DEVELOPMENT SERVICES – BUILDING INSPECTION

INSPECTION GUIDELINES:
PHOTOVOLTAIC (PV) – RESIDENTIAL

INSPECTION CODE: 701, 702, 246, 703

SCOPE: RESIDENTIAL

APPLICABLE CODES: 2016 CBC, CRC, CPC, CMC, CEC, CALGreen, CEnC, and PAMC

The information provided in this document is general and intended as a guide only. Each project is unique and additional requirements may be enforced as deemed appropriate.

WARNING

Meter removal and service disconnect/reconnect are to be performed by City of Palo Alto Utilities (CPAU) personnel only. Contractors who tamper with CPAU equipment will be issued a citation. Citations will be assessed at $500.00 per incident. (PAMC 12.20.01.0)

Failure to complete the items below prior to inspection may result in a re-inspection fee.

PROJECT INFORMATION:

☐ Permit Number: ________________________________
☐ Project Address: ____________________________________________________________
☐ Date: ________________________________

PRIOR TO INSTALLATIONS

☐ Plans shall be submitted and approved.

REQUIRED INSPECTIONS

1. Inspection 280: Any inspections West of 280
2. Inspection 701: Attachment Inspection [NOTE: This inspection is highly recommended for standing seam metal roofs, metal roof shingles, and all tile roofs]
3. Inspection 702: Rough Wiring (for conduit within building walls)
4. City of Palo Alto Electric Meter Shop:
   a. Call (650) 496-6987 for an inspection to receive a green sticker
   b. If the main breaker is going to be reduced, notify Meter Shop at time of requesting a meter shop PV inspection
5. Inspection 246: Electrical Torque Test
6. Inspection 703: Final (Inspection 246 and Inspection 703 may be scheduled at the same time)
PRE-INSPECTION

☐ De-energize electrical panels prior to removing the dead-front. Notify tenant/owner prior to de-energizing.

☐ Where PV source circuits, PV output, or inverter circuits are installed inside the structure, a separate rough inspection must be scheduled (Inspection 702).

☐ If a new roofing system is going to be installed, a separate roofing permit and inspections are required. (See the Roofing Checklist for specific roof being installed. Flashing and counter flashings are required.)

☐ The approved plans, permit, and installation instructions shall be on site at time of inspection.

☐ Provide a complete hard copy of the racking/rail system that is listed to UL 2703.

☐ For composition and shingles roofing, use a sealant under the shingles to adhere the shingles to the flashing. (CEC 110.3 (B))

☐ Major changes, including revisions, to the installation shall be submitted to the City for review and approval prior to inspection.

☐ Where junction boxes and grounding lugs are installed under the array and not readily accessible, the modules shall be removed for inspection.

☐ Embedded conduit in built-up, laminate, or membrane roofing materials in roof areas that are not covered by PV modules must be clearly marked. (CEC 690.31(G)(1))

☐ DC conductors, where the maximum system voltages are greater than 30V, shall be installed in a metallic raceway and when inside the structure shall be installed in a metallic conduit such as EMT, IMC, or RMC. (CEC 690.31(A))

☐ Where DC conductors are installed underground, conductors shall be buried 18” or more below grade and a warning tape installed 12” above the conduit. Label the conduit per the “Signs and Label” requirements (see the section below).

☐ Installer shall have ladder on site and set up at time of inspection. Portable ladders shall be rated four times that allowable intended load and extend three feet above the landing surface. When such an extension is not possible, the ladder must be secured and a grab rail must be provided per OSHA’s Stairways and Ladders – A Guide to OSHA Rules.

☐ All equipment shall be open and ready for inspection.

☐ A ground bushing is required around remaining pre-punched concentric or eccentric knockouts on the dc side. (CEC 250.97)
INSPECTION

GENERAL REQUIREMENTS

☐ Provide the following working clearances: 36” in depth, 30” in width, and 6’-6” in height. Working clearances apply to all electrical equipment associated with the PV system installation. Vegetation, including trees, which impact working clearances, shall be relocated. (CEC 110.26)

☐ Verify that the green sticker from CPA electric meter shop is posted on main electrical service. Call the CPA Meter Shop at 650-496-6987 to schedule an inspection from the meter shop if the sticker has not been placed. If the main breaker is going to be reduced, notify Meter Shop at time of requesting a meter shop PV inspection. (CPA Municipal Code)

☐ All connections shall be secure.

☐ All metallic raceways and equipment shall be bonded and electrically continuous.

☐ Unused opening shall be closed with protection equivalent to the wall of the enclosure. (CEC 408.7)

☐ Where DC conductors are installed underground, conductors shall be buried 18” or more below grade and warning tape must be installed 12” above the conduit. Label conduit per the “Signs and Labels” requirements (see matrix at the end of the checklist).

☐ Supports: EMT, IMC, and RMC shall be securely fastened in place at least every 10’ and within 3’ of each outlet box, junction box, device box, cabinet, conduit body or other termination. (CEC 342.30 (A), CEC 344.30 (A), CEC 358.30 (A))

☐ DC combiner boxes located on the roof are required to have an integral disconnect or a dc disconnect adjacent to the combiner box. (CEC 690.15(C))

☐ The inspector shall check the existing electrical panel for hot spots or unsafe conditions. If existing panel is found to be unsafe, it may be necessary for the property owner to hire a licensed electrician to make repairs or replace equipment. Repairs/replacement shall happen prior to photovoltaic hook up.

☐ Contractor shall be on site with torque wrench and torque screwdriver of the audible type to check torque at all connections per manufacturer’s specifications at all equipment including module clips and racking system (see the section below for torque requirements).

☐ Unless specified by the module manufacturer, all plumbing vents must have a clearance to the underside of the module of at least 1.0 times the vent diameter.
TORQUE REQUIREMENTS
☐ Contractor to provide a written list of torque specifications on site for the inspection specific to each piece of electrical equipment, including: circuit breakers, equipment grounds, neutrals, and feeders.

☐ Contractor to torque all connections per the manufacturer’s listings prior to the CPA inspection. The inspector will witness a spot check. If all terminations are found to be tight, no further torquing will be required. If loose connections are found, all connections will be required to be torqued in front of the CPA inspector.

☐ The PV installer must be on site with the following tools. (CEC 100.3 (b))
  o Torque wrench
  o Torque screwdriver (with a range of up to 50 lb-in.) and be audible type (ratcheting)
  o Channel locks to secure lugs in place when applying the proper torque

☐ Remove modules prior to the arrival of the CPA inspector from the rail where bonding/grounding device/lug is installed for torque verification.

STRUCTURAL ATTACHMENT
☐ If Inspection 701 has not been scheduled and approved, all attachment points must be exposed for metal roof shingles and all tile roofs.

☐ Verify that the attachment method is per the approved plans.

☐ The lag screw must have a minimum 2.5” embedment into the rafter or blocking.

☐ Verify that all framing members and load bearing walls are per plans.

☐ For wood shakes and wood shingles, provide the manufacturer’s specifications for a larger flashing. (CEC 110.3 (B))

☐ Verify equipment and conduit locations to address any issues.

ROUGH WIRING INSPECTION
☐ All circuit routing for PV source and PV output conductors shall be routed along building structural framing members. (CFC 605.11.1.2.6)

☐ Circuits embedded in built-up roofs must be identified. (CEC 690.31(G)(1))
DC DISCONNECT
- DC disconnect must be rated 600 VDC.
- Where fuses are installed, verify they are rated 600 VDC and that they are the same amperage as specified on the approved drawings.
- Label any fuse size inside the DC disconnects if they are different than the disconnect ampacity rating.
- Array conductors must be connected to the line side (top) input terminals at the top of the DC disconnect and conductors to inverter input shall be connected to the load side (bottom) output terminals of DC disconnect.
- The equipment grounding lug shall be as specified by the manufacturer. Verify that the lug matches the part number, as specified on the inside of the door of the DC disconnect. (CEC 110.3(B))
- Verify that the grounding lugs are located where specified by the manufacturer. (CEC 110.3 (B))
- Remove any insulating finish, such as paint, under the equipment grounding lug prior to installation. (CEC 250.12)
- Disconnects shall be installed so that the center of the operating handle, at its highest position, is not more than 6’-7’ above the floor or working platform; it shall also be located in a readily accessible location. (CEC 404.8(A)(1))
- PV Source Circuits, PV Output Circuits, and Inverter Circuits must be labeled at all terminations, connections, and splice points. (CEC 690.31(B)(1)&(2))
- Verify that the grounded conductors are not switched and must be white or gray. Check negative conductors for negatively grounded systems and positive conductors for positively grounded systems.

INVERTER LOCATION
- If electrical equipment is located near the gas meter, verify clearances are met (see the gas meter WGW Standard Drawing GD-02 attached to the plans for clearance requirements).
- The PV output and inverter circuit conductors shall be grouped and identified at all terminations, connections, and splices by means of separate color coding, tape, or tagging. (CEC 690.31(B)(2))
- Photovoltaic systems (those that are 80 volts or greater) must be protected by an arc-fault device. (CEC 690.11)
- AC and DC disconnects shall be located within sight of or in the inverter. (CEC 690.15(A))
- Verify the maximum and minimum height and clearance requirements per inverter manufacturer. (CEC 110.3 (B))
☐ Verify clear plastic barrier is returned to its original position separating the AC/DC wiring from the communication wires. (CEC 110.3 (B))

☐ Verify that the GEC and EGC are installed at the terminals as marked or specified by the manufacturer. (CEC 110.3 (B))

☐ Verify grounding electrode system. The grounding electrode system should include one of the following. (CEC 690.47)
  - GEC from the inverter to a separate ground rod then bonded to the existing AC grounding electrode.
  - GEC from inverter to the AC grounding electrode.
  - GEC combined with the EGC from the inverter to the grounding bus-bar in the associated AC equipment.

☐ Where the inverter is not within sight and not located within 10’ of the main service panel, an additional AC disconnect is required adjacent to the inverter. (CPAU Electrical Engineering)

**AC DISCONNECT**

☐ Verify that the utility AC disconnect is located within sight and within 10’ of main electrical service. The AC disconnect shall be readily accessible with visible-blades and lockable (the inverter backfeed breaker does meet this requirement). (CPAU Electrical Engineering)

☐ The equipment grounding lug shall be as specified by the manufacturer. Verify that the lug matches the part number as specified on the inside of the door. Verify that the grounding lugs are located where specified by manufacturer. (CEC 110.3 (B))

☐ Remove any insulating finish, such as paint, under the equipment grounding lug prior to installation. (CEC 250.12)

☐ The line side (top) terminals shall have circuits from utilities connected to terminals; the load side (bottom) terminals shall have circuit form inverter connected to these terminals. The conductors from the utilities shall land on the line side (top). The conductors from the inverters shall land on the load side (bottom) terminals.

☐ Disconnects shall be installed so that the center of the operating handle, at its highest position, is not more than 6’-7’ above the floor or working platform and shall be located in a readily accessible location. (CEC 404.8(A)(1))
MAIN ELECTRIC SERVICE

☐ The inspector shall check existing panel for hot spots or unsafe conditions. If existing panel is found to be unsafe, it may be necessary for the property owner to hire a licensed electrician to make repairs or replace equipment. Repairs/replacement shall happen prior to photovoltaic hook up.

☐ Overcurrent protection devices (e.g., breakers) shall be installed so that the center of the operating handle, at its highest position, is not more than 6’-7’ above the floor or working platform; it shall also be located in a readily accessible location. This applies to new and existing equipment installations. (CEC 404.8(A)(1))

☐ Verify utility point of interconnection (circuit breaker) is per plan, does not exceed 20% of the bus rating and is installed at the opposite end from the input feeder. (CEC 705.12(D)(2)(3)(D))

☐ Circuit breakers shall be of the same manufacturer as the main electrical service. (CEC 110.3 (B))

☐ When a back fed breaker is the method of utility interconnection, breaker shall not read “line and load.” (CEC 705.12 (D)(5))

☐ Verify that the existing AC grounding electrode system is connected to a Ufer or driven ground rod. The connection to the grounding electrode shall remain accessible. (CEC 250.68 (A))

☐ If there is no existing AC grounding electrode, the PV contractor shall install (2) ground rods at the main electrical service. If there is only (1) ground rod, a second one shall be installed. Ground rods shall be a minimum of 6’ apart. (CEC 250.52(5), CEC 250.53(A)(3))

☐ Verify that the grounding electrode system from the inverter to the additional ground rod is bonded to an existing AC grounding electrode or provide a grounding electrode conductor directly from the inverter to existing grounding electrode with separate attachment. (CEC 690.47)

PANELBOARD

☐ Verify utility point of interconnection (circuit breaker) is per plan, does not exceed 20% of the bus rating and is installed at the opposite end from the input feeder. (CEC 705.12(D)(2)(3)(D))

ROOFTOP

☐ PV Source Circuits and PV Output Circuits shall be identified at all terminations, connections, and splices by means of separate color coding, tape, or tagging. (CEC 690.31(B)(1), CEC 690.31(B)(2))

☐ DC conduits in the roof shall be located as close as possible to the ridge, hip, or valley to minimize trip hazards and to maximize ventilation opportunities. (CFC 605.11.1.2.6)

☐ All roof top modules must have the same fire rating as the roof system. (CRC R907.3, CRC R902.4, CBC 1505.9)

☐ PV source circuit conductors and PV output circuit conductors shall be protected from physical damage when installed outside of the array (i.e. EMT). (CEC 690.31 (A), CEC 690.31(B))
Connectors require the use of a tool to open. (CEC 690.33(C))

Connectors shall also be marked (CEC 690.33(E)(2)):
  - “Do Not Disconnect Under Load” or
  - “Not for Current Interrupting”

Verify photovoltaic source circuit conductor types are USE-2 or photovoltaic (PV) wire. (CEC 690.31(C)(1))

All equipment on the roof, requiring servicing, shall meet the required clearances. (CEC 110.26)

Verify roof penetrations are flashed and counter flashed. (CBC, CEC 110.3(B))
  - For metal roof types, penetrations shall be per the metal roof manufacturer’s details; have a printed detail on site for inspection.

Modules shall be of the same manufacturer per plan. (CEC 110.3 (B))

If modules are bonded through the racking/rail system, the racking/rail system must be listed to UL2703 and the installation instructions must be on site for the inspection.
  - Where equipment listed to UL 2703 is not installed, verify grounding lugs, at the module frames, are installed per the module manufacturer’s installation instructions. The grounding method must be located at the ground to earth symbol on the module frame.

Surfaces for bonding of painted metal components shall be scratched to get good contact.

Equipment on DC side of inverter shall be rated 600 VDC.

Dc combiners, installed on roofs, shall have a load break disconnecting means located in the combiner or within 6’ of the combiner. (CEC 690.15(C))

Verify that fuse sizes match the approved plans and are rated at 600 VDC.

Electrical equipment located in the attic shall be accessible.

Exposed pressure treated wood is not allowed. (CPA Municipal Code)

For ungrounded (functionally grounded) systems, the source circuit conductors cannot be white. These conductors shall be black and red and must also be identified as PV Wire. (CEC 200.6)

Provide separation between the roof top modules to prevent damage from expansion. (CEC 110.3 (B))
An auxiliary electrode is required when the array is more than 6’ from the premise wiring electrode (see the figure below for clarification). (CEC 690.47(D))

If the array is more than 6’ horizontally from the premise wiring grounding electrode (e.g., water service, ground rods, Ufer ground, etc.), an auxiliary grounding electrode is required.

Connect grounding lug to array separately; do not bond to other grounding conductors.

**Figure CPA 080** – Auxiliary grounding electrode

**RAPID SHUTDOWN**

- String inverters must be within 10’ of the array to comply with rapid shutdown requirement. (CEC 690.12)

- DC-to-DC combiners and microinverters must be listed for rapid shutdown per UL 1741. (CEC 690.12)
# SIGNS AND LABELS
Labels shall be phenolic where exposed to sunlight. Labels required on conduit shall be permanent, weather resistant, and suitable for the environment. Labels shall be red background with white lettering. The following labels must be provided:

<table>
<thead>
<tr>
<th>CEC Article</th>
<th>Location of Label</th>
<th>Verbiage</th>
</tr>
</thead>
<tbody>
<tr>
<td>690.5(C)</td>
<td>Utility-interactive inverter &amp; battery enclosure</td>
<td>WARNING: ELECTRIC SHOCK HAZARD IF A GROUND FAULT IS INDICATED, NORMALLY GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED</td>
</tr>
<tr>
<td>690.35(F)</td>
<td>Inverters, combiner boxes, disconnects and other energized devices.</td>
<td>WARNING: ELECTRIC SHOCK HAZARD. THE DC CONDUCTORS OF THIS PHOTOVOLTAIC SYSTEM ARE UNGROUNDED AND MAY BE ENERGIZED</td>
</tr>
<tr>
<td>690.15 705.10</td>
<td>At the main service. Required when on roofs or other non-accessible locations.</td>
<td>A PLAQUE SHALL BE INSTALLED IN ACCORDANCE WITH 705.10 (ORIENTED IN THE CORRECT DIRECTION)</td>
</tr>
<tr>
<td>690.13(B)</td>
<td>On the AC and DC disconnect</td>
<td>PHOTOVOLTAIC SYSTEM DC DISCONNECT PHOTOVOLTAIC SYSTEM AC DISCONNECT</td>
</tr>
<tr>
<td>690.53</td>
<td>On the DC disconnects</td>
<td>Rated maximum power-point current______ Rated maximum power-point voltage______ Maximum system voltage________________ Maximum rated output circuit of the charge controlled (if installed)________________________</td>
</tr>
<tr>
<td>690.54</td>
<td>At interactive points of interconnection, usually the main service</td>
<td>RATED AC OUTPUT CURRENT XXX AMPS NORMAL OPERATING AC VOLTAGE XXX VOLTS</td>
</tr>
<tr>
<td>690.17(E)</td>
<td>At the DC disconnect</td>
<td>WARNING! ELECTRIC SHOCK HAZARD. DO NOT TOUCH TERMINALS. TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION</td>
</tr>
<tr>
<td>690.56(C)</td>
<td>Main electric service</td>
<td>“PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN” <em>Must be reflective</em> Note: This label may a sticker is supporting documentation is provided showing labels have been tested suitable for 7 to 10 years or more.</td>
</tr>
<tr>
<td>690.31(G)</td>
<td>Inverter output OCPD</td>
<td>“WARNING: INVERTER OUTPUT CONNECTION DO NOT RELOCATE THIS OVERCURRENT DEVICE”</td>
</tr>
<tr>
<td>690.31(G)(3), 690.31(G)(4)</td>
<td>On AC and DC conduit, raceways, enclosures, mark every 10’, at turns, above/below penetrations</td>
<td>WARNING: PHOTOVOLTAIC POWER SOURCE <em>Must be sunlight resistant</em> <em>Must be reflective</em> Note: This may be a sticker. Provide supporting documentation showing labels have been tested suitable for 7 to 10 years or more.</td>
</tr>
<tr>
<td>CEC Article</td>
<td>Location of Label</td>
<td>Verbiage</td>
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<tr>
<td></td>
<td>On the inverter where PV systems are positively grounded</td>
<td>POSITIVE GROUNDED SYSTEM</td>
</tr>
<tr>
<td></td>
<td>Load centers used as PV ac combiners.</td>
<td>PHOTOVOLTAIC CIRCUITS ONLY. NO ADDITIONAL CIRCUITS ALLOWED</td>
</tr>
<tr>
<td>690.55</td>
<td>Battery enclosure</td>
<td>MAXIMUM OPERATING VOLTAGE EQUALIZATION VOLTAGE POLARITY OF GROUNDED CONDUCTORS</td>
</tr>
<tr>
<td></td>
<td>Main electric service</td>
<td>MAXIMUM MAIN BREAKER SIZE: XXX AMPS</td>
</tr>
<tr>
<td>UTILITIES REQUIREMENT</td>
<td>At the main electrical service when a supply side tap is used</td>
<td>CAUTION! SUPPLY SIDE TAP. OPEN AND LOCK AC PV DISCONNECT BEFORE REMOVING METER</td>
</tr>
</tbody>
</table>