

SECTION 16069
PHOTOVOLTAIC SYSTEM

PART 1 GENERAL

1.01 SCOPE

- A. The Contractor shall design, furnish and install the photovoltaic (solar) system as specified herein and as contained within the contract specifications and shown on the contract drawings.
- B. The complete operational system (module, mounting system, inverter, etc.) using the minimum solar module listed herein and based upon the available footprint shown in the contract drawings shall produce a minimum peak power output as measured at the input to the inverter of 456 KW, PTC-DC.
- C. The complete system must strike an optimal balance between delivered KW, KWh, reliability, life cycle, maintainability, and cost effectiveness for the San Francisco International Airport (SFIA) and the San Francisco Public Utilities Commission (SFPUC).
- D. For this project, the Contractor must submit a complete system design to be approved by the Contract Manager and a utility interconnection agreement must be submitted to PG&E for their approval.

1.02 RELATED SECTIONS

- A. Section 16010 thru 16470 contained within the contract documents.

1.03 REFERENCES

- A. All components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA, ANSI, NEC and UL.
- B. In addition to the codes cited in Section 16010, specific requirements for individual components of the solar system include but are not limited to the guidelines shown herein.
- C. All electrical work shall be designed and installed in accordance with the latest edition of all applicable codes, standards, and recommendations of the following agencies:
 - ANSI-American National Standards Institute.
 - ASHRAE-American Society Of Heating, Refrigeration, and Air Conditioning Engineers.
 - ASCE-American Society of Civil Engineers
 - ASME-American Society of Mechanical Engineers
 - CAL OSHA-California /Occupational Safety and Health Administration
 - CBC-California Building Code
 - CEC-California Energy Commission
 - ETL-Electrical Testing Laboratories.
 - IEEE-Institute of Electrical and Electronic Engineers
 - ICEA-Insulated Cable Engineer's Association.
 - IAIE-International Association Of Electrical Inspectors.
 - IPMVP- International Performance Measurement and Verification Protocol.
 - NFPA-101-National Fire Protection Association.(Life Safety Code)
 - NEMA-National Electrical Manufacturers Association.
 - NESC-National Electrical Safety Code.
 - NETA-National Electrical Testing Association.
 - NEC-National Electrical Code
 - UL-Underwriters Laboratories.

1.04 SUBMITTALS – FOR REVIEW AND APPROVAL PRIOR TO CONSTRUCTION

- A. The following information shall be submitted to the Contract Manager:
1. PV System Description and a report detailing the suitability of the roof.
 2. Master drawing index showing all drawings to be submitted for review.
 3. Full Electrical Calculations at various stages of the electrical circuit showing Kilowatts (KW), Amperes, Voltages, Line losses (Watts), Efficiency losses (Watts or %), and any other losses (KWH or %) based on such factors as panel mismatch, dirt accumulation, and temperature changes must be shown.
 4. PV module, inverters, isolation transformer, AC/DC loadbreak disconnect switches specifications and associated equipment specifications as appropriate.
 5. Site plan with detailed solar array layout and integrated mounting system that meets the requirements as set forth in the contract documents.
 6. Seismic certification and equipment anchorage details.
 7. Array wiring diagrams: Single line, Electrical Physical Equipment Layout, Combiner Boxes Electrical Details and All Specifications, Switches and Fuses, Physical Layout and Full Electrical Specifications (AC or DC as appropriate), Electronic Revenue Grade Meter Specifications, Data Acquisition System, Wiring Diagram and Specifications.
 8. Nameplate schedules.
 9. Conduit entry/exit locations.
 10. Cable terminal sizes.
 11. Product data sheets.
- B. Prior to final design, Contractor will commission a roof inspection by a professional independent roof consultant to evaluate the existing condition of the roof where the PV System and all associated equipment shall be installed. The deliverable will be a report outlining the general description and specific condition of the roof, the building's location with regard to wind exposure, shading, orientation, layout, and any other specifics that may require attention prior to beginning installation of the PV System. A full report indicating expected roof life and photo documentation shall be included in the final report.

1.05 SUBMITTALS – REQUIRED FOR PG&E REBATE

- A. Contractor shall apply for and secure the interconnection agreement with PG&E and provide all engineering, design, studies, etc., as may be required. The Airport and HHWP-Power Enterprise will be the name for whom the application is placed, and HHWP-Power Enterprise will sign the applications and agreements with PG&E as necessary.
- B. Contractor agrees that the City or HHWP-Power Enterprise is only responsible for the interconnection fee.
- C. Contractor agrees to submit an interconnection application to PG&E that includes detailed system information, an electrical single line diagram, and a site plan diagram.
- D. The application for interconnection will be submitted electronically to PG&E or as required. The application will then be distributed internally to the appropriate protection engineers and local division distribution planners at PG&E for their review.
- E. Note that due to the relatively small amount of power supplied by the PV system compared to the total power consumed at the site (i.e.-approx. 5MW at point of Airport grid connection), no net exports are expected to occur here. Thus California Assembly Bill AB-594 would not apply and consequently California Electric Rule 21 would apply.

1.06 SUBMITTALS – FOR AS-BUILT

- A. The following information shall be submitted for record purposes:
 - 1. Final as-built drawings and information for items listed in paragraph 1.04
 - 2. Array wiring diagrams
 - 3. Certified production test reports
 - 4. Installation information
 - 5. Seismic certification and equipment anchorage details.
- B. The final (as-built) drawings shall include the same drawings as the construction drawings and shall incorporate all changes made during the installation process.

1.07 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. The manufacturer and system installer of this equipment shall have produced and commissioned similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
- C. The equipment and major components shall be suitable for and certified to meet all applicable seismic requirements of the California Building Code. This shall include both vertical and lateral required response spectra as specified. Alternatively, the manufacturer's certification may be based on a detailed computer analysis of the entire assembly structure and its components. Guidelines for the installation consistent with these requirements shall be provided by the switchgear manufacturer and be based upon testing of representative equipment. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment.
- D. The following minimum mounting and installation guidelines shall be met, unless specifically modified by the above referenced standards.
 - 1. The Contractor shall provide equipment anchorage details, coordinated with the equipment mounting provision, prepared and stamped by a licensed structural engineer in the state. Mounting recommendations shall be provided by the manufacturer based upon approved methods used to verify the seismic design of the installation.
 - 2. The equipment manufacturer shall certify that the equipment can withstand, that is, function following the seismic event, including both vertical and lateral required response spectra as specified in the above codes.
 - 3. The equipment manufacturer shall document the requirements necessary for proper seismic mounting of the equipment. Seismic qualification shall be considered achieved when the capability of the equipment, meets or exceeds the specified response spectra.
- E. Mounting system shall be integral with the module and See Architectural contract documents for all mounting system requirements.

1.08 REGULATORY REQUIREMENTS

- A. All equipment supplied shall bear a UL label. Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.

1.09 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment. Equipment shall not be stored on the

Terminal roof area. The roof area is open to the aircraft apron below. With possible high winds and poor weather, loose construction debris and/or equipment is not acceptable.

- B. Contract shall submit a storage and delivery plan to the Contract Manager for review and approval.

1.10 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets, instruction bulletins and renewal parts lists where applicable, for the complete assembly and each major component.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Modules: Sharp, Kyocera, Sanyo or approved equal.
- B. Inverter with Isolation Transformer: Xantrex or approved equal.
- C. Mounting System: Sunlink or approved equal.

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions.

2.02 SYSTEM DESIGN

- A. The Contractor shall conduct the engineering design of the complete turn-key PV system shown contained within the contract drawings, providing all documentation to the Contract Manager. The complete PV system with mounting system shall be properly grounded per NEC.
- B. A minimum of 11.4 watts of power output (DC-PTC) per square foot of PV panel is required for this project location as based upon the system size shown in the contract drawings. The PV system should fully meet or exceed the stated 456 KW-DC-PTC peak power input to the sum of all the installed inverters.
- C. A minimum ten (10) foot width around the array perimeter shall be maintained per the contract drawings. In addition, appropriate aisles must be provided to provide proper module maintenance, to avoid existing structures and equipment currently located on the roof. The PV array shall be placed in accordance with the contract drawings so that proper access to other equipment located near the PV arrays is maintained.
- D. Equipment shall not straddle the existing expansion joints on the roof. Contractor shall afford sufficient space noted on the contract drawings on either side of the expansion joints to anchor the PV array, conduits and other equipment. Approved expansion joint fittings shall be placed for all conduits crossing over expansion joints.
- E. All required modifications or additions to the facility shall follow strict code compliance, paying particular attention to safety. No conduits, air ducts or other cooling equipment, other equipment placements or building alterations, which affect the exterior or interior appearance of buildings, walls, or facilities, will be allowed unless approved by the Contract Manager. The appearance of buildings and facilities shall be maintained and aesthetic treatment utilized where necessary.

2.03 SYSTEM SPECIFICATION

- A. The system will include a complete solar PV generating system as described above and will provide an total expected peak output in excess of 456 KW-DC-PTC for the Terminal T3 Solar Power System project.
- B. Pertinent Data provided by SFPUC's SF#10 Solar Monitoring Station (located at the South East Water Treatment Plant, Phelps and Jerrold Streets, SF, CA.) shall be used in the projected energy output calculations for the Terminal T3 Solar Power System Project. This data includes solar insolation levels taken at this

location, which is the closest of the City's 11 Solar Monitoring Stations. Additional details are further listed at the SFPUC website address:

- http://sfwater.org/detail.cfm/MC_ID/12/MSD_ID/139/MTO_ID/360/C_ID/1984

- C. The 60 HZ, 3 phase AC output voltage and configuration at the systems isolation transformer must be compatible with the voltage at the Terminals main electrical panel on the basement floor, where the two electrical grid connections will be made.
- D. The exact layout, number and type of PV panels must be clearly shown on the design documents as shown in the contract drawings and detailed in the contract documents. Adequate space for walkways (i.e. a minimum of 10 feet around the roof perimeter.), grouping of common conduit runs, proper drainage, and the avoidance of existing protrusions must also be considered in the design. In addition, all fire escape pathways and all other necessary pathways on the roof space must be maintained.
- E. The contractor shall keep a detailed installation log showing the placement of the individual PV panels by manufacturer ID number. This information will be used in the event a recall is issued by the manufacturer and becomes necessary to replace certain number of the panels by ID number.

2.04 PV MODULES AND PANELS

- A. The modules shown in the contract drawings shall be Sharp NT-180U1, or approved equal. The modules shall work seamlessly with the approved mounting system to meet all contract requirements and applicable building codes. Any approved equal must produce the same or greater PTC-DC power output per square foot as listed on the CEC (California Energy Commission) website. (www.consumerenergycenter.org/cgi-bin/eligible_pvmodules.cgi.)
 1. The noted DC-PTC power output for the Sharp NT-180U1 is calculated at 159 watts/14 sq. ft. = **11.4 watts per square foot.**
- B. Must meet or exceed the following current requirements:
 1. UL Subject 1703-2003, "Standard for Flat Plate Photovoltaic Modules and Panels".
 2. IEEE Std 1262-1995 IEEE recommended practice for qualification of photovoltaic (PV) modules, or IEC1215 Crystalline Silicon Terrestrial Photovoltaic (PV) modules-Design Qualification and Type Approval.
 3. Modules shall be provided with 25- year manufacturer warranty on power output as specified. All module electrical specifications including PTC outputs and degradation data shall be listed and utilized in determining the minimum peak output. Panels shall not exhibit more than 0.5% (one half percent) power depreciation per year.
 4. In addition to an appropriate UL Agency Listing, all PV panels must be on the California Energy Commission's (CEC) current eligibility list.
- C. All other thermal parameters and operating temperature coefficients must be clearly indicated and the panels must meet these specifications over their 25 year guarantee.
- D. Weight of the modules and the mounting support equipment must be less than 5 lbs. per square foot and shall maintain a Class C fire rating.
- E. Each solar module shall be grounded with a tin-plated lay-in lug and stainless steel hardware. The ground conductor shall be #10 AWG bare copper minimum. Ground cable shall be installed and concealed with approved method so as not to touch aluminum mounting system. The ground lug shall be ILSCO GBL4 DBT or approved equal.

2.05 INVERTER/ISOLATION TRANSFORMER

- A. In addition to being UL 1741 certified, inverters must also be listed on the California Energy Commission's (CEC) current Eligibility List. Inverters must be sized to properly accommodate the DC input from the PV panels under all expected electrical, thermal, and other operational conditions. Inverters shall be provided with five (5) year manufacturer warranty on power output as specified.

- B. The inverter must contain all self-protection features as stated in IEEE 929 including over and under voltage and frequency safeguards. An integral, anti-islanding protection scheme shall prevent the inverter from feeding power to the Airport grid in the event of a loss to normal power.
- C. Inverter efficiency shall be rated at greater than or equal to 94.5%. Standby losses shall be 30 watts or less.
 - D. The inverter shall include provisions for automatic operation including start up, shut down, self-diagnosis, and fault detection.
 - E. Inverter shut off and reset toggle switches will be provided.
 - F. User definable power tracking that matches the inverter to the array, as well as adjustable delay periods to customize system shut down sequences shall be provided.
 - G. The inverter must have a continuous power rating that exceeds the PV array output and AC current distortion at rated power must be less than 5% THD (Total Harmonic Distortion).
 - H. The inverters shall be interconnected to the customer's electrical panel by the use of a dry type, isolation transformer that provides both impedance and fault protection, and redundant protection against DC current injection to the SFIA Grid. The isolation transformer must provide the appropriate AC output power and voltage at the meter as specified herein and be listed for outdoor use.
 - I. Transformers must incorporate vibration isolation pads in their construction that are located between the transformer coil assembly and the case in order to minimize noise. External vibration isolation pads are not to be used. All connections to the transformer will be made by means of flexible metallic conduit.
 - J. Thermal and other operating parameters specific to the installation site must also be considered for this component of the system with the ambient temperature rated at between -4 degrees F and 122 degrees F.
 - K. Manufacturer shall be Xantrex PV225S-480-P or approved equal. The combined unit shall have a minimum rating of 94.5% efficiency including isolation transformers as listed on the CEC website (www.consumerenergycenter.org/cgi-bin/eligible_inverters.cgi).

2.06 MOUNTING SYTEM

- A. The PV system for this project shall be suitable for 90 mph wind loading. Use of ballasts shall be required as warranted and shall be integrated into the overall solar array system. The system shall be suitable and adjustable to be installed as shown in the contract drawings. Mounting system shall be provided with ten (10) year manufacturer warranty and be suitable for various solar panels that meet the specifications.
- B. The mounting system shall contain the PV panels in a durable, racked mounting system that shall lock the PV modules in a fixed five (5) degree tilt.
- C. To aid in roof and system maintenance, the mounting system shall allow the panels to rotate vertically a full 90 degrees from the five (5) degree position into a fixed locking position for access. To allow for air flow and water run off, the solar panels shall have a minimum space between the roof area and the bottom of the solar array of 6 inches.
- D. The system shall not add more than 5 pounds per square foot to the overall solar array system.
- E. Manufacturer of mounting system shall be Sunlink or approved equal.

2.07 COMBINER BOXES

- A. Combiner boxes shall be UL listed per UL 508, Industrial Controls Specification.
- B. Each box shall be oversized to allow for 25% spare capacity for addition of future PV strings and applicable fuses.
- C. Routing of conduits into and out of the combiner box shall afford the addition of future conduits and cabling.

2.08 FUSES

- A. All fuses and other protective devices and holders must be engineered to safely protect system components under “worst case” expected field conditions including temperature extremes.
- B. All fuses for disconnects must be current limiting UL class J, RK1, or RK5 and of the appropriate voltage, delay or non delay characteristic, and current rating to provide both complete short circuit and overload protection per NEC sections regarding component protection.
- C. Fuses located in the combiner boxes protecting PV string branch circuits shall be UL listed 600V DC rated, be in “shock-safe” type fuse holders providing load break disconnect capabilities when changing fuses. Midget fuses and fuse holders used in these circuits must be fully DC rated and adequate DC short circuit withstand and let-through capability must be provided for all power situations including “back-fed” conditions. Manufacturer shall be Littlefuse Midget Type KLKD-15 or approved equal.

2.09 CUSTOMER METERING

- A. Where indicated on the drawings, provide a separate metering compartment for each inverter output that is integral with the electrical distribution board as shown on the contract drawings.
- B. Meters shall be utility-grade revenue, electronic, bi-directional, with a .5%(one half percent) or better accuracy, Time of Use (TOU), KWh, KVARh and KWD demand meter must be installed to measure the AC output of the inverter at the delivery point to the facility’s electrical system.
- C. The meter shall have capability for connection to the data acquisition system for logging of electrical information and be equipped with optional onboard battery for continuous operation in any condition.
- D. The manufacturer shall be ABB Alpha Plus A1RL+ with 50ESS ERT or approved equal.

2.10 DATA ACQUISITION SYSTEM (DAS)

- A. Where indicated on the drawings, provide a separate metering compartment integral with the electrical equipment as shown on the contract drawings. All components shall be installed in open space on the roof of the inverter enclosure. Conduit from the NEMA 4 enclosure to each device shall be with ¾” rigid steel conduit minimum. Exposed cabling is not acceptable. See the contract drawings for mounting requirements. Submit installation plan to the Contract Manager for review and approval. All mounting hardware shall be stainless steel. All components of the DAS and Weather Station shall be suitable for operation as a seamless system. See suitable items listed below:
 - 1. Datalogger: Campbell Scientific Model #CX10 with Logger Net Software or approved equal.
 - 2. Silicon Pyranometer: Li-Cor Model #Li-Cor 200 or approved equal.
 - 3. Anemometer: Campbell Scientific Model #03101 RM Young Wind Sentry or approved equal.
 - 4. Temperature Probe: Campbell Scientific Model #108L or approved equal.
- B. The Contractor will be required to demonstrate that the installed DAS monitoring system meets all stated output performance standards. The monitoring system shall allow the City to view current and historical data over the Internet, including on the Contractor’s website if applicable, in 15 minute intervals.
- C. The monitoring system will utilize a data logger that records cumulative AC Energy (KWH), AC Power (KW), Ambient Temperature (deg C), Solar Irradiance (W/sq. meter) and Wind Speed (m/s).
- D. Minimum Accuracy Ranges for the above are:
 - 1. Energy & Power = Revenue Grade.
 - 2. Ambient Temp = +/- 1.0 deg C.
 - 3. Solar Irradiance = 5% max, typically 3% in natural light.
 - 4. Wind Speed = Within .1 m/s for the range 5-25 m/s.

- E. The data logger shall capture this information from the various sensor units comprising the metrological station located on the roof near the PV array. Electrical power and energy information is to be supplied from the auxiliary meter output near the inverter. This data is to be captured at one second intervals and stored by the data logger, until being sent to the remote host computer system for processing.
- F. The DAS and Weather Station shall include the sensors, data logger, modem for data retrieval, properly sized NEMA 4 Enclosure, dry bulb temperature measuring device with a radiation shield, anemometer, thermocouple, and solar sensor (pyranometer). Measurements must be calibrated for PT-RMS measurement.
- G. The monitoring system shall interface to a TCP/IP connection or phone line provided by the City and the Contractor shall provide all conduit and wiring for this interface connection. The City shall have access to the raw data in an ANSI data file.
- H. Data shall be downloaded to the specified computer system at increments of no more than 5 minutes. The City shall be able to retrieve these performance data records in comma separated, ANSI data files every 5 minutes on a daily basis.
- I. The contractor shall provide all conduit, wiring to the TCP/IP connection or phone terminal, and other devices such as transient suppression or power line filters as may be required for proper operation of the DAS.
- J. The system shall be have a 12 volt rechargeable battery suitable for operation due to normal power disruption.

2.11 EQUIPMENT ENCLOSURES

- A. The type of enclosure shall be in accordance with NEMA standards for Type 4 with gasketed doors unless otherwise noted. All enclosing sheet steel, wireways and unit doors shall be gasketed.
- B. See the Architectural contract drawings for information and dimensions of the outdoor enclosures that the solar equipment (inverter unit, panelboards, etc.) shall be housed within.

2.12 NAMEPLATES

- A. All equipment, panels, boxes and associated equipment shall be clearly labeled with engraved phenolic nameplates. Shall be black background with white letters, measuring a minimum of 1.5 in (38 mm) H x 6.25 in (159 mm) W total outside dimensions or as required to contain the pertinent information. Contractor shall submit the proposed nameplates with desired labeling for approval.
- B. Install engraved signs for instruction or warning identifying that a solar PV system is operational on the premises at appropriate locations and that there are potentially multiple power sources on the premises.
- C. Provide identification of all DC power circuits on switches and clearly identify individual module strings in DC combiner boxes. Use appropriate wire color codes (i.e. Red & Black) for negative and positive circuits.
- D. PV panels must include serial numbers on the frame and be easily viewed from the top side of the panel.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. All factory tests required by the latest ANSI, NEMA and UL standards shall be performed.
- B. A certified test report of all standard production tests shall be available to the Engineer upon request.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the contractor in installation and startup of the equipment specified under this section for a period of up to fifteen (15) working days. The manufacturer's representative shall provide technical direction and assistance to the Contractor in

general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

- B. The following minimum work and testing shall be performed by the Contractor but not limited to:
1. Obtain required permits.
 2. Maintain a clean site at all times. Due to nature of job site, loose debris shall not be permitted at any time.
 3. Field Testing of the PV Solar System shall include the following:
 - a. PV modules shall be factory tested by the suppliers and upon receipt by the contractor.
 - b. Factory testing of the inverter and transformer shall be performed by the supplier.
 4. Procure and install all equipment noted in the contract drawings and items not shown but equally critical to the operation of a complete PV system.
 5. Perform insulation tests on each phase conductor and verify low-resistance ground connection on the grounding system. System testing of installed PV array shall be performed on all strings of modules, including open circuit voltage, DC amperage, and megger. Each voltage measurement will include the following ancillary data: the date, time of day, sample panel temperature, dry bulb temperature, and the solar irradiation at the time. This data will then be recorded in the O & M manual in a clear tabular format.
 6. Connect all power wiring and control wiring and verify basic operation.
 7. Torque all bolted connections made in the field and verify all factory bolted connections.
 8. At such time as Contractor determines that the project is completed notification shall be given to the Airport Contract Manager for the scheduling of the final inspection and testing of the system.
 9. Start up system per manufacturers recommendations.
 10. Conduct initial Operation and Maintenance training as specified.
- C. The Contractor shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. Equipment shall be inspected prior to the generation of any reports.
- B. The Contractor shall provide three (3) copies of the manufacturer's representative's certification.

3.04 TRAINING

- A. The Contractor shall provide a training session for up to five (5) owner's representatives for 5 normal workdays at the jobsite or other office location chosen by the owner.
- B. The training session shall be conducted by a manufacturer's qualified representative.
- C. The training program shall consist of the following:
 1. Review of the PV system one-line drawings and schedules.
 2. Review of the factory record shop drawings and placement of the various PV arrays.
 3. Review of each type of PV module, combiner box, inverter, isolation transformer, meter, DAS, etc.
 4. Review PV system equipment replacement procedures.
 5. Discuss the maintenance timetable and procedures to be followed in an ongoing maintenance program.
 6. Provide three-ring binders to participants complete with copies of drawings and other course material covered.

3.05 EXAMINATION

- A. Installing Contractor to fully inspect shipments for damage and report damage to manufacturer and file claim upon shipper, if necessary.
- B. Fusing at the combiner box must be properly sized and coordinated for each PV string installed.
- C. Installing Contractor to verify NEC clearances as dictated on the contract drawings prior to installation.
- D. Verify UL labeling of the assembly prior to installation.

3.06 INSTALLATION

- A. Contractor to follow the installation instructions supplied by the manufacturer.
- B. Wiring shall be as shown on the contract drawings except as modified by the approval and submittal process. PV string wiring shall be submitted to the Contract Manager for approval for compliance with the requirements of the SFIA TIG, contract documents and applicable codes.

3.07 FIELD ADJUSTMENTS

- A. Follow the manufacturer's instructions and the contract documents concerning any short-circuit device settings or startup of components.

3.08 ACCEPTANCE TEST

- A. Follow the minimum requirements as stipulated per the manufactures recommendation and the California Energy Commission.
- B. After inverter startup, current shall be recorded for each PV string, each sub-array, and the entire array. Each current measurement will also include the same ancillary data as taken above during voltage measurements.
- C. Generate a field report on tests performed, test values experienced, etc., and make available to owner upon request.
- D. The test shall be conducted by an independent testing company, specializing in such test, such as Electro-Test or Power Systems Testing. The cost of the test shall be included in the bid price.

3.09 OPERATIONS AND MAINTENANCE

- A. During the first five years of operation following acceptance of this project, specific routine PV-related scheduled maintenance shall be undertaken every six months by the Contractor. It shall comprise of a visual inspection of the array, testing of power levels at the Combiner Box using hand held multi-meter, and tightening bolts on the inverter equipment per manufacturers' recommendations. Contractor shall prepare a report for submission to the Airport Contract Manager detailing the extent of the scheduled maintenance, the results of those items tested and reviewing items replaced and/or repaired.
- B. Cleaning of the array shall be undertaken by the Contractor every six months for the first five years following acceptance of this project. This shall be comprised of cleaning off and removing any loose debris, especially rinsing any accumulated dust, dirt, and bird droppings from the PV modules. Contractor may use the two (2) existing hose bibs located near the two roof penthouses. All other equipment – hoses, cleaning equipment, and properly badged labor shall be provided at the sole expense of the contractor. Use of toxic cleaning solutions shall not be permitted nor allowed to be flushed down the existing roof drains. Contractor must submit cleaning plan for Airport review and approval. All contractor provided cleaning personnel shall be properly badged per the contract requirements.
- C. During the first five years following acceptance of this project, the Contractor shall electronically monitor, document system performance and status. In addition, the contractor shall provide solar system performance data to the City. The City shall have the ability to view historical system performance for daily/weekly/monthly periods and to generate illustrative graphs of all actual data measured vs. expected PV performance.

END OF SECTION