

Lompoc Fire Department

Building and Fire Safety

SOLAR PHOTOVOLTAIC SYSTEM REVIEW

In collaboration with the State Fire Marshal's office, the Lompoc Fire Department (LFD) has developed a standard of conditions to ensure firefighter and public safety for all Solar PV systems. LFD appreciates the environmental friendly technologic advances these systems bring. However, traditional firefighting techniques, such as roof venting, water extinguishment and fire overhaul will have to be modified to ensure human safety. Roofs that contain solar arrays will be most difficult for firefighters to vent. Delayed roof venting may increase the time factor in fire containment resulting in a greater extent of fire damage overall. Conventional water extinguishment on roofs with Solar PV systems may not be an option for firefighters if the integrity of any portion of the solar array is threatened as the risk of accidental electrocution is greatly increased. Fire overhaul will also be a challenge for firefighters, as broken panels or compromised solar conduit will remain energized during daylight hours or when illuminated by lights.

The following conditions will apply to all roof and ground mount Solar PV systems:

1. There will be a minimum of 36" of clearance at the ridgeline where Solar Array's are installed on roofs. Arrays are allowed to be installed down to the eave if there remains (3) three access points from the ground to the ridge. If there is less than (3) three access points to the roof ridge then there shall remain a 36" perimeter of walking area around the array.
2. Ground mounted solar arrays will be erected in areas clear of combustible vegetation. A minimum vegetation clearance or mowed perimeter of 10' shall be maintained.
3. All Solar conduits, interior or exterior, will be permanently labeled with fade resistant material stating:

“CAUTION: Solar PV Wiring May Remain Energized After Disconnection During Daylight Hours”

4. Permanent placard installed on exterior and interior of main electrical panel stating:

“CAUTION: Solar PV System Installed-When Power Disconnected Solar Panels And Wiring May Remain Energized During Daylight Hours”

5. Battery storage in enclosed rooms to be mounted a minimum of 24" above floor. If contained within cabinet a permanent placard to be posted. Storage battery rooms shall also comply with the Fire and Building Code.
6. All disconnects shall be accessible to fire department and located together when possible.

7. A separate emergency disconnect on roof to disconnect solar panels from interior and exterior wiring running to inverter. This disconnect must be permanently labeled, in reflective, fade resistant material, **“Emergency Disconnect: Caution-Solar Panels and Wiring in Conduit May Remain Energized”**.

SIGNAGE REQUIREMENTS FOR SOLAR PV SYSTEMS

Two forms of signage are required for Solar PV Systems. Permanently affixed reflective labels should have a white background with red lettering. Printed material should resist fading. Size of lettering should be equal to the example below.

1. Exterior/Interior Conduit signage:

Horizontal and Vertical to be installed every 20'. For vertical conduit a minimum of 1 label to be affixed at eye level.

“CAUTION Solar PV Wiring May Remain Energized After Disconnection During Daylight Hours.”

2. Exterior/Interior of Electrical Panel signage:

**“CAUTION
Solar PV System Installed. When Power
Disconnected
Solar Panels And Wiring In Conduit May Remain
Energized During Daylight Hours”**

SOLAR ELECTRIC (PV) SYSTEM INSTALLATION CHECKLIST

Following the completion of each item on the checklist below, check the box to the left of the item and insert the date and initials of the person completing the item whether that is the installing contractor or owner-installer. Remember to follow the proper safety procedures while performing the system installation. The appropriate safety equipment for each section of the checklist is listed above each section of the checklist.

Before starting any PV system testing: (hard hat and eye protection recommended)

- 1. Check that non-current carrying metal parts are grounded properly. (array frames, racks, metal boxes, etc. are connected to the grounding system)
- 2. Ensure that all labels and safety signs specified in the plans are in place.
- 3. Verify that all disconnect switches (from the main AC disconnect all the way through to the combiner fuse switches) are in the open position and tag each box with a warning sign to signify that work on the PV system is in progress.

PV ARRAY--General (hard hat, gloves, and eye protection recommended)

- 1. Verify that all combiner fuses are removed and that no voltage is present at the output of the combiner box.
- 2. Visually inspect any plug and receptacle connectors between the modules and panels to ensure they are fully engaged.
- 3. Check that strain reliefs/cable clamps are properly installed on all cables and cords by pulling on cables to verify.
- 4. Check to make sure all panels are attached properly to their mounting brackets and nothing catches the eye as being abnormal or misaligned.
- 5. Visually inspect the array for cracked modules.
- 6. Check to see that all wiring is neat and well supported.

PV ARRAY CIRCUIT WIRING (hard hat and eye protection recommended)

- 1. Check home run wires (from PV modules to combiner box) at DC string combiner box to ensure there is no voltage on them.
- 2. Recheck that fuses are removed and all switches are open.
- 3. Connect the home run wires to the DC string combiner box terminals in the proper order and make sure labeling is clearly visible.

REPETITIVE SOURCE CIRCUIT STRING WIRING (hard hat, gloves, and eye protection recommended)

The following procedure must be followed for each source circuit string in a systematic approach—i.e. east to west or north to south. Ideal testing conditions are midday on cloudless days March through October.

- 4. Check open-circuit voltage of each of the panels in the string being wired to verify that it provides the manufacturer's specified voltage in full sun. (Panels under the same sunlight conditions should have similar voltages--beware of a 20 Volt or more shift under the same sunlight conditions.)
- 5. Verify that the both the positive and negative string connectors are identified properly with permanent wire marking.
- 6. Repeat this sequence for all source circuit strings.

CONTINUATION OF PV ARRAY CIRCUIT WIRING (hard hat, gloves, and eye protection recommended)

- 7. Recheck that DC Disconnect switch is open and tag is still intact.
- 8. **VERIFY POLARITY OF EACH SOURCE CIRCUIT STRING** in the DC String Combiner Box (place common lead on the negative grounding block and the positive on each string connection--pay particular attention to make sure there is NEVER a negative measurement). Verify open-circuit voltage is within proper range according to manufacturer's installation manual and number each string and note string position on as-built drawing. (Voltages should match closely if sunlight is consistent.) **WARNING: IF POLARITY OF ONE SOURCE CIRCUIT STRING IS REVERSED, THIS CAN START A FIRE IN THE FUSE BLOCK RESULTING IN THE DESTRUCTION OF THE COMBINER BOX AND POSSIBLY ADJACENT EQUIPMENT.**

REVERSE POLARITY ON AN INVERTER CAN ALSO CAUSEDAMAGE THAT IS NOT COVERED UNDER THE EQUIPMENT WARRANTY.

9. Retighten all terminals in the DC String Combiner Box.

WIRING TESTS--Remainder of System: (hard hat, gloves, and eye protection recommended)

10. Verify that the only place where the AC neutral is grounded is at the main service panel.

11. Check the AC line voltage at main AC disconnect is within proper limits (115-125 Volts AC for 120 Volts and 230-250 for 240 Volts).

12. If installation contains additional AC disconnect switches repeat the step 11 voltage check on each switch working from the main service entrance to the inverter AC disconnect switch closing each switch after the test is made except for the final switch before the inverter (it is possible that the system only has a single AC switch).

INVERTER STARTUP TESTS (hard hat, gloves, and eye protection recommended)

1. Be sure that the inverter is off before proceeding with this section.

2. Test the continuity of all DC fuses to be installed in the DC string combiner box, install all string fuses, and close fused switches in combiner box.

3. Check open circuit voltage at DC disconnect switch to ensure it is within proper limits according to the manufacturer's installation manual.

4. If installation contains additional DC disconnect switches repeat the step 4 voltage check on each switch working from the PV array to the inverter DC disconnect switch closing each switch after the test is made except for the final switch before the inverter (it is possible that the system only has a single DC switch).

5. At this point consult the inverter manual and follow proper startup procedure (all power to the inverter should be off at this time).

6. Confirm that the inverter is operating and record the DC operating voltage in the following space. _____

7. Confirm that the operating voltage is within proper limits according to the manufacturers installation manual.

8. After recording the operating voltage at the inverter close any open boxes related to the inverter system.

9. Confirm that the inverter is producing the expected power output on the supplied meter.

10. Provide the homeowner with the initial startup test report.

SYSTEM ACCEPTANCE TEST (hard hat and eye protection recommended)

Ideal testing conditions are midday on cloudless days March through October. However, this test procedure

accounts for less than ideal conditions and allows acceptance tests to be conducted on sunny winter days.

1. Check to make sure that the PV array is in full sun with no shading whatsoever. If it is impossible to find a time during the day when the whole array is in full sun, only that portion that is in full sun will be able to be accepted.

2. If the system is not operating, turn the system on and allow it to run for 15 minutes before taking any performance measurements.

3. Obtain solar irradiance measurement by one of two methods and record irradiance on this line: W/m². To obtain percentage of peak sun, divide irradiance by 1000 W/m² and record the value on this line . (example: 692 W/m² ÷ 1000 W/m² = 0.692 or 69.2%.) Method 1: Take measurement from calibrated solar meter or pyranometer. Method 2: Place a single, properly

operating PV module, of the same model found in the array, in full sun in the exact same orientation as the array being tested. After 15 minutes of full exposure, test the short circuit current with a digital multimeter and place that reading on this line: Amps. Divide this number into the short circuit current (Isc) value printed on the back of the PV module and multiply this number by 1000 W/m² and record the value on the line above. (example: Isc-measured = 3.6 Amps; Isc-printed on module = 5.2 Amps; Irradiance = 3.6 Amps/5.2 Amps * 1000 W/m² = 692 W/m²)

4. Sum the total of the module ratings and place that total on this line Watts_{STC}. Multiply this number by 0.7 to obtain expected peak AC output and record on this line Watts_{AC-estimated}.

5. Record AC Watt output from the inverter or system meter and record on this line Watts_{AC-measured}.

6. Divide Watts_{AC-measured} by percent peak irradiance and record on this line Watts_{AC-corrected}. This "AC-corrected" value is the rated output of PV system. This number must be within 90% or higher of Watts_{AC-estimated} recorded in step 4. If it is less than 90%, the PV system is either shaded, dirty, miswired, fuses are blown, or the modules or inverter are not operating properly.

I have read the above safety concerns involved in the installation of a Solar PV system and understand the conditions set forth above. The subject Solar PV System has been installed and tested in accordance with applicable codes and standards.

Signed by _____ Date _____

Print Name _____

Title _____

Company's name and address: _____

Address of installed system: _____

Permit # _____

Submittal Requirements – Photovoltaic System Ground or Roof Mounted

1. Three sets of Construction plans, including plot plan.
2. Cover Sheet:
 - a) Potential limitations for Homeowners
 - b) List of reference codes
 - c) Required signage (CA Electrical Code, Article 690-10 and 690-17)
 - d) Contractor shall verify that the roof Structure will withstand the additional dead and live loads. An architect or engineer may be required to verify existing structure and new elements required for installation.
 - e) Lag screws shall penetrate a minimum 2" into structural members.
3. Roof plan or ground mount plan with panel location.

4. Panel anchorage/attachment details.
 - a) A mounting detail from the manufacturer such as Unirac or Tilerac is required.
 - b) If ground mounted; footing and structural details are required.
5. Electrical one line diagram.
 - a) Show panels, inverter, main panel disconnects, conduits and wire size and types.
6. Equipment cut sheets (inverter and photovoltaic panels).
 - a) Inverter and panel must be a listed product.
 - b) Indicate panels listed product weight.
7. Address on first page and number all pages.
8. Responsible designer to sign all plans that they prepared.
9. The City's Electrical Division must review proposed project. Electrical Division may require additional fees and inspections.

Reference Codes:

California Code of Regulations, Title 24
As amended by the City of Lompoc, CA
2007 California Building Code
2007 California Electrical Code
2005 California Energy Code
2007 California Fire Code
2007 California Mechanical Code
2007 California Plumbing Code

Notice to Homeowners

Your homeowners' association may have potential limitations applicable to your project.

Installation to comply with article 690 of the 2007 CEC.