



**SUPPLEMENTAL CORRECTION SHEET
FOR
SOLAR PHOTOVOLTAIC SYSTEMS (ELEC)**

This is intended to provide uniform application of the codes by the plan check staff and to help the public apply the codes correctly.

Plan Check No. _____ **PCIS #:** _____ - _____ - _____

Checked by: _____ **Telephone:** _____

NOTE: Unless otherwise as noted, numbers in a parenthesis () refer to Code sections of the 2008 editions of the City of Los Angeles Electrical Code.

PLAN DETAILS

A. General:

- 1. Provide the following information for the photovoltaic (PV) System: (LAEC 93.0207, 690)
 - a. Scope of the project, including system KW rating.
 - b. Complete single line diagram of the PV and utility interconnect.
 - c. Site plan, including location of system components, (i.e. inverter, convertor, batteries, modules, disconnects, etc).
 - d. Type of system (i.e Alternating-Current Modules, Bipolar, grounded, ungrounded, Hybrid, isolated, interactive, stand-alone, etc).
 - e. Utility service Operating voltage or class.
 - f. Provide information on the size, type, and insulation ratings (voltage, temperature, etc) of all conductors and associated wiring components on the direct current (DC) and alternating (AC) side of the PV system.
 - g. Indicate type, size and material of raceway(s).

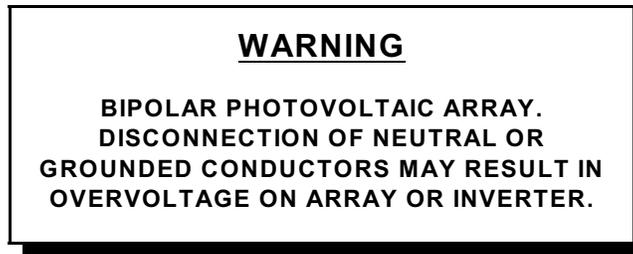
- 2. Show the roof access and roof mounted equipment, on the roof plan.
(LAEC 93.0207, 240.24)

- 3. Provide the following information (as applicable) for the direct current (DC) side of the PV system:
(LAEC 93.0207, 690)
 - a. Number of series connected modules in every PV source circuit.
 - b. Number of parallel connected modules or panels PV source circuits in each array or PV power source.
 - c. Number of combiner boxes, control boxes, or PV power centers for each array, sub-array or PV power source.
 - d. Number of PV output circuits.
 - e. PV source circuit modules or panels connection arrangement.
 - f. Operating and open-circuit voltage of each module or panel.
 - g. Operating voltage of each array or PV power source.
 - h. Operating current of every PV source circuit.
 - i. Operating current of each array.
 - j. Maximum array, panel or module system voltage.
 - k. Short circuit current of modules or panels.
 - l. Short circuit current of array and subarrays.
 - m. Short circuit current of battery system.

- n. Disconnecting means electrical ratings.
 - o. Disconnecting means wiring diagram.
 - p. Disconnecting means rated short-circuit current per pole.
- 4. Provide the manufacturer's specification sheets for the PV modules (or panels), including manufacturer's name, catalog numbers, complete electrical information, required marked acceptable series backfeed fuse protection rating and installation instruction. (LAEC 93.0207)
 - 5. Provide the manufacturer's specification sheets for the inverters, converters, charge controllers, and AC modules, indicating the following ratings: (LAEC 93.0207)
 - a. Maximum Input AC and DC voltage, and the range of operating voltage(s),
 - b. Nominal AC output voltage,
 - c. Nominal DC voltage and operating range for Utility Interactive or Stand-Alone systems with charge controller,
 - d. Maximum Input AC and DC current, and maximum input short circuit current,
 - e. Maximum inverter output short circuit current and duration.
 - e. Maximum utility source backfeed current(short or open circuit) for utility interactive System with or without charge controller,
 - f. Maximum continuous AC output current and power,
 - g. Normal operation temperature range.
 - 6. Provide the manufacturer's specification sheets for inverters manufacturer's name, model designation, and listing (UL safety standard 1741) requirements (i.e., grid-tie or not). (LAEC 93.0207)
 - 7. Provide information indicating if the inverter(s) or charge controller(s) contains current limiting devices that limits the output circuit current to the maximum inverter input DC current rating. (LAEC 93.0207)
 - 8. Provide the manufacturer's wiring details for combiner boxes, control boxes, or PV power centers manufacturer's name, model designation, and listing requirements.(LAEC 93.0207)
 - 9. Provide information on the size, type, and insulation ratings (voltage, temperature, etc) of all conductors and associated wiring components on the DC and AC side of the PV system. (LAEC 93.0207)
 - 10. Provide battery specification sheet(s) indicating the its type, nominal output voltage and the rated capacity in ampere-hours. (LAEC 93.0207, 690.71(B)(1))
 - 11. The roof mounted photovoltaic modules or panel layout shall be approved by the Fire Department. (LAEC 93.0206)
 - 12. Provide information indicating compliance with the NEC 690.61 requirement, Loss of Interactive System Power. (LAEC 93.0207, 690.61)
 - 13. Provide details for connector specification sheet(s) indicating configuration, construction, type, grounding member and circuit current interruption capability and method. (LAEC 690.33)
 - 14. Indicate if the photovoltaic system uses a diversion charge controller as the sole means of regulating the charging of a battery. (LAEC 690.72(B)(1))
 - 15. Indicate method of access to the junction, pull or outlet boxes behind the modules or panels. (LAEC 690.34)

B. Circuits

- 1. The maximum system voltage of bipolar circuits shall be the highest voltage achieved between the ungrounded sides of each 2-wire circuits that are connected to bipolar source array when all of the following conditions are met: (LAEC 690.7(E))
 - (1) One conductor of each 2-wire circuit is solidly grounded.
 - (2) Each 2-wire circuit is connected to a separate subarray.
 - (3) The equipment is clearly marked with a label as follows:



- 2. The circuit conductors and overcurrent protective devices shall be sized to carry not less than 125% of the maximum current as calculated in LAEC 690.8(A). (LAEC 690.8(B))
- 3. The overcurrent protection of output circuits with internal current limiting devices shall be not less than 125% of the maximum limited current of the output circuit. The conductors in such an output circuit shall be sized in accordance with LAEC 690.8(B)(1). (LAEC 690.8(B)(2))
- 4. The common-return conductor of systems with multiple voltages (i.e., multi-tap battery banks) shall not be smaller than the sum of the ampere ratings of the overcurrent devices of the individual output circuits. (LAEC 690.8(C))
- 5. Where a single overcurrent device is used to protect a set of two or more parallel-connected module circuits, the ampacity of each of the module interconnection conductors shall not be less than the sum of the (modules required marked acceptable series backfeed protection) fuse rating and 125% of the short-circuit from the other parallel-connected modules. (LAEC 690.(D))

C. Overcurrent Protection:

- 1. Photovoltaic source circuits, output circuits, inverter output circuits, and storage battery circuit conductors and equipment shall be protected in accordance with the requirements of Article 240 of the Los Angeles Electrical Code. (LAEC 690.9(A))
- 2. Circuits connected to more than one electrical source (i.e., parallel strings, inverters, storage-battery circuits, etc) shall have overcurrent protective devices providing overcurrent protection from all sources. (LAEC 690.9(A))
- 3. Overcurrent protective devices in the DC portion of the system shall be listed for use in DC circuits and shall have the appropriate voltage, current, and interrupting ratings. (LAEC 690.9(D))

D. Disconnecting Means:

- 1. Provide a disconnecting means for all current carrying conductors of PV sources from all other conductors in the building or other structure. This disconnecting means shall be installed at a readily accessible location either on the outside of the building or structure or inside nearest the point of entrance of the PV system conductors. (LAEC 690.13&14)
- 2. Provide a disconnecting means for the following items:
 - a. PV source circuit(s)(isolating switches),
 - b. Overcurrent devices,
 - c. Blocking diodes,
 - d. Inverters,
 - e. Batteries,
 - f. Charge controllers,
 - g. _____ (LAEC 690.14&15)
- 3. The PV disconnecting means shall be grouped together and the maximum number of disconnects shall not exceed six. (LAEC 690.14(C)4&5)
- 4. Disconnecting means shall be provided to disconnect a fuse from all sources of supply if the fuse is energized from both directions and is accessible to other than qualified persons. (LAEC 690.16)
- 5. The switch or circuit breaker that is intended to disconnect ungrounded conductors of a PV system shall be readily accessible and comply with all applicable provision of the section 690.17 of LAEC. (LAEC 690.17)
- 6. Current carrying conductors of battery circuits, consisting of field serviceable batteries with more than twenty four 2-volts cells connected in series string (48 volts, nominal), shall have provisions to disconnect them into 24 cells (48 volts, nominal) or less segments for maintenance by qualified personnel. Non-load-break bolted or plug-in disconnects are permitted. (LAEC 690.71(E))

E. Wiring Method:

- 1. Wires used in PV system shall be of a type indicated in NEC 690.31(B). Indicate the wires intended to be used on this installation. (LAEC 690.31(B))
- 2. DC source and output circuits of a utility-interactive inverter must be installed in approved metallic raceways or enclosures from the point of penetration of the surface of the building or structure to the first readily accessible disconnecting means. (LAEC 690.31(D))
- 3. Ungrounded source and output circuits shall be provided with disconnects, overcurrent protection(s), ground-fault protection(s) and listed inverter or charge controller for the purpose as required in section 690.35 of LAEC. (LAEC 690.35)
- 4. The ungrounded source and circuit conductors shall be consist of sheathed (jacketed) multi-conductor cable or shall be in an approved raceway. (LAEC 690.35(D))

F. Grounding:

- 1. Indicate if the components of the system are negatively or positively grounded. (LAEC 93.0207)
- 2. Provide a solidly grounded or other approved equivalent methods of system grounding for a grounded system. (LAEC 690.41)

- 3. The DC circuit grounding shall be made at a single point on the photovoltaic output circuit. (LAEC 690.42)
- 4. Exposed non-current-carrying metal parts of module or panel frames, equipment and conductor enclosure shall be grounded in accordance with NEC 250.134 or 250.136(A) regardless of voltage. Provide information on the equipment grounding method. (LAEC 690.43)
- 5. The equipment-grounding conductor for the photovoltaic source and photovoltaic output circuits for roof-mounted DC photovoltaic array in dwellings shall be sized per section 250.122 of the Los Angeles Electrical Code. (LAEC 690.45)
- 6. Indicate grounding electrode system used for the AC, DC or combined AC/DC systems. (LAEC 690.47)
- 7. Provide detail drawing or indicate the method used to insure the removal of an equipment from the system shall not disconnect the (equipment grounding) bonding connection between the grounding electrode conductor and exposed conducting surfaces. (LAEC 690.48)
- 8. Provide detail drawing or indicate the method used to insure the removal of a DWP-interactive inverter or other equipment that does not disconnect(remove) the bonding connection between the grounding electrode conductor and the photovoltaic source and/or output circuit grounded conductor. (LAEC 690.49)

G. Ground Fault Protection:

- 1. Provided DC ground-fault protection for dwellings with roof mounted DC - PV arrays. (LAEC 690.5)
- 2. The AC side of PV inverter connected to the load side of a service or feeder disconnecting means containing ground-fault relaying and sensing equipment (GFRSE) protection shall be protected by a listed "Equipment Ground-Fault Protective Device (EGFPD)", located immediately on the AC output side of the inverter. (LAEC 690.64(B)(3)Exception)
- 3. All GFRSE and ground fault circuit interrupters must be listed for the back feed current when the AC side of an inverter(s) are connected to their load side. (LAEC 110.3(B))
- 4. The EGFPD shall not be installed in service equipment unless listed for such an installation. (LAEC 110.3(B))

H. Storage Batteries:

- 1. The storage batteries shall be installed in accordance with provisions of Article 480 and 702 of the Los Angeles Electrical Code. (LAEC 690.71, and Article 702)
- 2. In dwellings, provide information on how are the battery cells interconnected and what is their nominal operating voltage. (LAEC 690.71(B)(1))

- 3. Provide a listed current limiting overcurrent device at the output of each battery circuit. This device must have adequate short circuit interrupting rating and be able to reduce the available short circuit below the withstand rating of other equipment in that circuit.

(L A E C
690.71(C))
- 4. Battery systems consisting of more than twenty-four 2-volts cells connected in series (more than 48 volts, nominal) are permitted to operate with ungrounded conductors, provided the comply with the following:
 - a. The photovoltaic array source and output circuits are solidly grounded according to provisions of LAEC section 690.41.
 - b. The DC and AC load circuits are solidly grounded.
 - c. All main ungrounded battery input/output circuit conductors are provided with switched disconnects and overcurrent protection.
 - d. A ground-fault detector and indicator installed to monitor for ground faults in the battery bank.

(LAEC 690.71(G))
- 5. Provide either a battery charge control **OR** show that the photovoltaic source circuit is matched to the voltage rating and charge requirements of the interconnected battery cells.

(L A E C
690.72(A))
- 6. Flexible cords used from battery terminals to a nearby approved junction box shall be sized 2/0 AWG or larger.

(L A E C
690.74)

H. Systems Over 600 Volts:

- 1. The photovoltaic system with maximum system voltage of over 600 volts shall comply with Article 490 and other applicable over 600 volts installation requirements of the code.

(L A E C
690.80)
- 2. The voltage rating of battery circuit cable shall not be smaller than the charging or equalizing condition of the battery system.

(LAEC
690.8
1)

CALCULATIONS

- 1. Provide maximum system voltage calculation based on the expected ambient temperature of 14 to 31 °F.

(LAEC 690.7)
- 2. Provide maximum system open-voltage calculation based on manufacturer's instructions for photovoltaic power source modules made of materials other than crystalline or multi-crystalline silicon.

(LAEC 690.7(A), 93.0207, 93.0402)
- 3. Provide maximum DC circuit current calculation for each PV source circuit.

(L A E C
690.8(A)(1))
- 4. Provide the maximum DC current calculation for each PV output circuit.

(LAEC 690.8(A)(3))

- 5. Provide fault current calculation from Department of Water Power side to the AC disconnect(s) and inverter(s). (93.0207)
- 6. Provide calculations to determine the minimum overcurrent protection device rating for the DC side. Photovoltaic system currents shall be considered as continuous. (LAEC 690.8(B), 690.8(B)(1), 690.8(B)(2))
- 7. Provide proper size conductors, between inverter output of the stand alone systems and the building or structure disconnecting means, between the inverter output of stand-alone systems and the building or structure based on the output rating of the inverter and protected in accordance with Art. 240. (LAEC 690.10(B))
- 8. For flexible cords and cables exposed to direct sunlight the ampacities shall be derated by the correction factors given in Table 690.31(C) for an ambient temperature of 36-40 °C. (LAEC 690.31(C))
- 9. For conductors exposed to direct sunlight the ampacities shall be derated by the correction factors given in Table 310.16 for an ambient temperature of 36-40 °C. (LAEC 310.15(A)(2))
- 10. Provide calculation showing the size of equipment-grounding conductor for the photovoltaic source and photovoltaic output circuits sized at not less than 125% of the short circuit from the photovoltaic source. (LAEC 690.45)
- 11. Provide calculation showing the required maximum charging current of the interconnected battery cells. (LAEC 690.72(A))
- 12. Provide calculation for ampacity of the neutral conductor of a 2-wire inverter output connected to the ungrounded conductors of a 3-wire or a 3-phase, 4 wire systems. (LAEC 690.62)
- 13. For other than dwelling units, provide the sum of the ampere ratings of all overcurrent devices in circuits, connected on the load side of service disconnecting means, supplying power to a busbar or conductor. The sum shall not exceed the rating of the busbar or conductor. (LAEC 690.64(B)(2))
- 14. For dwelling units, provide the sum of the ampere ratings of overcurrent devices in circuits, connected on the load side of service disconnecting means, supplying power to a busbar or conductor. This sum shall not exceed 120% of the rating of the busbar or conductor. (LAEC 690.64(B)(2) Exception)
- 15. Provide calculation showing the total DC leakage current in the DC ground or DC grounded circuits in non-isolated photovoltaic systems does not exceed the EGFPD leakage current trip setting. (LAEC 110.3(A), 93.0207)
- 16. Provide calculation showing the required current and voltage ratings of DC diversion charge controller and diversion load in a circuit. (LAEC 690.72(B)(1))

- 17. Provide calculation showing the required conductor ampacity and overcurrent protective device rating for circuits containing DC diversion charge controller and diversion load.
(L A E C
690.72(B)(2))
- 18. Provide calculation showing if expansion fittings are not required for the roof mounted raceways due to thermal expansion or building expansion joints if the raceway is used as equipment grounding conductor.
(LAEC 300.7(B) and
352.44)

NOTES ON PLANS

- 1. Indicate the PV Electrical System Type, KW rating, and list all associated components.
- 2. Indicate the number of PV cells and modules in each PV Array.
- 3. Indicate the PV modules manufacturer's name, model or catalog number, physical size, weight and supporting means.
- 4. Indicate the following information on the DC side of the inverter in PV system:
 - a. Input Voltage,
 - b. Maximum Open circuit Voltage,
 - c. Maximum Input Current,
 - d. Maximum DC power,
 - e. Maximum Short Circuit Current,
 - f. Maximum Permitted system Voltage,
- 5. Indicate the manufacturer's name, model designation, complete electrical ratings (AC and DC), fault current withstanding and recognized listing agency name for each Inverter Unit.
- 6. Indicate the following AC output values of the PV system:
 - a. Maximum Output Power,
 - b. Nominal Output Power,
 - c. Operating range, utility voltage,
 - d. Maximum continuous Output Current,
 - e. Frequency Operating range,
 - f. Total Harmonic Distortion,
 - g. Maximum Efficiency,
 - h. Maximum allowable overcurrent protection.
- 7. Indicate the operating temperature range of the system.
- 8. Indicate on the plans that all PV system components shall be listed by a recognized testing agency (i.e., UL 1741, etc).
- 9. Indicate on the plans that the wiring material shall be suitable for the sun exposure and wet locations. Field applied protective coatings are not acceptable.
- 10. Indicate the maximum series fuse type and rating for each array.
- 11. Indicate on the plans that where the terminal of the disconnecting means may be energized in the open position, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and have the following words or equivalent: "WARNING - ELECTRIC SHOCK HAZARD, DO NOT TOUCH TERMINALS. TERMINALS ON THE BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN

POSITION. “

(LAEC 690.17)

- 12. Indicate on the plans that signs shall be posted adjacent to each PV disconnect and inverter to indicate, “ Photovoltaic SYSTEM”.
- 13. Indicate on the plans that all PV modules and associated equipment and wiring material shall be protected from any physical damage.
- 14. Indicate on the plans, that in one- and two-family dwelling, live parts in PV source circuits and PV output circuits over 150 Volts to ground shall not be accessible to other than qualified persons while energized. (LAEC 690.7(D))
- 15. Indicate on the plans that all field installed junction, pull and outlet boxes located behind modules or panels shall be accessible directly or by displacement of a module(s) or panel(s) secured by removable fasteners. (LAEC 690.34)
- 16. Indicate on the plans that in an ungrounded PV system, the power source shall be labeled with the following warning at each junction box, combiner box, disconnect and device where the ungrounded circuits may be exposed during service: “ WARNING - ELECTRIC SHOCK HAZARD. THE CURRENT CIRCUIT CONDUCTORS OF THIS PHOTOVOLTAIC POWER SYSTEM ARE UNGROUNDED BUT MAY BE ENERGIZED WITH RESPECT TO GROUND DUE TO LEAKAGE PATHS AND/OR GROUND FAULTS.” (LAEC 690.35(F))
- 17. Each side of a power transformer shall be considered as primary and protected in accordance with LAEC 450.3. (L A E C 690.9(B))
- 18. The grounded conductors of battery circuits consisting of more than twenty four 2-volts cells connected in series string (48 volts, nominal) shall have provisions to disconnect them into 24 cells (48 volts, nominal) or less segments for maintenance by qualified personnel. The disconnects shall only be accessible to qualified personnel. A non-load-break-rated switch is permitted. (LAEC 690.71(F))
- 19. Single-conductor cable types SE, UF, USE and USE-2 are permitted to be used in the source circuits when installed in the same manner as Type UF multiconductor cable in accordance with Part II of Article 340. (LAEC 690.31(B))
- 20. Removal of a DWP-interactive inverter or other equipment shall not disconnect the bonding connection between the grounding electrode conductor and the photovoltaic source and/or output circuit grounded conductor. (L A E C 690.49)
- 21. The roof mounted photovoltaic modules, panels or solar voltaic roll roofing material shall have the same or better listed fire-resistance rating than the building roof-covering material. (LAEC 110.3(B))