or high dust area)

##### Relative Humidity (non-condensing): 0-95%

##### Sound level: <85 dBa

##### Capable of producing reactive power to operate between a power factor of 0.9 lagging to 0.9 leading (as adjusted on the inverter equipment).

##### Protective Functions: Standard wakeup voltage, wakeup time delay, shutdown power, shutdown time delay, AC over / under voltage and time delays, AC over / under frequency and time delays, ground over current, over-temperature, AC and DC over current, DC over voltage

##### User Display: Standard-LCD with on/off capability and physical screen cover or other means of protection from UV exposure.

##### DC Disconnect: 1,000 VDC load break rated (or higher where DC voltage is higher).

##### Seismic Rating appropriate for the site and installation method.

##### Internal combiner panel option to allow connections of sub-arrays at the Inverter without the use of additional equipment.

### All equipment costs shall include all known and future duties, tariffs, export tariffs, customs, demurrage, and shipping costs.

### No substitution for contracted equipment shall be made without the written consent of Judicial Council.

### Upon connection of the new PV systems, provide a placard on the respective Main Switchboard to identify the two sources of power feeding the equipment.

### Combiner boxes (where used) shall be NEMA 3R rated (minimum, NEMA 4X shall be used within 5 miles of a marine environment) and shall include fuses for string inputs and a bus bar to combine the strings into sub-arrays, for input into the Inverter system. Minimum combiner box output bus ampacity shall be 156% of the rated short circuit current available to be carried on the bus (the sum from all strings to the bus).]

### All AC interconnecting feeders shall be sized per applicable sections of CEC Articles 310, 690 and 705. Conduit fill to 40% max. Include temperature derating as required for the ambient temperatures and roof conditions per CEC. Provide equipment grounding conductor in each conduit.

### All roof and exterior mounted raceways shall be designed and installed to accommodate expansion and contraction due to heating affects, including adequate cable length and listed expansion couplings. All expansion couplings or installations shall include grounding bonding jumpers as required by code.

### All AC circuits to be 3-wire or 4-wire + ground, as required by inverter manufacturer’s installation manual based on the site’s electrical system. All grounding per CEC 690, Part V.

### All DC circuits and feeders sized to CEC table 310.15(B)(16) (90-degree column). Minimum ampacity shall be 156% of the rated short circuit current available to be carried on the specific conductor. Conduit fill to 40% max. Include temperature derating as required for the ambient temperatures and roof conditions per CEC, and conduit fill derating as required. Provide equipment grounding conductor in each conduit.

### All DC circuits to be 2-wire + ground.

### AC conductors in raceways shall be Type THWN-2 or XHHW-2 for wet and dry locations. AC conductors shall be installed in raceways.

### DC PV string conductors shall be Type PV or USE-2/RHW-2 marked minimum 1000V and sunlight resistant.

### Above ground exposed conduit shall be rigid (RMC) or intermediate (IMC) galvanized steel with threaded fittings except where AHJ and other applicable codes or specifications specifically allow for the use of EMT conduit. All conduit shall meet CEC Code, AHJ Guidelines and any applicable standards. Exterior installations shall have watertight fittings. All conduit shall be rated for exposed installation and a minimum design life equivalent to the solar panels. Paint all visible exposed raceways and boxes to match adjacent surface finish after installation. Colors to be selected and approved by the Judicial Council.

### All conduits and stub-ups under canopies shall be encased within concrete caissons or piers. Where conduits or stub-ups are not at canopy base, they shall be protected from vehicle strikes with appropriately sized bollards if protection is required by code or the electrical engineer.

### All interior conduit to be EMT with steel set-screw fittings (no cast fittings).

## WIRE MANAGEMENT

### All wiring methods must meet or exceed current industry standards for wire management, strain relief and fastening.

### All DC string wire management shall use stainless steel or galvanized steel cable clips, Heyco or similar. UV rated cable ties shall be used minimally and only in locations where the use of cable clips is impossible.

### Wiring shall not be routed over sharp edges of structural members, equipment or modules.

### Wiring shall be routed under the modules of the array wherever possible to avoid direct exposure to the sun or elements.

### Wiring shall be secured under the array so as to prevent excessive slack resulting in wire motion, and to minimize visibility of inter-module and home run wiring to the public.

### Excess slack in the wire shall be secured such that it is in the module channel or secured to the junction box of the module. Factory-installed wire leads for modules can be wrapped around the junction box of the module.

### Where exposed, wires, cables and conductors shall be managed in a neat and orderly manner. Where exposed to environmental conditions (e.g., sunlight, rain, wind, etc.) and visible from below, wires shall be fastened in a uniform and discrete fashion.

### All conductors and conduits between separate arrays shall be routed underground. Wiring shall be routed down columns, encased in piers/caissons, routed underground between arrays or carports, and up the nearest column on the adjacent array. Under no circumstance shall circuits, conduits, or chaseways be mounted overhead between separate structures, including seismic gaps.

### Strain relief and drip loops shall be utilized at all entrances to and from conduit bodies, junction boxes, weather heads, switchgear, inverters and panelboards etc. Conductors shall be strapped with strain relief as not to stress panel leads, home runs or mechanically crimped connections within the array. Sufficient slack shall be provided at both ends of cables to allow service and re-termination, and to prevent thermal expansion and contraction from stressing connections.

### Wire in switchboards, panelboards, meter cabinets, pull boxes, and other cabinets shall be neatly grouped and tied in bundles with nylon ties rated for the temperature rating of the electrical equipment at 10-inch intervals. In switchboards, panels and terminal blocks, wires shall be fanned out to terminals and trained for straight entry into the terminals. At no point shall nylon ties be used on bussing or bussing used in any manner to support other materials including but not limited to circuit conductors.

### Maintain the conductor required bending radius per NEC and manufacturer specifications.

### Wires shall not be installed until debris and moisture is removed from conduits, boxes, and cabinets. Wires stored at site shall be protected from physical damage until they are installed and walls are completed.

### Wire-pulling compounds furnished as lubricants for installation of conductors in raceways shall be compounds approved and listed by UL, NRTL, or equal. Oil, grease, graphite, or similar substances are not permitted. When pulling conductors, do not exceed manufacturer's recommended values.

### Conductor Color Codes

#### AC Circuits (<600V): Conductors must be color-coded by phase and voltage as required by NEC, the AHJ, and the utility.

#### DC Circuits, grounded

### Conductor Color

### Positive Red

### Negative White

#### DC Circuits, ungrounded

### Conductor Color

### Positive Red

### Negative Black

#### For phase and neutral conductors 6 gauge or larger, permanent thermoplastic-colored tape may be furnished to mark conductor end instead of coded insulation. Tape shall cover not less than 2 inches of conductor insulation within enclosure.

### Conductor Identification

#### All conductors, including DC homerun circuits, shall be labeled at each point the conduit run is broken by a cabinet, box, gutter, etc. Where terminal ends are available, identification shall be by means of heat shrink wire markers.

#### Labels shall indicate circuit or string and phase in accordance with the project drawings.

### Tape and Splice Kits

#### Wire splice kits shall be UL listed for their manner of use, such as direct burial or wet operation. Splices, joints, and connectors joining conductors in dry and wet locations shall be covered with listed insulation approved by the manufacturer for use with the splice, or as contained in the listed splice kit. Free ends of conductors connected to energized sources shall be taped.

#### Thermoplastic insulating material approved by UL, NRTL, or equal for installation as sole insulation of splices shall be furnished and shall be installed according to manufacturer's printed specifications. Standard electrical tape shall not be the sole insulation material for splices unless explicitly listed for use in the application and meeting the temperature rating of the insulation requirements for the splicing connection.

### Terminations

#### Terminations of conductors shall be performed to the requirements and recommendations listed within the manufacturer manuals of the termination hardware and equipment where the termination shall occur.

#### Conductors shall be terminated with minimal exposure of the bare conductor.

#### Conductors cannot exceed the size and quantity restrictions of the lug. Contractor to verify equipment lugs supplied will accept the size and quantity of conductors shown in the project drawings.

#### Full engagement of the conductor within the lug must be maintained.

#### Provide necessary coating of anti-oxidation coating on all exposed conductor ends entering the lug.

#### Where mechanical connectors are used, torque all set-screws to manufacturer specifications with a calibrated torque wrench and indicate with torque marks. Torquing electrical connectors "hand tight" is not allowed.

#### Where compression connectors are used, they must be installed with compression tools and dies approved by the manufacturer for use with the connector.

#### Ensure the final portion of the conductor before entering the termination is not part of a conductor bend (straight on entry).

#### Terminations of aluminum conductors cannot be made within 18 inches of earth/grade.

#### Termination fittings, connectors, and lugs must be rated and listed for the conductor metal type connected.

## MISC. SYSTEM REQUIREMENTS

### All exterior equipment to be sunlight and UV resistant as well as rated for elevated temperatures at which they are expected to operate (on roofs in hot sunlight).

### No dissimilar metals are allowed to contact each other (use deox, joint compound, plastic or rubber washers) with the exception of anodized aluminum module frames in contact with galvanized carport purlins. Best practices shall be used to avoid corrosion.

### No aluminum in contact with concrete or masonry materials.

### Bolted connections shall be non-corrosive and include locking devices designed to prevent twisting over the design life of the PV system.

### Environmental impact of system equipment containing hazardous materials shall be disclosed, as well as maintenance and disposal instructions for equipment at the end of its useful life.

### PV Module Mounting and Grounding Devices

#### Contractor shall submit proposed method for mounting and grounding PV modules to the canopy structure. The proposed method shall meet AHJ requirements and utilize either of the following:

##### UL 2703 listed module mounting and grounding clamps and devices.

##### Direct bolting of the module to the canopy steel structural purlins and UL listed PV module grounding devices.

#### If PV modules are mounted to the canopy structure with module mounting clamps, the clamps must be approved for this purpose by their manufacturer as part of a UL 2703 listed assembly. Clamps shall be listed for PV module grounding to galvanized steel substrate, and their installation shall comply with the clamp installation manual and the PV module installation manual.

#### If PV modules are direct bolted to the canopy steel structural purlins, mounting bolt size and specification must be written and detailed in the canopy structural drawings. Mounting bolt size must comply with the PV module installation manual, and be compatible with the module mounting hole diameter.

#### Washer-type PV module grounding devices shall be listed for grounding PV modules to galvanized steel substrate, and shall be installed according the manufacturer’s installation manual with appropriate bolt size and clearance hole size.

#### All PV modules shall be bonded to each other and to the canopy galvanized steel structural purlins with listed PV module grounding devices and equipment grounding conductors. The canopy galvanized steel structural purlins shall be bonded to the structural beams, unless a welded structural connection exists between the purlins and beams. An equipment grounding conductor shall ground the PV array to the PV inverter ground bar, and a grounding electrode conductor shall ground the PV inverter to the canopy grounding electrode.

#### Where PV modules and steel purlins are grounded and bonded, contact between dissimilar metals such as copper and galvanized steel shall be avoided. Where contact cannot be avoided, outdoor-rated deox or conductive joint compound shall be applied between the interfacing metal surfaces.

## SYSTEM ELECTRICAL

### The modules shall be interconnected using cable assemblies. The pigtails shall be quick-connect electrical wiring connections rated for the application (90-degree rated). DC string connectors for homerun wires and jumpers provide by the Contractor must match the make and model of the connectors supplied with the PV module, or must be UL listed as compatible with the connectors supplied with the PV module.

### Raceway system shall be installed in a manner that prevents water from draining into electrical equipment.

### Full specifications of the inverter shall be supplied as part of the system submittal.

### All major components of the systems and the installation procedures shall meet National Electrical Code requirements, including Articles 690 and 705.

### The PV system shall be designed to automatically drop offline when normal utility power is lost to avoid unintentional islanding effects as required by the local utility. Exceptions may be made by Judicial Council where PV system is part of an emergency power/battery backup allowed by Utility and AHJ.

### All electrical system equipment shall be properly rated to withstand and interrupt (in the case of over current protection devices) the available fault current at the point of use.

### All required overcurrent protection and electrical bussing sizes per CEC 690.

### Means of system grounding to be approved by professional Electrical Engineer of record and GFCI protection shall be in accordance with latest CEC requirements.

### Arc-fault protection where applicable per CEC 690.11.

### Add Rapid shut-down capability as applicable in compliance with CEC 690.12 requirements (Rapid Shutdown of PV Systems on Buildings)

### For PV system supply side interconnection, the Contractor shall inspect the existing main service switchgear to confirm suitability of the switchgear supply side bus for interconnection of the PV system. Where required by the AHJ, any modification of the existing switchgear necessary to construct the supply side connection shall be approved by the switchgear manufacturer or a Nationally Recognized Testing Laboratory. Where a NRTL approves modification of the switchgear, a field labeling report shall be provided to the Judicial Council. The Contractor is responsible for obtaining switchgear manufacturer approval of any modification required to accommodate the supply side connection, or NRTL approval and report.

### Outdoor grounding connections between dissimilar metals (such as aluminum lugs and copper wire) will be protected against galvanic corrosion by the application of outdoor-rated deox or conductive joint compound between the interfacing metal surfaces.

## MONITORING

### Contractor shall provide the following monitoring instrumentation:

#### PRODUCTION METER – A PV system production meter measuring the output of the solar array on a minimum 15-minute interval.

#### CONSUMPTION METER - A separate consumption meters shall be provided for each utility account on a minimum 15-minute reporting interval. Consumption meters shall be synced with PV meter production intervals. Consumption metering shall provide for clear disaggregation of PV production and site consumption.

#### WEATHER STATION - A weather station shall be provided at all sites. The station shall provide at a minimum: solar irradiation (coplanar and horizontal), ambient temperature and any other data relevant to weather correction of solar PV system performance.

### A Data Acquisition and Monitoring System (DAS) shall be provided for all points of interconnect. The DAS shall include, but not be limited to, the measurement, calculation, display, and reporting of the following items:

#### PV production in 15-min reporting intervals.

#### Energy consumption in 15-min reporting intervals.

#### Weather data in 15-min reporting intervals

#### Varying levels of summary data, including daily, weekly, monthly and yearly intervals.

#### A minimum of 1-year of 15-min interval data shall be downloadable in a single instance.

#### System electrical functions (instantaneous and accumulated power output (kW and kWh), AC and DC system voltage and amperage, and peak value tracking with associated time stamps).

#### Pounds of CO2 emissions avoided from the generation of PV energy at the site (compared to local utility fuel mix electric carbon content). CO2 avoidance factor shall be readily customizable for the local utility.

#### Capable of outputting data in the Western Renewable Energy Generation Information System (WREGIS) format sufficient for registering Renewable Energy Credits (RECs) from each system.

#### Lifetime logging and access to data reported by DAS, including database-level, "unprocessed" data for lifetime of system operation.

#### DAS shall provide access to all data through an open data exchange protocol (FTP Push or Application Program Interface (API)) to Judicial Council and Judicial Council’s Third-Party Designee at no additional cost. This data shall, at a minimum, include PV production data, energy consumption data, inverter production data, inverter AC power data, inverter current data, inverter voltage data, weather station and/or satellite data, weather-adjusted expected production data, and alarm status readings. All data shall be available over multiple timescales, ranging from 15-min intervals to annual intervals and shall include both real-time and historic data.

### Cellular data shall be used for communications with the DAS and metering systems. In the absence of cellular service availability, the Judicial Council may, at its own discretion, provide internet connections on a site by site basis. Regardless of the source of data, connectivity is to be provided for the Term of the Agreement.

### Contractor shall load software (as applicable) on Judicial Council provided computers and train Judicial Council in operation and maintenance of software or cloud-based systems and related monitoring functions.

# EXECUTION

## REQUIRED PLACARDS

### All placards shall be machine generated phenolic type with red background and white lettering, affixed to equipment with stainless steel screws or with permanent adhesive where set screws are not feasible. Minimum lettering size to be 1/4" unless otherwise noted or required for legibility.

### Provide a placard clearly visible at each main service panel to identify both sources of power, with the following wording in 1/4" high lettering per CEC 690.64(B)(4): “Warning - This Service Is Fed by Two Sources Of Power – The Utility Service Main Disconnect And The PV System Main Disconnect – Both Services Must Be Disconnected To Remove Power From The Switchboard”.

### Provide a placard on each PV system input circuit breaker (where used) at the main panel with the following wording in 1/4" high lettering per CEC 690.64(B)(7): “Warning – Inverter Output Connection – Do Not Relocate This Overcurrent Device”.

### Provide a placard on all disconnects with the following wording in 1/4" high lettering per CEC 690.17: "Warning - Electric Shock Hazard - Do Not Touch Terminals - Terminals On Both The Line and Load Sides May Be Energized In The Open Position".

### Provide a placard on the Main PV System Disconnect (adjacent to each main service panel) with the following information in 1/4" high lettering per CEC 690.53: "Photovoltaic Power Source Disconnect - Operating Current: X Amps; Operating voltage: XX VAC; Maximum System Voltage: XX VAC; Short-Circuit Current: XXX Amps", where X is the operating current, XX is the system voltage, and XXX is the maximum short circuit current contribution of the generating facility at the point of interconnection with the utility system.

### Provide a placard at each Main Switchboard with the following information in 1/4" High lettering per CEC 690.54: "Caution - Possible Backfeed From Photovoltaic Power System – X VAC, XX Amps", where X is the system voltage and XX is the maximum AC amperes of the installed system.

### Provide a placard on each PV System Inverter with the following information in 1/4" high lettering: "Photovoltaic Power Source Inverter Rating - Operating Current: XX Amps; Operating voltage: XXX VDC; Maximum System Voltage: 1,000 VDC; Short-Circuit Current: XXXX Amps", where XX is the maximum DC amperes of the installed system, XXX is the operating voltage DC, and XXXX is the short circuit current that the Inverter can provide (from all strings in parallel).

### Provide utility-required System Directory placard and utility safety switch Identification placard as required by local utility company, to identify all system components.

### Provide a placard for all Combiner Boxes to read: “DC Combiner Box [XXX]– [*System Voltage*] VDC Maximum”.

## UTILITY INTERCONNECTION

### The Contractor shall complete the submissions for the utility interconnection agreement with the Judicial Council’s approval. The Contractor shall submit the required authorization form with the utility to act on behalf of the Judicial Council. In the event that the Judicial Council has already submitted interconnection applications, the Contractor shall take all responsibility for the interconnect process upon contract execution. The Contractor shall promptly review any past applications and begin coordination with the Utility for any proposed modifications to the system design. The Contractor shall ensure that any tariff grandfathering or other milestone achieved by the initial application is maintained. Should an issue arise that may jeopardize tariff grandfathering, some other utility milestone, substantially increase interconnection costs or the ability to interconnect the project, the Contractor shall promptly notify the Judicial Council and seek approval from Judicial Council before making any changes to the interconnect application.

### The PV system at each Site shall not be interconnected with the Utility’s distribution facilities until written authorization from the Utility Company has been obtained. Unauthorized interconnections may result in injury to persons and damage to equipment or property for which the installing contractor may be liable.

## INSTALLATION STANDARDS

### System Installation shall conform to the equipment manufacturers Installation Manual(s) and requirements or guidelines.

### All Local, State, and CEC codes shall be observed, including all industry standards related to the installation, operation, and maintenance of photovoltaic power systems.

## TESTING

### Photovoltaic modules shall be tested in the factory for design performance and results shall be included in the Operation and Maintenance manuals.

### Inverters shall be factory tested for performance and the results shall be included in the Operation and Maintenance manuals.

### System testing of the installed photovoltaic array shall be performed on all system strings and recorded in commissioning documentation and the Operation and Maintenance manuals.

### Performance testing to ASTM E2848-13 standard. Contractor shall define methodology within the protocol and obtain Judicial Council's acceptance and notify Judicial Council before performing testing.

### Commissioning of PV Systems shall adhere to IEC 62446-1 requirements and shall include the following at a minimum:

#### CONDUCTORS

##### AC & DC conductor inspection / megger, when possible. Insulation resistance and DC hi-pot testing of each AC and DC conductor, phase-to-phase and phase-to-ground.

##### Wire management check

##### DC string polarity, Voc & Isc, when possible, testing and recording

##### Confirm all conduits & junction boxes are installed properly/watertight

#### Inspection of DC fusing and disconnects

#### Inspection of AC components: AC Disconnect, Main Switch Board, AC Combiner Panel Boards, Breakers, Fuses, Terminations, Phasing, OCPD operation, etc.

#### Grounding & bonding system inspection and continuity testing

#### INVERTERS

##### Inverter inspections and tests per manufacturer instructions

##### Inverter start-up and confirm proper inverter settings

##### Inverter output tests - Confirm PV system AC output as expected based on design, insolation and inverter readings

#### IV Curve Trace, Performance testing and recording, when possible

#### As-built sun access measurement at the corners of all arrays, minimum.

#### THERMAL IMAGING

##### Check all electrical components while systems are energized

##### Spot check, Modules, Inverters, Disconnects, AC system, etc.

#### Torque spot check on all mechanical and electrical terminations

#### Inspection of corrosion control measures

#### Confirm signage and placards meet plans

#### Workmanship evaluation

#### Inspection of DAS / CT metering and monitoring equipment

#### Weather station component inspection and performance audit

#### Confirm web-based monitoring interface operations

#### LIGHTING CONTROLS

##### Confirm canopy lighting levels match photometric design

##### Verify component installations

##### Confirm lighting controls function as specified

#### Commissioning of any other major electrical infrastructure installed on the project per manufacturer requirements

#### Medium voltage equipment tested to NETA requirements

### Testing to be performed per CPUC Electric Rule 21 testing procedures and requirements. All testing to be done on “no-cloud” days to avoid system fluctuation by passing clouds. Contractor to provide all testing and certification / commissioning.

### System start-up procedure shall be as outlined by the Manufacturer’s Installation Manual(s).

## DOCUMENTATION

### All commissioning and testing reports shall be provided to the Judicial Council within 15 days of completion of testing.

### Contractor shall submit comprehensive closeout documentation as specified in Section 01 33 01: Design-Build Process & Submittals and Section 01 77 00, Closeout Procedures.

Judicial Council END OF SPECIFICATION SECTION 48 14 00