TUSTIN…

Proud of its Heritage, Preparing for its Future…

August 2015

USER GUIDE FOR THE INSTALLATION OF PHOTOVOLTAIC SYSTEMS

PURPOSE
This user guide provides information as to the City of Tustin requirements for the installation of photovoltaic systems.

BACKGROUND
California Assembly Bill (AB) 2188 required local governments to adopt a solar ordinance by September 30, 2015 that created a streamlined permitting process for small residential rooftop solar systems. By improving the efficiency of solar permitting statewide, AB 2188 was intended to help lower the cost of solar installations and further expand the accessibility of solar to more California homeowners who want to control their electricity bills and generate their own clean energy. In addition, making solar energy more affordable will help the State reach its renewable energy and greenhouse gas reduction goals.

On July 21, 2015, the Tustin City Council adopted Ordinance No. 1456 to comply with state law. Ordinance No. 1456 creates an expedited, streamlined permitting process for solar PV and solar thermal systems consistent with the goals and intent of the California Solar Rights Act and substantially conforms to the recommendations, standard plans, and checklists found in the Office of Planning and Research's Solar Permitting Guidebook. Plan check for small photovoltaic projects (submitted with complete information) will be completed and permits or authorizations issued within three days.

In addition, Ordinance No. 1456 provides an expedited inspection process. Only one inspection will be required for installations eligible for expedited review unless corrections occur at the time of that inspection. It is the Building Division's current practice to perform all inspections within 24 hours of request.

SUBMITTAL REQUIREMENTS
A building and/or electrical permit **is** required for the installation of any photovoltaic system.

Pursuant to AB 2188 and Ordinance No. 1456, the Building Division has established a checklist of all requirements with which small rooftop solar energy systems shall comply to be eligible for expedited review, as well as the standard plan and submittal documents necessary for expedited permit review. Ordinance No. 1456, the checklists and plan requirements are also consistent with guidance provided by the Governor's Solar Permitting Task Force (California Solar Permitting Guidebook), and the California Building Officials' (CALBO) model ordinance and analysis of Assembly Bill 2188.

Future applications for Solar PV which meet simplified conditions as established by AB 2188 shall "substantially conform" to the checklist and standard plan and submittal requirements. In other words, once the City completes plan check and confirms that the application and supporting documents are complete and meet the requirements of the checklist, all required permits or authorizations will be issued. Best practices dictate this review process should take not more than three (3) days.

Online permitting is a best practice. On a case by case basis, the Division is willing to accept faxed or emailed photovoltaic system plan submittals that meet the checklist and standard plan and submittal requirements provided in this handout.

Only one (1) inspection will be required for installations eligible for expedited review unless corrections occur at the time of that inspection. Pre-inspections or rough inspections will not be required. The Building Division's current practice is to perform all inspections within 24 hours of request.

The following guidance documents are available (below) for the preparation and submittal of a photovoltaic system permit application for one- and two-family dwellings.

- Project Processing
- PV Submittal Checklist
- Submittal Requirements
- City of Tustin Residential PV Standard Notes
- String Inverter Systems
- Micro-Inverter and AC Module Systems
- Optimizer Systems
- Common Inspection Guidelines

City of Tustin
Community Development Department
300 Centennial Way
Tustin, California 92780
(714) 573-3131 or 573-3132

Staff is available to answer your questions during office hours between 7:30 a.m. and 5:30 p.m. Monday through Thursday and 8:00 a.m. to 5:00 p.m. on Fridays.

OTHER USER GUIDES AVAILABLE

Signs
Pools and Spas
Residential Room Additions
Temporary Use Permits
Gazebos and Patio Covers
Reroofing
Furnaces
Water Heaters
Wood and Metal Fences
Masonry Fences & Walls
Patio Slabs and Walkways
Suspended Ceilings
Drywall Installation
Commercial Tenant Improvements
Retaining Walls
Chain Link Fences

PREPARED BY THE CITY OF TUSTIN
COMMUNITY DEVELOPMENT DEPARTMENT

PRINTED ON RECYCLED PAPER

SOLAR PHOTOVOLTAIC SYSTEMS for ONE– and TWO-FAMILY DWELLINGS

Project Processing

October 2015

City of Tustin forms referenced in the sections below are available at:
the Tustin Building Counter (City Hall, 300 Centennial Way, Tustin 92780) and
on-line at www.TustinCA.org

Submittal Requirements

1. Complete the City of Tustin Building Permit Application form.
2. Comply with the Solar Photovoltaic Systems for One and Two Family Dwellings Submittal Requirements.
3. Project documents may be submitted in person or by email. (See Contact Information section below.) Other types of electronic submittal will be available soon.

Review and Approval Requirements

1. The submitted documents will be screened for meeting qualifications of expedited plan review. Any submittal that does not meet those requirements will be returned to the applicant without being reviewed.
2. Submitted documents that do meet the qualifications of an expedited review will be checked and returned within one (1) to three (3) business days. Those submittals that meet all requirements will be approved and issued. Those submittals that do not meet all the requirements will be returned with a correction list of items to change to meet requirements.

Plan Review

See referenced sheets for additional information on design and installation of PV systems:

1. PV Submittal Requirements
2. City of Tustin Residential PV Standard Notes (to be included in the plans)
3. Calculation worksheets (to be included in the plans) for
   - String Inverter Systems
   - Optimizer Systems, and
   - Micro-Inverter and AC Module Systems

Fees

Fees will be determined by the Permit Technicians. Please call 714-573-3131 or 714-573-3132.

Inspection

Inspection request line: 714-573-3141

1. Once all permits to construct the solar installation have been issued and the system has been installed, it must be inspected before final approval is granted for the solar system.
2. An on-site inspection shall be scheduled by contacting the Building Office in person, by telephone (see the request line above), or electronically through the Building Office's website.
3. Inspection requests received before 4 PM are typically scheduled for the next business day. If the next business day is not available, the inspection will be scheduled within the next three business days.
4. For the inspection to be considered ready, the installation shall be complete, including all labeling. Approved plans, inspection card, a safety ladder and any other safety equipment needed to access the installation shall be available on-site.
5. A knowledgeable PV contractor's representative shall be on-site to answer any question the inspector may have.
6. If the inspection is not approved, a Correction Notice will be given to the PV contractor's representative. Deficiencies shall be corrected and a re-inspection shall be scheduled. If a re-inspection fee is noted, the fee shall be paid at the Building Office before the next inspection will be scheduled.

City Contact Information

Community Development Department
Building Division
300 Centennial Way
Tustin, CA 92780

Building Office phone: 714-573-3131
Building Office fax line: 714-573-3129

Email: PVSubmittals@TustinCA.org

PV SUBMITTAL CHECKLIST

Please upload the following documents **SEPARATELY** when submitting Photovoltaic plans on line.

1. Permit Application; filled.
2. Photovoltaic Plans signed, stamped and dated.
3. Electrical calculation work sheets; filled.
4. Structural calculations signed, stamped and dated by Civil/Structural Engineer.
5. PV modules manufacturer's specification sheets.
6. Inverter manufacturer's specification sheets.
7. Anchor system and racks manufacturer's documentations.
8. Fire classification certification for the rack and module assembly.

SOLAR PHOTOVOLTAIC SYSTEMS for ONE– and TWO-FAMILY DWELLINGS

Submittal Requirements

September 2015

Administrative

1. Submit three complete sets of plans.
2. Incorporate the City of Tustin Residential Photovoltaic Standard Notes into the plans, on the same size sheet as the plans.
3. The plans shall be prepared by a licensed B, C-10 or C-46 contractor only if the permit is issued to that same contractor. Otherwise, the plans shall be prepared by a licensed electrical engineer and issued to any one of those licensed contractors. Provide signature, date signed, name and contractor's license number on each sheet.
4. Provide Project Information on the cover sheet:
    a. Occupancy Group: R3/U (one- and two-family dwellings/private garage)
    b. Type of Construction: V-B (wood construction)
    c. Number of Stories: Two-story, maximum
    d. Construction shall comply with the 2013 CRC, CBC, CEC and CFC.
5. Provide site plan drawn to scale. Show:
    a. Location and size of all structures on the lot.
    b. Show north arrow.
    c. Distances (setbacks) between buildings and property lines.

Roof Plan

6. Provide a partial roof framing plan.
   ALTERNATE: Framing information is not required if arrays are supported at a maximum spacing of 4 feet in each direction.
7. Provide three feet clear access on the roof per OCFA Examples 1 through 4, attached.
8. Provide calculations by a licensed civil/structural engineer or architect to verify supporting members are adequate for existing and proposed loads.
   ALTERNATE: Calculation is not required if arrays are supported at a maximum spacing of 4 feet in each direction and the maximum cantilever distance of panels is 18".
9. Detail equipment support connections to roof. Provide a detail for flashing and waterproofing at system supports. (Stamped by a licensed civil/structural engineer.)
10. Provide a detail to show the riser height of the PV panel from the roof surface. Riser height shall be less than 8 inches.
11. Provide manufacturer's documentation and calculations for anchor system and racks.

12. Provide lateral calculations by a licensed professional engineer or architect showing that affected existing lateral resisting elements are no more than 10% overstressed according to the 2013 CBC.
    ALTERNATE: Lateral analysis is not required if total area of arrays is less than 250 sq. ft. over a second story roof or 350 sq. ft. over a first story roof.

Electrical

13. Effective January 1, 2015, where Class A or Class B roofing assembly is required, the photovoltaic solar system (photovoltaic panels with the rack support system) shall have a Class A or Class B fire rating, respectively, complying with UL 1703. Provide approved certificates to verify the fire classification of the photovoltaic assembly.
14. PV systems operating at 80 volts or greater shall be protected by a listed DC arc-fault circuit interrupter. CEC 690.11. (Does not apply to Micro-Inverter or AC Module systems.)
15. Show the location and size of main electrical service, AC/DC disconnects and all solar photovoltaic equipment and PV array on the roof plan.
16. Provide single line diagram showing array configuration, conductor and conduit size and type with calculations as shown in calculation sheets for Single Inverter system, Optimizer system, Micro-Inverter system or AC Modules.
17. AC breaker to be sized no more than the next standard breaker size up from the required circuit conductor AC ampacity, between inverter and main panel. CEC 240.4(B) and CEC 240.6(A)
18. Bus Rating: CEC Art. 705.12(D)(2) states that the sum of the ampere ratings of the overcurrent devices in circuits supplying power to a busbar or conductor shall not exceed 120% of the rating of the busbar or conductor.
19. Provide all inverter and photovoltaic manufacturer's specifications and listing.
20. Specify the solar modules' grounding lugs' manufacturer's name, model #, and UL approval report number on plans. (CEC Arts. 690.43, 690.45, 690.48, 250.122 and 250.136.)
21. Use #8 bond wire from Service panel to rooftop, then #6 bare copper on rooftop where exposed. (CEC Art. 250.120)
22. Smoke detectors and carbon monoxide alarms shall be installed per CRC 2013.

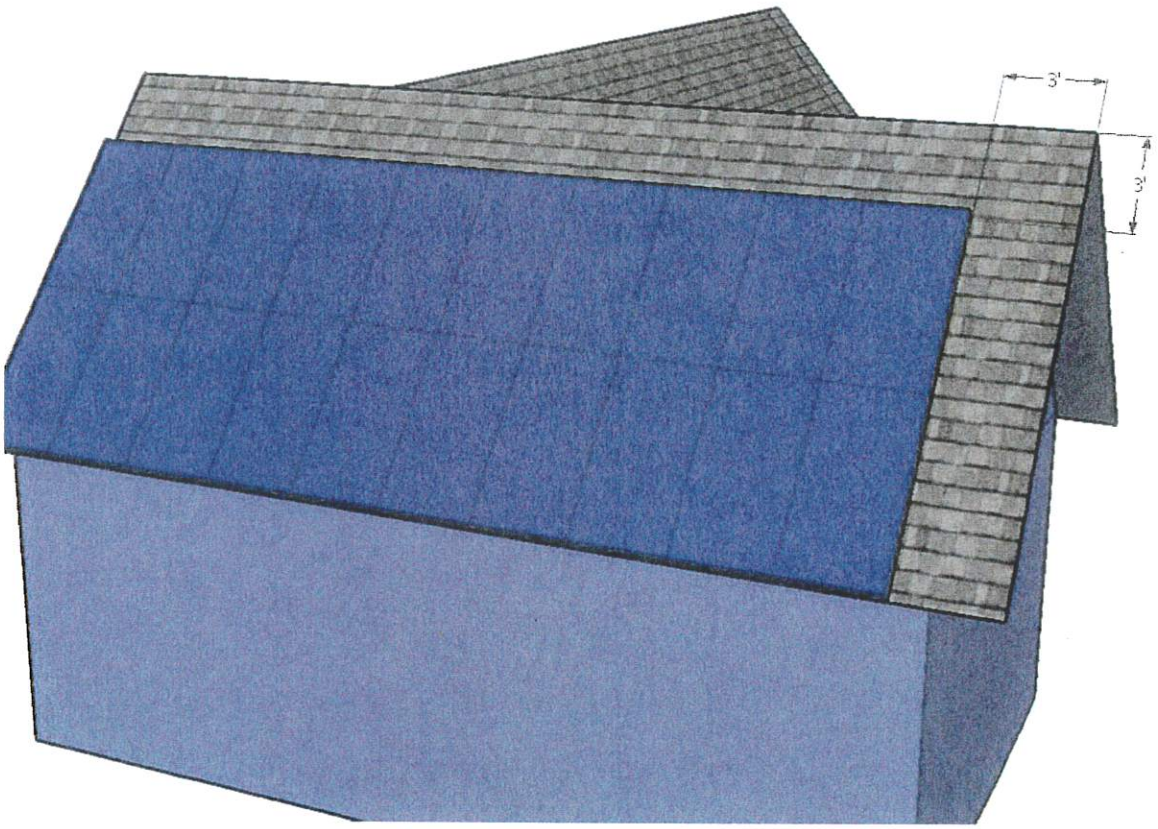
Calculations

23. Print and complete the calculation worksheet that applies to your project from the list below. Attach a copy of the completed worksheet to each set of plans submitted.
    a. String Inverter
    b. Micro-Inverter
    c. Optimizer

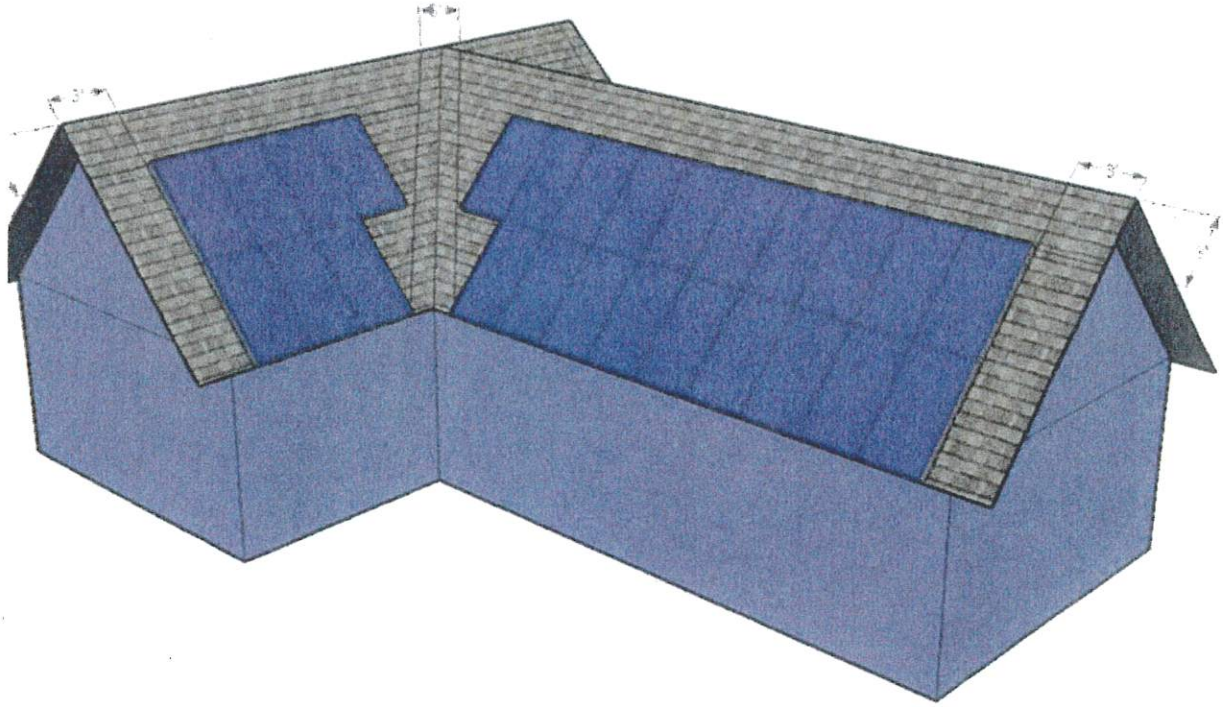
Roof Clear Access Path way

24. See following typical layout options.

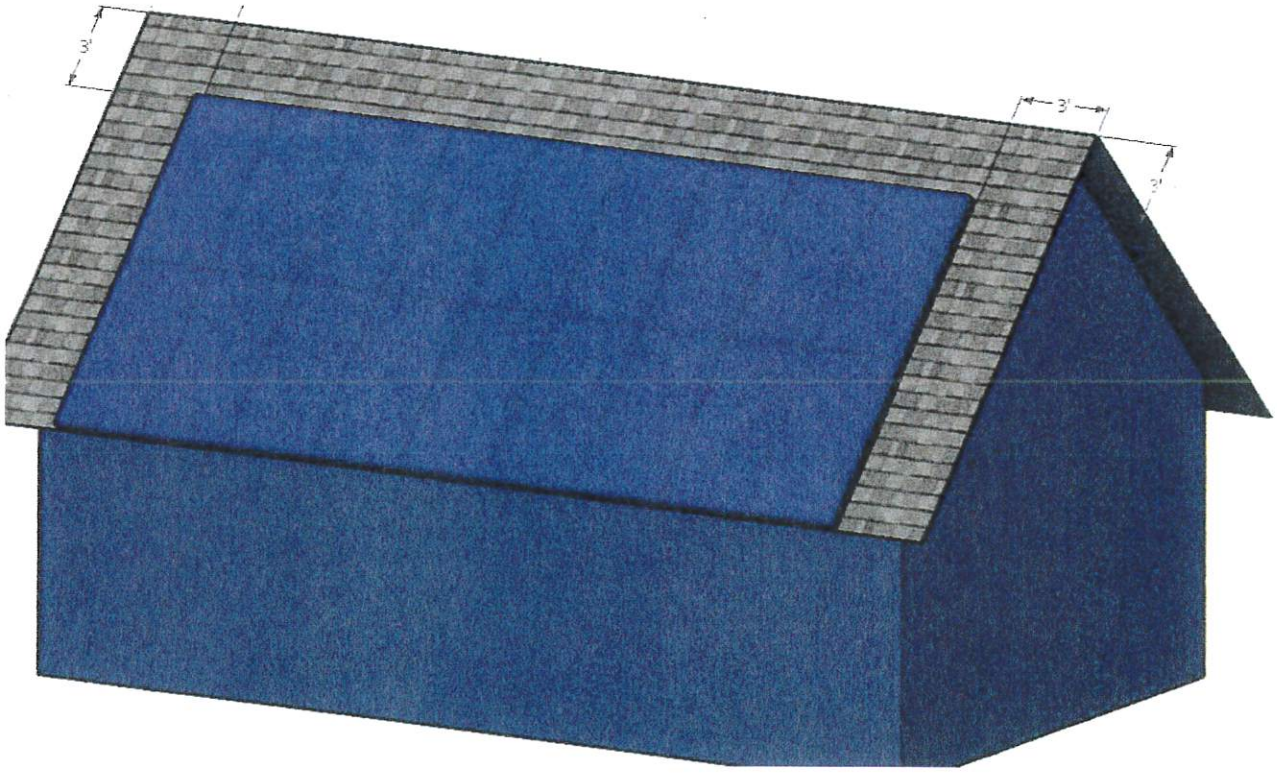
Example 1, CROSS GABLE ROOF



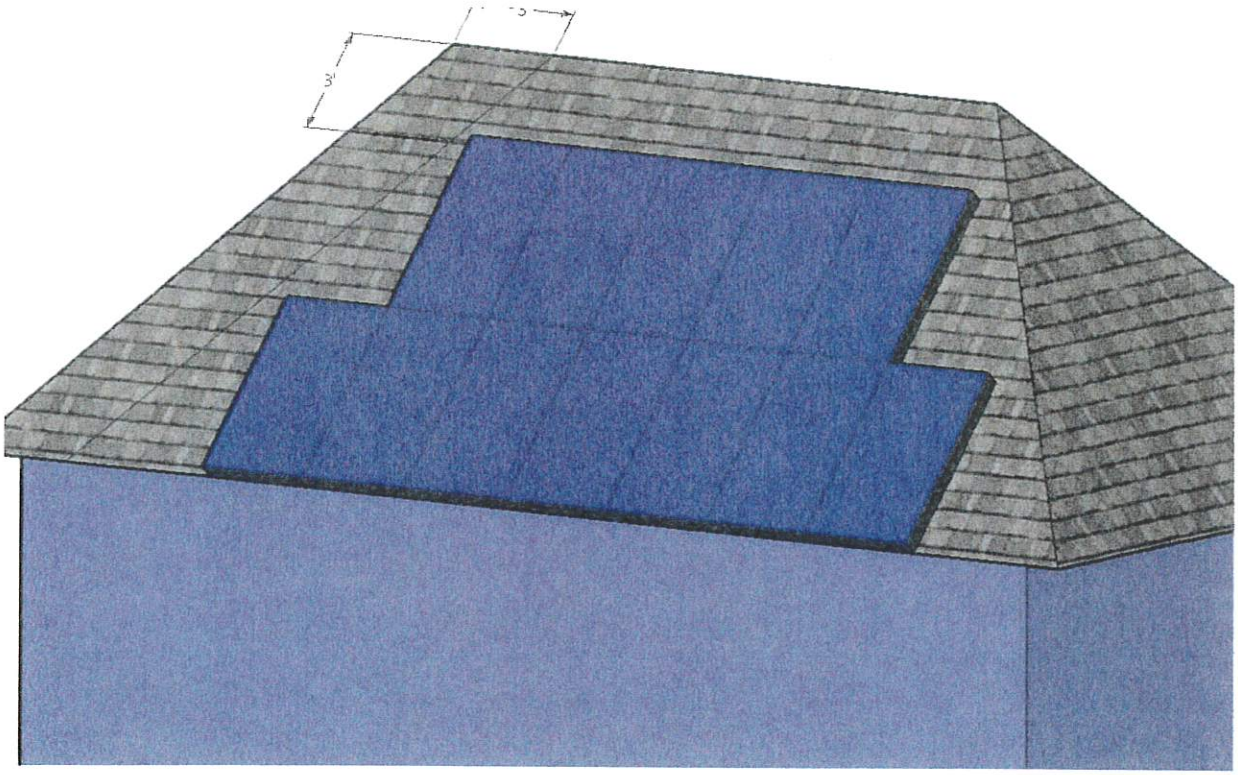
Example 2, CROSS GABLE WITH VALLEY



Example 3, FULL GABLE



Example 4, **FULL HIP ROOF**



TUSTIN

BUILDING OUR FUTURE
HONORING OUR PAST

COMMUNITY DEVELOPMENT DEPARTMENT
BUILDING DIVISION

RESIDENTIAL PHOTOVOLTAIC STANDARD NOTES

The standard notes listed below will supersede the information on plans when applicable (The code sections referenced are from the 2013 CEC u.n.o.)

1) Contractor shall be present to assist City inspector on job site during inspection. Safety equipment shall be available on site and provided upon request by the City inspector.
2) The City of Tustin will not be held responsible for roof damage that may result from accessing the roof for the inspection of the PV system.
3) Contractor shall verify existing smoke and carbon monoxide detectors are in good working order and provide missing smoke and carbon monoxide alarms per CRC Sections R314 & R315.
4) If the inverter is not installed at a readily accessible location (i.e., on the roof) (690.14D), then all the following apply:
   a. Both AC & DC disconnects shall be mounted within sight of the inverter;
   b. An additional AC disconnect shall be provided at a readily accessible location;
   c. A permanent plaque or directory denoting all electrical power sources on or in the premises shall be installed at each service equipment location and at locations of all electrical power production sources capable of being interconnected (705.10).
5) The sum of the ampere ratings of the over current devices in circuits supplying power to a bus bar or conductor shall not exceed the rating of the bus bar or conductor (705.12(D)(2)).
6) Module frames and racking systems shall be grounded at UL-listed locations provided by the manufacturer using UL-listed grounding lugs. The removal of one panel shall not interrupt the continuity of the grounding system for the rest of the panels or racking system (690.43).
7) Metallic mounting structures, other than building steel, used for grounding purposes shall be identified as equipment-grounding conductors or shall have identified bonding jumpers or devices connected between the separate metallic sections and shall be bonded to the grounding PV modules.
8) DC grounding electrode conductor. If the existing AC grounding electrode is a concrete encased electrode, the DV GEC shall be a #6 THWN-2 per 250.166 (D). The GEC shall be continuous as described in 250.64(C).
9) Grounding electrode conductor from the AC side on the inverter sized according to Table 250.66 (#8 minimum).
10) Signage required by 690.5 (C) at the ground-fault indicator stating that if a ground fault is indicated, the normally grounded conductors may be energized and ungrounded (690.5 (C).
11) DC ground-fault protection shall be per 690.5.

12) The equipment and system in 690.4(A) through (D) and all associated wiring and interconnections shall be installed only by qualified persons.
13) All equipment requiring servicing shall meet the required clearances of 110.26.
14) A permanent plaque shall be placed at the point of interconnection stating the MAXIMUM AC OUTPUT OPERATING CURRENT and the OPERATING AC VOLTAGE. (690.54)
15) Commercial projects will require a permanent plaque at main service showing the location of the main service disconnect, PV AC disconnect, and DC disconnects on the roof.
16) Provide permanent signage at **all AC disconnects**. "PHOTO VOLTAIC ARRAY AC DISCONNECTS". (690.14 (C) (2))
    a. The markings may be placed within the main service disconnect. If the main service disconnect is operable with the service panel closed, then the marking should be placed on the outside cover.
    b. A permanent warning label shall be applied to the distribution equipment with the following or equivalent: WARNING INVERTER OUTPUT CONNECTION DO NOT RELOCATE THIS OVERCURRENT DEVICE. 705.12(D)(7)
    c. Where the disconnecting means are located more than 6-feet from the overcurrent device, a directory showing the location of each disconnect shall be installed at the overcurrent device location.
    d. Red background, white lettering, minimum 3/8" letter height, all capital letters, Arial or similar font, non-bold, reflective weather resistant material suitable for the environment. (OCFA 1.1.1.1)
17) Marking DC conduits: Marking is required on all interior and exterior DC conduit, raceways, enclosures, cable assemblies, and junction boxes to alert the fire service to avoid cutting them. Markings ("CAUTION: SOLAR CIRCUIT") shall be placed every 10-feet, at turns and above and/or below penetrations, and all DC combiner and junction boxes.
    a. Marking shall be as follows: Red background, white lettering, minimum 3/8" letter height, all capital letters, Arial or similar font, non-bold, **Reflective weather resistant material** suitable for the environment.
18) If a switch or circuit breaker is to be used as the AC disconnect and all terminals are energized when in the open position, a label is to be placed at the AC disconnect indicating:

WARNING
ELECTRICAL SHOCK HAZARD – DO NOT TOUCH TERMINALS.
TERMINALS ON BOTH LINE SIDE AND LOAD SIDE
MAY BY ENERGIZED IN THE OPEN POSITION

19) All conduits and boxes are required to be painted to match the existing building color.
20) Provide a DC disconnect between the inverter and the array, unless an integrated inverter disconnect that separates from the inverter is provided. (690.14(C)
21) Conduit that is installed in the attic or concealed shall be a minimum of 18" below the top surface of the roof to prevent fire personnel from cutting the conduit in the event of a fire.

22) Inverter output connections. The connection in a panel board shall be positioned at the opposite end from the feeder location or main circuit location. A permanent warning label shall be applied to the distribution equipment with the following or equivalent marking: 705.12(D)(7)

WARNING - INVERTER OUTPUT CONNECTION
DO NOT RELOCATE THIS OVERCURRENT DEVICE

S:\Cdd\Building\PlanCheck\B\PV Standard Notes\PV STANDARD RESIDENTIAL, 2013.doc

SOLAR PHOTOVOLTAIC SYSTEMS for ONE– and TWO-FAMILY DWELLINGS

String Inverter Systems

September 2015

Complete these calculations and attach to the PV plans.

A. Specifications:

Module Manufacturer: _____ Model:_____

I_{sc} =_____ amps (module name plate)

V_{oc} =_____ volts (module name plate)

Module DC output power (STC) = _____ watts (module name plate)

# of modules in series = _____ # of arrays/strings in parallel = _____

a. Maximum PV DC voltage (CEC 690.7):

Maximum PV voltage = voltage correction factor x V_{oc} x # of modules in series

= 1.12 x _____ x _____ = _____ volts

CEC 690.7(C) requires the Max PV DC voltage to be Less than 600 volts

b. Maximum PV DC current (CEC 690.8)

Maximum PV current = 1.56 x I_{sc} x # of strings in parallel

1.56 x _____ x _____ = _____ amps

(1.25 x 1.25 = 1.56) Required by CEC 690.8(B)(1)(a) and -(B)(2)(a)

B. DC CONDUCTOR AMPACITY CALCULATIONS: *(Array to combiner box)* CEC 310.15

a. Expected wire temperature (Tustin) = 41°C or 105°F
Temperature correction = 0.87 CEC Table 310.15 (B)(2)(a)

b. Add 22°C or 40°F for **conduits exposed to sunlight on or above roof**
Temperature correction = 0.65 CEC Table 310.15 (B)(2)(a)

c. # of current carrying conductors = ____ (up to 8 conductors in roof-mounted conduits exposed to sunlight)

d. Conduit fill correction = 0.80 for 4 to 6 conductors in conduit; or
= 1.00 for 3 conductors or less, CEC Table 310.15 (B)(3)(a)

e. Circuit conductor size: _____ awg Min. #10 awg Cu, 90°C wet
(USE-2, PV wire, XHHW-2, THWN-2, RHW-2)

f. Circuit conductor ampacity = _____ amps CEC Table 310.15 (B)(16)

g. Required Circuit conductor ampacity: CEC 690.8 (A) information note

Required Circuit conductor ampacity =1.25 x 1.25 x I_{sc}

= 1.25 x 1.25 x _____ = _____amps

h. Derated ampacity of circuit conductor: CEC Table 310.15 (B)(2)(a)

*Derated ampacity of circuit conductor (amps) = **Temperature correction** x conduit fill **correction** x circuit conductor ampacity*

= 0.65 if exposed (or 0.87) x _____ x _____ = _____ amps

Note: "h" must be larger than "g" **Yes ___ No ___ (check one)**

C. DC CONDUCTOR AMPACITY CALCULATIONS: *(from combiner box to inverter)*

a. Ambient temperature adjustment, exposed conduit CEC Table 310.15 (B)(2)(a), CEC Table 310.15 (B)(3)(c)

Expected wire temperature (Tustin) = $41^{oC} + 22^{oC} = 63^{oC}$

Expected wire temperature (Tustin) = $105^{oF} + 40^{oF} = 145^{oF}$

Temperature correction = 0.65 CEC Table 310.15 (B)(2)(a)

or current carrying conductors: _____

Conduit fill correction = 0.80 (for 4 to 6 conductors in conduit)

or = 1.00 (for 3 or less conductors) CEC Table 310.15 (B)(3)(a)

Circuit conductor size: _____ awg

Circuit conductor ampacity: _____ amps

b. Required circuit conductor ampacity CEC 690.8(A) information note

Required circuit conductor ampacity = 1.25 x 1.25 x Isc x # of strings in parallel

= 1.25 x 1.25 x _____ x _____ = _____ amps

c. Derated ampacity of circuit conductors:

Derated ampacity of circuit conductors = Temperature correction x conduit fill correction x circuit conductor ampacity

= 0.65 if exposed (or 0.87) x _____ x _____ = _____ amps

Note: "c" must be larger than "b" **Yes ___ No ___ (check one)**

D. AC CONDUCTOR AMPACITY CALCULATION: *(between inverter and main electric panel)*

a. Ambient temperature adjustment, exposed conduit CEC Table 310.15 (B)(2)(a)

Expected wire temperature (Tustin) = 41^{oC} or 105^{oF}

Temperature Correction = 0.87 CEC Table 310.15 (B)(2)(a)

(= 1.00 if AC conductors are not on roof)

Circuit conductor size = _____ awg

# of current carrying conductors = _____

Conduit fill correction = 0.80 (for 4 to 6 conductors in conduit) CEC Table 310.15 (B)(3)(a)

or = 1.00 (for 3 or less conductors)

Circuit conductor ampacity = _____ amps

Inverter Model # _____

Inverter's maximum AC Output current (for 240 V) = _____ amps (per manufacturer's specification)

b. Required circuit conductor ampacity : CEC 690.8(A) information note

Required conductor ampacity = 1.25 x maximum inverter's output current (amps)

= 1.25 x _____ amps = _____ amps

c. Derated ampacity of circuit conductors:

Derated ampacity of circuit conductor = Temperature correction x conduit fill correction x Circuit conductor ampacity

= 0.87 x _____ x _____ = _____ amps

Note: "c" must be greater than "b" **Yes ___ No ___ (check one)**

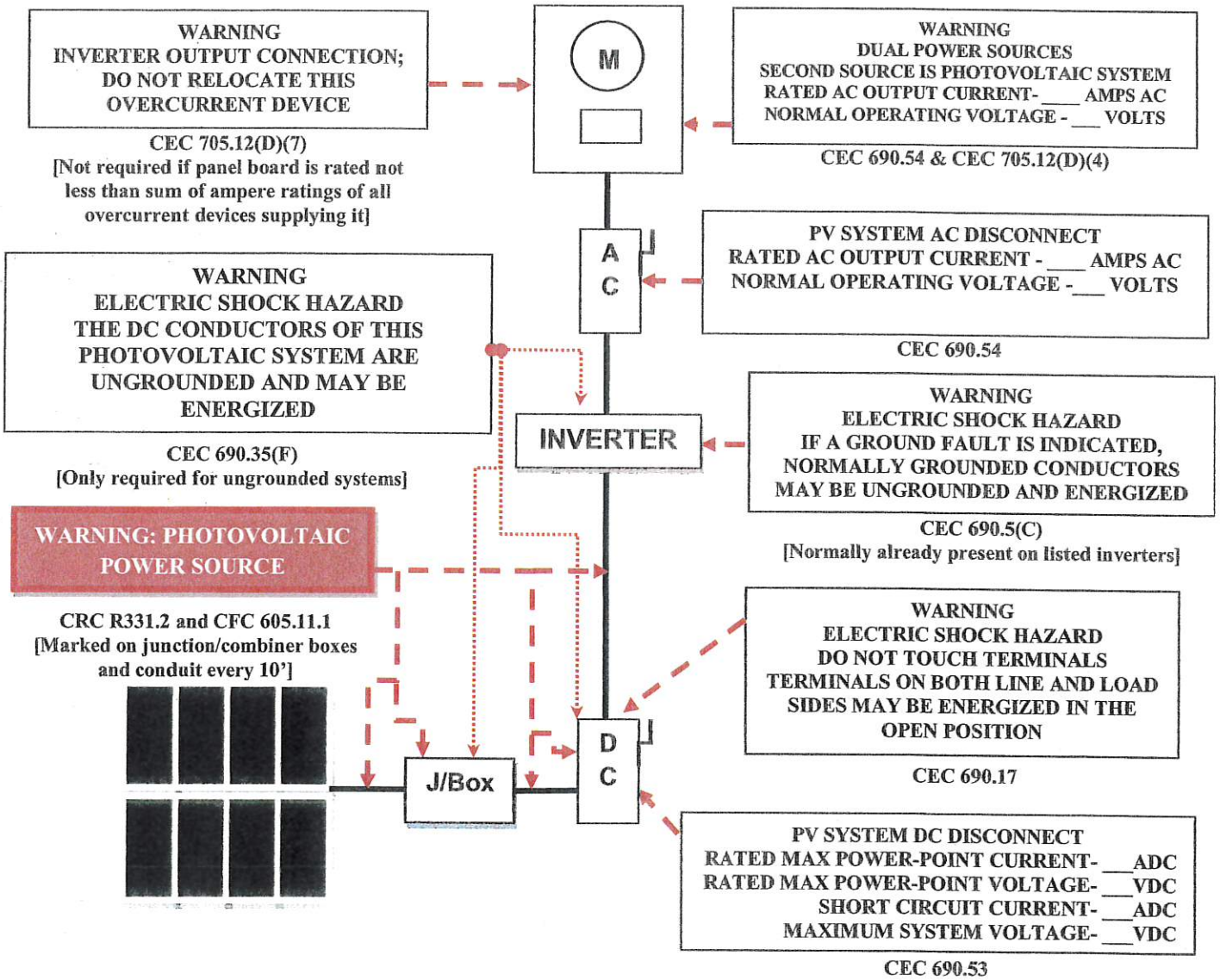
Show all the required signage and their location on the plans per CEC Art. 690.
(See next sheet for Markings)

SOLAR PHOTOVOLTAIC SYSTEMS for ONE- and TWO-FAMILY DWELLINGS

String Inverter Systems – Markings

September 2015

CEC Articles 690 and 705, CRC Section R331 and CFC Section 605 require the following labels or markings be installed at these components of the photovoltaic system:



Code Abbreviations:
CEC - California Electrical Code
CRC - California Residential Code
CFC - California Fire Code

Informational note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.

CEC 705.12 requires a permanent plaque or directory denoting all electric power sources on or in the premises.

SOLAR PHOTOVOLTAIC SYSTEMS for ONE- and TWO-FAMILY DWELLINGS

Micro-Inverter and AC Module Systems

September 2015

Complete these calculations and attach to the PV plans.

A. Specifications:

___ Micro-inverter (MI) ___ AC Module (ACM)

# of PV modules installed = _____ # of ACMs installed = _____

# of Micro-inverters installed = _____ *ACM is installed per CEC Art 690.6*

Module Manufacturer: _____ Model: _____

I_{sc} = _____ amps (module name plate)

V_{oc} = _____ volts (module name plate)

Module DC output power (STC) = _____ watts (module name plate)

Micro-inverter or ACM Manufacturer: _____ Model: _____

Rated (continuous) AC output power = _____ watts (MI or ACM specs)

Nominal AC voltage = _____ volts (MI or ACM specs)

Nominal AC output current = _____ amps (MI or ACM specs)

Maximum DC input voltage rating = _____ (for Micro-inverters only)

Total AC power rating = Rated (continuous) AC output power x total # of M. I. = _____

B. Adjusted PV DC voltage (CEC 690.7):

Adjusted PV DC voltage = 1.12 (voltage correction factor) x V_{OC}

Adjusted PV DC voltage = 1.12 x _____ = _____ volts

NOTE: Cannot exceed Maximum DC input voltage rating of Micro-inverters.

C. AC CONDUCTOR AMPACITY CALCULATIONS: *(Array to junction box)* CEC Art 310.15

a. Expected wire temperature (Tustin) = 41^{oC} or 105^{oF}
   Temperature Correction factor = 0.87 CEC Table 310.15(B)(2)(a)

b. Add 22^{oC} or 40^{oF} for **conduits exposed to sunlight on or above roof**
   Temperature Correction factor = 0.65 CEC Table 310.15 (B)(2)(a)

c. # of current carrying conductors = ____ (up to 8 conductors in roof-mounted conduits exposed to sunlight)

d. Conduit fill correction = 0.80 (4-6 conductors in conduit) CEC Table 310.15(B)(3)(a)
or = 1.00 (3 or less conductors in conduit)

e. Circuit conductor size: _____ awg Minimum #10 awg Cu, 90°C wet
(USE-2, PV wire, XHHW-2, THWN-2, RHW-2)

f. Circuit conductor ampacity = _____ amps CEC Table 310.15(B)(16)

g. Required Circuit conductor ampacity: CEC Art 690.8(A) information note

Required Circuit conductor ampacity = 1.25 x MI output current x # of MI

= 1.25 x _____ amps x _____ = _____ amps

h. Derated ampacity of circuit conductor: CEC Table 310.15(B)(2)(a)

Derated ampacity of circuit conductor (amps) =Temperature correction x conduit fill correction x circuit conductor ampacity

= 0.65 x _____ x _____ = _____ amps

NOTE: "h" must be larger than "g" **Yes ___ No ___ (check one)**

D. AC CONDUCTOR AMPACITY CALCULATIONS *(from combiner box/J-box to main panel)*

a. Ambient temperature adjustment, exposed conduit CEC Table 310.15(B)(2)(a)
CEC Table 310.15(B)(3)(c)

Expected wire temperature (Tustin) = $41^{oC} + 22^{oC} = 63^{oC}$

Expected wire temperature (Tustin) = $105^{oF} + 40^{oF} = 145^{oF}$

Temperature correction = 0.65 if exposed, or 0.87 CEC Table 310.15 (B)(2)(a)

# of current carrying conductors: _____

Conduit fill correction = 0.80 (4-6 conductors in conduit) CEC Table 310.15(B)(3)(a)
or = 1.00 (3 or less conductors in conduit)

Circuit conductor size: _____ awg

Circuit conductor ampacity: _____ amps

b. Required circuit conductor ampacity CEC Art 690.8(A) information note

Required Circuit conductor ampacity = 1.25 x MI output current x # of MI

= 1.25 x _____ amps x _____ = _____ amps

c. Derated ampacity of circuit conductors:

Derated ampacity of circuit conductors = Temperature correction x conduit fill correction x circuit conductor ampacity

= 0.65 (or 0.87) x _____ x _____ = _____ amps

NOTE: "c" must be larger than "b" **Yes ___ No ___ (check one)**

E. GROUNDING AND BONDING

Check one of the boxes for whether system is grounded or ungrounded:

Grounded ☐ Ungrounded ☐

For Micro-inverters with a grounded DC input, systems must follow the requirements of GEC (CEC 690.47) and EGC (CEC 690.43).

For ACM systems and Micro-inverters with an ungrounded DC input, follow the EGC requirements of (CEC 690.43).

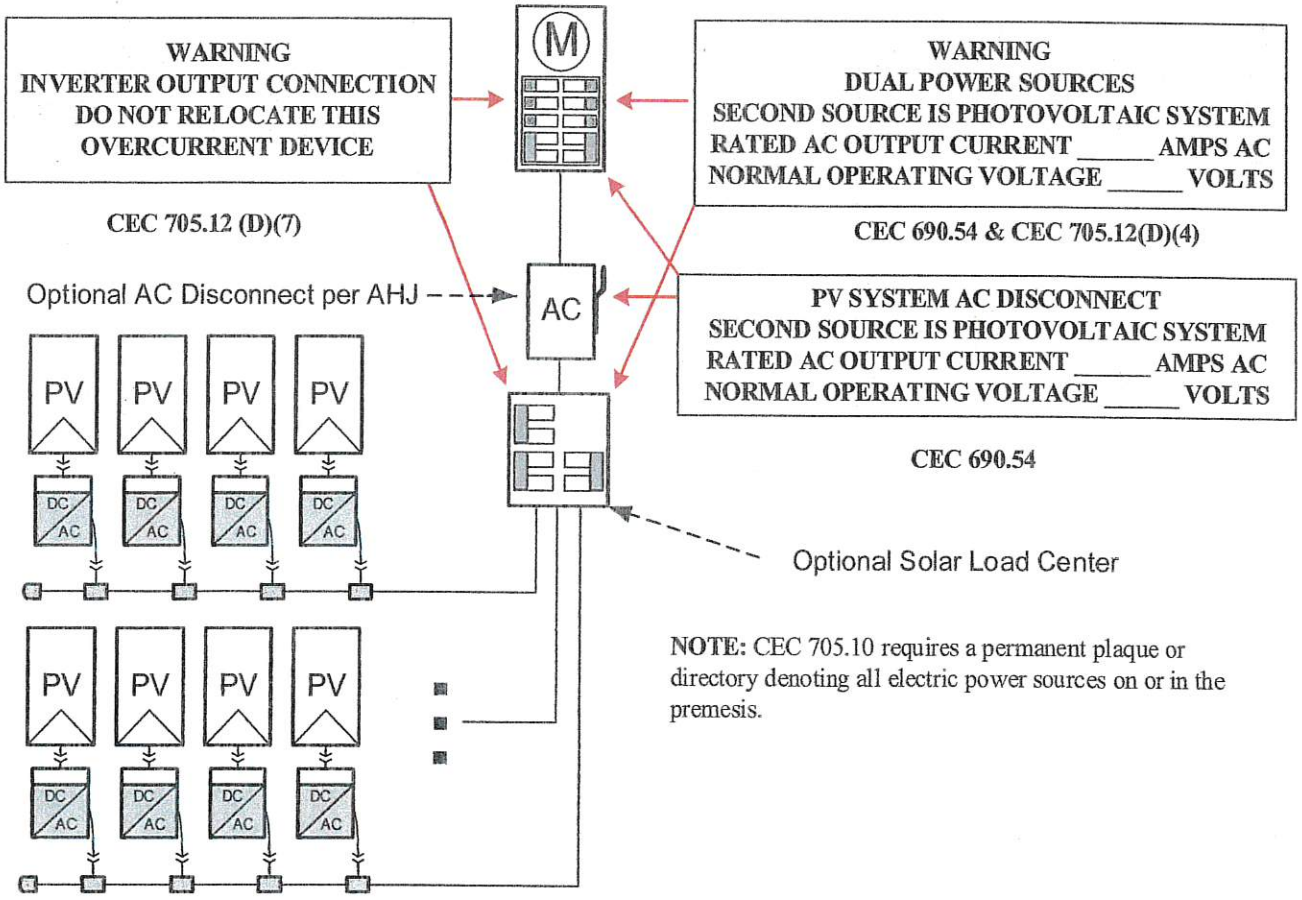
Show all the required signage and their location on the plans per CEC Art 690.
(See next sheet for Markings.)

SOLAR PHOTOVOLTAIC SYSTEMS for ONE- and TWO-FAMILY DWELLINGS

Micro-Inverter and AC Module - Markings

September 2015

CEC Articles 690 and 705, CRC Section R331 and CFC Section 605 require the following labels or markings be installed at these components of the PV system.



NOTE: CEC 705.10 requires a permanent plaque or directory denoting all electric power sources on or in the premesis.

Code Abbreviations:

CEC - California Electrical Code

CRC - California Residential Code

CFC - California Fire Code

Informational Note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20-point (3/8") should be considered the minimum.

SOLAR PHOTOVOLTAIC SYSTEMS for ONE- and TWO-FAMILY DWELLINGS

Optimizer Systems

September 2015

Complete these calculations and attach to the PV plans.

A. Specifications:

Module Manufacturer: _____ Model: _____

I_{sc} = _____amps (module name plate)

V_{oc} = _____ volts (module name plate)

Module DC output power (STC) = _____ watts (module name plate)

# of modules in series = _____ # of arrays/strings in parallel = _____

Optimizer Manufacturer: _____ Model: _____

Maximum Optimizer Output current: _____ (optimizer specifications)

Inverter Manufacturer: _____ Model: _____

Maximum Inverter Input current (for 240V system): _____ (inverter specifications)

Maximum Inverter Input voltage (for 240V system): _____ (inverter specifications)

a. Maximum PV DC voltage (CEC Art. 690.7):
Maximum PV DC voltage = Maximum inverter input voltage (inverter specifications)
CEC Art 690.7(C) requires the Maximum PV DC voltage to be less than 600 volts

b. Maximum PV DC current (CEC Art. 690.8)
Maximum PV DC current = Maximum Optimizer Output current (cannot exceed the inverter input current)

B. DC CONDUCTOR AMPACITY CALCULATIONS: *(Array to combiner box)* (CEC Art. 310.15)

a. Expected wire temperature (Tustin) = 41^{oC} or 105^{oF}
Temperature Correction factor = 0.87 CEC Table 310.15(B)(2)(a)

b. Add 22^{oC} or 40^{oF} for **conduits exposed to sunlight on or above roof**
Temperature Correction factor = 0.65 CEC Table 310.15 (B)(2)(a)

c. # of current carrying conductors = ____ (up to 8 conductors in roof-mounted conduits exposed to sunlight)

d. Conduit fill correction = 0.80 (for 4 to6 conductors in conduit) CEC Table310.15(B)(3)(a)
or = 1.00 (for 3 or less conductors in conduit)

e. Circuit conductor size: _____ awg Minimum #10 awg Cu, 90°C wet
(USE-2, PV wire, XHHW-2, THWN-2, RHW-2)

f. Circuit conductor ampacity = _____amps CEC Table 310.15(B)(16)

g. Required Circuit conductor ampacity:

Required Circuit conductor ampacity = Maximum Optimizer Output current (amps) (from optimizer specifications)

h. Derated ampacity of circuit conductor: CEC Table 310.15(B)(2)(a)

Derated ampacity of circuit conductor
= Temperature correction x conduit fill correction x circuit conductor ampacity
= 0.65 (or 0.87, if in free air) x _____ x _____ = _____ amps

Note: "h" must be larger than "g" **Yes ____ No ____ (check one)**

C. DC CONDUCTOR AMPACITY CALCULATIONS *(from combiner box to inverter)*

a. Ambient temperature adjustment, exposed conduit CEC Table 310.15(B)(2)(a)
CEC Table 310.15(B)(3)(c)

Expected wire temperature (Tustin) = 41^{oC}+ 22^{oC} = 63^{oC}
Expected wire temperature (Tustin) = 105^{oF}+ 40^{oF} = 145^{oF}
Temperature correction = 0.65 CEC Table 310.15 (B)(2)(a)
# of current carrying conductors: _____
Conduit fill correction = 0.80 (for 4 to 6 conductors in conduit) or
or = 1.00 (if 3 or less conductors) CEC Table 310.15(B)(3)(a)
Circuit conductor size: _____ awg
Circuit conductor ampacity: _____ amps

b. Required circuit conductor ampacity:

Required circuit conductor ampacity = Maximum inverter Input current (amps) (from manufacturer's specifications)

c. Derated ampacity of circuit conductors:

Derated ampacity of circuit conductors = Temperature correction x conduit fill correction x circuit conductor ampacity
= 0.87 x _____ x _____ = _____amps

Note: "c" must be larger than "b" **Yes ____ No ____ (check one)**

D. AC CONDUCTOR AMPACITY CALCULATION: *(between inverter and main electrical panel)*

a. Ambient temperature adjustment, exposed conduit CEC Table 310.15 (B)(2)(a)

Expected wire temperature (Tustin) = 41^{oC} or 105^{oF}
Temperature Correction = 0.87 CEC Table 310.15 (B)(2)(a)
Circuit conductor size = _____ awg

# of current carrying conductors = _____

Conduit fill correction = 0.80 (for 4 or more conductors) or

or = 1.00 (for 3 or less conductors) CEC Table 310.15(B)(3)(a)

Circuit conductor ampacity = _____ amps CEC Table 310.15(B)(16)

Inverter Model # _____

Inverter's maximum AC Output current (for 240 V) = _____ amps (Inverter manufacturer's specifications)

b. Required AC conductor ampacity : CEC 690.8(A) information note

Required AC conductor ampacity

= 1.25 x Maximum inverter's output current (amps)

= 1.25 x _____ amps = _____ amps

c. Derated ampacity of circuit conductors:

Derated ampacity of circuit conductor

= temperature correction x conduit fill correction x circuit conductor ampacity

= 0.87 x _____ x _____ = _____ amps

Note: "c" must be greater than "b" **Yes ____ No ____ (check one)**

Show all the required signage and their location on the plans per CEC Art 690.

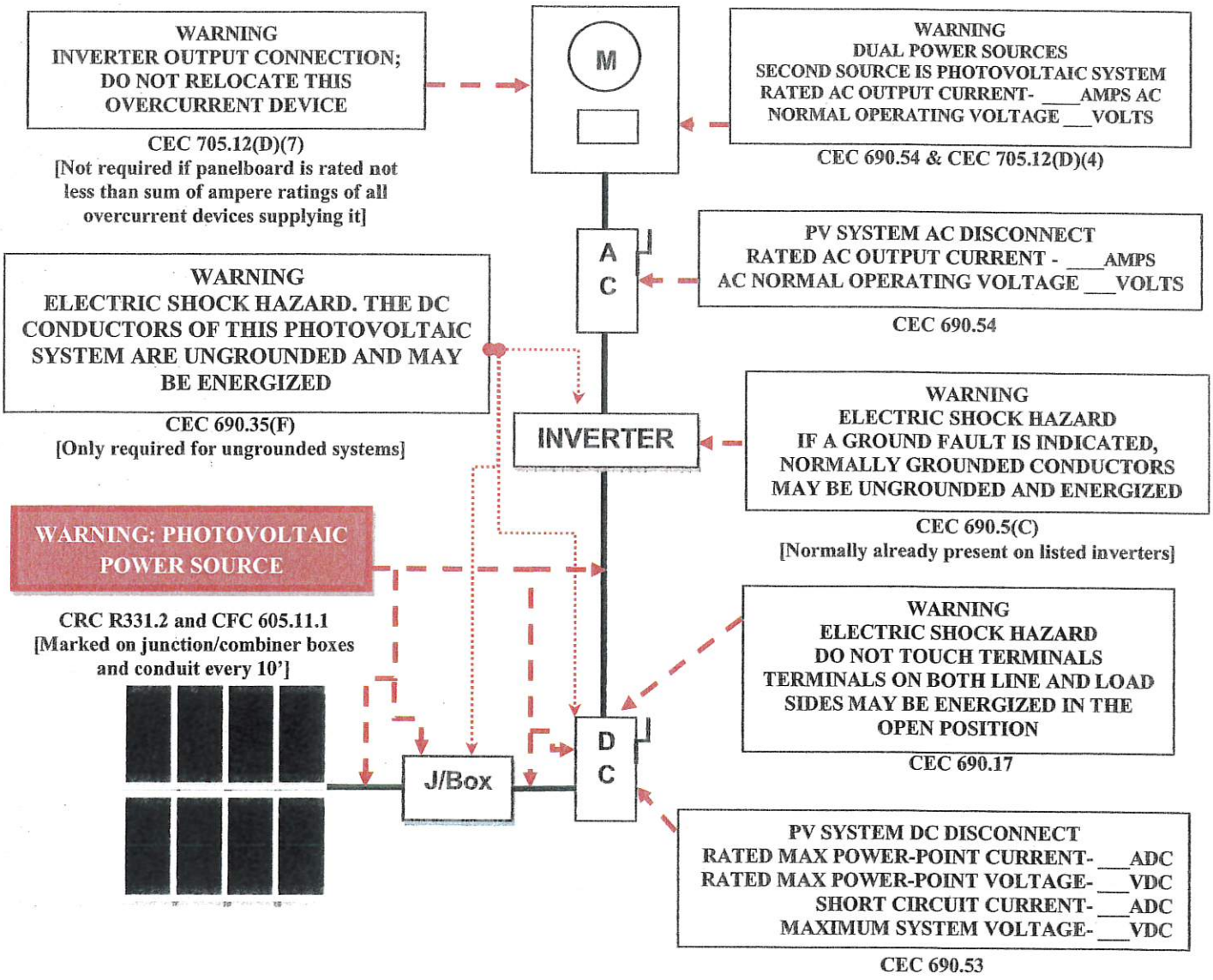
(See next sheet for Markings)

SOLAR PHOTOVOLTAIC SYSTEM for ONE- and TWO-FAMILY DWELLINGS

Optimizer Systems - Markings

September 2015

CEC Articles 690 and 705, CRC Section R331 and CFC Section 605 require the following labels or markings be installed at these components of the photovoltaic system:



Code Abbreviations:
California Electrical Code (CEC)
California Residential Code (CRC)
California Fire Code (CFC)

Informational note: ANSI Z535.4 provides guidelines for the design of safety signs and labels for application to products. A phenolic plaque with contrasting colors between the text and background would meet the intent of the code for permanency. No type size is specified, but 20 point (3/8") should be considered the minimum.

CEC 705.12 requires a permanent plaque or directory denoting all electric power sources on or in the premises.

SOLAR PHOTOVOLTAIC SYSTEMS for ONE– and TWO-FAMILY DWELLINGS

Common Inspection Guidelines

September 2015

Once all permits to construct the solar installation have been issued and the system has been installed, it must be inspected before final approval is granted for the solar system. On-site inspections can be scheduled by contacting the City of Tustin Building Division by

FAX at 714-573-3129, or ON LINE at www.TustinCA.org.

Provide the following information:

Permit number, Job address, Type of inspection, and Day or Date for the inspection.

Inspection requests received before 4 PM will made the following business day.

It is the duty of the person requesting the inspection to provide access to and means for inspecting the work.

The Contractor (or a knowledgeable superintendent) shall be on site for the inspection. If such knowledgeable person is not present, the inspection will be canceled and a re-inspection fee shall be paid prior to the next inspection request.

Preparation

1. The installation shall comply with the approved plans, details and specifications.
2. All work shall be done in a neat and workmanlike manner.
3. Approved plans, details, specifications and inspection card shall be on-site for the inspector's use at all times.
4. The contractor shall leave a safety ladder and other safety gear on site and in place for the inspector to gain access to the installation location on the roof.

Systems

Common items that will be checked are:

1. The type, model number, number and location of PV modules shall match the plans and specifications.
2. The array mounting system and structural connections are according to the approved plan.
3. Roof penetrations are flashed and sealed according to the approved plan.
4. Array exposed conductors are properly secured, supported and routed to prevent physical damage.
5. Firefighter access is according to approved plan.
6. The PV system has the required fire classification (equal or better than the roofing assembly).

7. Electrical boxes are accessible and connections are suitable for the environment.
8. The PV arrays are grounded according to the manufacturer's instructions and CEC.
9. For ungrounded inverters, the installation shall comply with CEC 690.35.
10. For grid-connected systems, the Inverter shall be labeled "utility interactive."
11. Conductors, cables and conduit types and sizes are labeled according to the approved plan.
12. Overcurrent devices are labeled according to the approved plan.
13. Disconnect devices are located and labeled according to the approved plan.
14. At the load center or service panel, the Inverter output circuit breaker is located at the opposite end of the bus from the utility supply end. This is not required if the sum of the inverter and the utility supply circuit breaker does not exceed the panel board bus rating.
15. Provide all required access and working spaces for the operation and maintenance of all PV equipment, except PV modules.
16. All PV system markings, labels and signage are according to the approved plan, CEC and CFC.

Labeling

Appropriate signage is properly constructed and installed, and displays the following:

1. Identifies the PV power source system attributes at the DC disconnect;
2. Identifies the AC point of connection; and
3. Identifies switch gear for an alternative power system.

Final

1. During installation, any changes to the approved plans, specification or calculations shall first be submitted to the City of Tustin Building Division for review and approval.
2. After final approval, a copy of the approved plans, specifications, calculations and inspection card shall be given to the homeowner at no charge.