



*City of Rancho Cucamonga*

**BUILDING AND SAFETY SERVICES DEPARTMENT**

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# CODE REQUIREMENTS FOR SOLAR PHOTOVOLTAIC (PV) SYSTEMS

Based on the 2010 California Building Code (CBC)

And the 2010 California Residential Code (CRC)

## **PURPOSE:**

The purpose of this information bulletin is to clarify requirements of the State Building Standards Codes (Title 24) that pertain to solar PV installations. This bulletin can serve as a reference guide for permit applicants and enforcing agencies to clarify how state code requirements are practically applied in the local jurisdiction. It is intended to minimize permitting uncertainty and differing interpretation regarding specific code requirements for solar PV installations. This information bulletin primarily clarifies requirements pertaining to the California Building Code and the California Residential Code, since these codes in their current form require significant local interpretation. This information bulletin does not address local regulations.

The implementation of uniform standards to achieve the timely and cost-effective installation is consistent with the California Solar Rights Act that views solar installation as a matter of statewide concern and prohibits local jurisdictions from adopting unreasonable barriers to the installation of solar energy systems (CA Government Code Section 65850.5).

## **PART I: BUILDING AND RESIDENTIAL CODE REQUIREMENTS**

### **1. Definitions**

**1.1 Solar photovoltaic (PV) system:** The total components and subsystems that, in combination, convert solar energy into electric energy suitable for connection to utilization load (CEC Article 690.2)

**1.2 Solar photovoltaic module:** A complete, environmentally protected unit consisting of solar cells, optics, and other components, exclusive of tracker, designed to generate DC power when exposed to sunlight (CEC Article 690.2)

**1.3 Solar photovoltaic (PV) panel:** A collection of modules mechanically fastened together, wired, and designed to provide a field-installable unit (CEC Article 690.2)

**1.4 Building integrated photovoltaic (BIPV) system:** Photovoltaic cells, devices, modules, or modular materials that are integrated into the outer surface or structure of a building and serve as the outer protective surface of the building (CEC Article 690.2)

### **2. Structural Requirements**

**2.1 PV systems positively anchored to the building:**



- 2.1.1 Exemption from structural calculations: The building official may waive the requirement for structural calculations for solar PV installations on top of existing roofs if the official can readily determine that the additional weight of the new solar PV system on the roof does not affect the structural integrity of the building. Some jurisdictions may have a prescriptive approach for when structural calculations can be waived, however, that varies by the enforcing agency.

To help streamline and simplify the permitting process for roof-mounted solar PV systems, it is highly recommended that local jurisdictions develop a prescriptive approach to meeting the structural requirements so that structural calculations are not always required. Here are some parameters to consider under such prescriptive approach:

- Maximum distributed weight of the solar PV system in psf
  - Maximum perpendicular distance between the solar PV system and the roof below
  - Maximum concentrated load imposed by the PV panel support onto the building's roof
  - Minimum size and spacing of rafters or joists for portion of the roof that is supporting the solar PV system
  - Maximum span of rafters or joists for portion of the roof that is supporting the solar PV system
  - Anchoring requirements such as type of fasteners, minimum fastener size, minimum embedment, and minimum number of attachment points
  - Any limitation on the type of building construction
- 2.1.2 Structural calculations: When structural calculations are required, calculations shall demonstrate that the primary structure will support the additional vertical and lateral loads from the panels and related equipment.
- 2.1.2.1 Roof dead Load: The weight of solar PV systems shall be considered in the design of the structure. (CBC Section 1606, CRC Section R301.4)

For installation of conventional (not BIPV) solar PV panels on existing roofs, the building official may allow a certain percent of the code required live load to be reduced to accommodate the additional weight of the solar PV panels provided the roof design is adequate for the concentrated loads from the solar PV panel support frames. This allowance may vary by jurisdiction and is generally based on the assumption that solar PV panels will not be stepped on or used by anyone to support any live load.

When the roof live load is allowed to be reduced, consideration should be given to the possibility that a roof may have more than one layer of existing roofing and the possibility of having smaller size rafters in older buildings.



Section 3403 of the CBC states, in part, that: “Any existing gravity load-carrying structural element for which an addition and its related alterations cause an increase

in design gravity load of more than 5 percent shall be strengthened, supplemented, replaced, or otherwise altered as needed to carry the increased load required by this code for new structures.”

2.1.2.2 Roof live load: The building official may allow the live load to be reduced in the area covered by each solar PV panel when such area is inaccessible as determined by the enforcing agency and as discussed in Section 2.1.2.1 of this information bulletin. Roof surfaces not covered by solar PV panels shall be designed for the roof live load. (CBC Section 1607, CRC R301.6)

The building official may determine that live load need not be considered for solar PV panels and associated supporting members that are built on grade. Such interpretation is generally based on the assumption that the solar PV panels will not be stepped on or used by anyone to support any live load

2.1.2.3 Wind design: Calculations shall demonstrate that the solar PV panels and associated supporting members are designed to resist wind loads. For ballasted PV systems, see Section 2.2 of this information bulletin (CBC Section 1609, CRC R301.2.1)

Note 1: The Structural Engineering Association of California is in the process of developing a white paper titled “Wind Loads on Low-Profile Solar Photovoltaic Systems on Flat Roofs.” Once available, a link to the white paper will be included in this document.

2.1.2.4 Seismic design: Calculations shall demonstrate that the solar PV panels and associated supporting members are designed to resist earthquake loads. For ballasted PV systems, see Section 2.2 of this information bulletin. (CBC Section 1613, CRC 301.2.2)

Note that Section 3404 of the CBC states, in part, that “Any existing lateral load-carrying structural element whose demand-capacity ratios with alteration considered is no more than 10 percent greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered. . . .”

2.1.2.5 For wood construction, supports shall be attached with fasteners of sufficient length and size to achieve minimum required embedment into solid wood taking into consideration the plywood and multiple layers of roofing that may exist, unless otherwise approved by the enforcing agency. (ASCE/SEI 7 Section 13.4, CRC Section R301.1.3)



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2.1.2.6 Snow load: When applicable, include snow loads and loads from snow drift. (CBC Section 1608, CRC R301.2.3)

2.1.2.7 Requirements for load combinations: The applicable load combinations in CBC 1605 shall be applied to all loading conditions, including evaluating the effects of dead load

to counteract wind uplift for ballasted and anchored systems. (CBC Section 1605, CRC Section R301.1.3)

2.1.2.8 Alterations, additions, and repairs: Sections 3403, 3404, and 3405 of the CBC shall apply to additions, alterations, and repairs associated with PV systems. Roof structural components, their connections, additions, alterations, and repairs shall be designed to support the loads from the PV panel support frames

**2.2 Ballasted PV system:**

PV panels in a ballasted system are typically not attached to the roof and rely on their weight, aerodynamics, and friction to counter the effect of wind and seismic forces. In some cases, ballasted systems have few attachment points to supplement the friction forces. Ballasted systems have low ratios of height-to-base width or length, which makes them inherently stable against overturning.

Section 13.4 of ASCE/SEI 7-05 requires that nonstructural components and their supports be attached (or anchored) to the structure. Ballasted solar PV systems are not addressed in the ASCE/SEI 7 or in the building code. When approved by the enforcing agency as an alternative material, design or method of construction pursuant to CBC Sections 12.2, 1.8.7, or 1.11.2.4 as applicable, these systems may be unrestrained or partially restrained subject to conditions of approval set by the enforcing agency.

Note 1: Electrical connections and wiring in a ballasted system should be designed to accommodate movements within the system.

Note 2: The Structural Engineering Association of California is in the process of developing a white paper, titled "Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Systems," addressing the seismic design of ballasted systems. Once available, a link to the white paper will be included in this document.



### 2.3 **Structural strength of PV panels:**

The structural strength of solar PV panels is not addressed in the code.

UL 1703, Third Edition, published March 15, 2002, requires that solar PV panels are tested to withstand a superimposed load of 30lb/ft<sup>2</sup>. Therefore, all solar PV panels that are listed per UL 1703 are considered to meet this requirement.

When used as a building component and depending on the load values that the solar PV panels are subjected to, the enforcing agency may require a test report from an agency recognized by the enforcing agency showing the strength of the solar PV panels.

### 2.4 **Condition of existing roof:**

Solar PV systems shall not be installed on an existing roof that is deteriorated to the point where it is not adequate as a base. (this interpretation is based on CBC Section 1510 and CRC R907)

### 2.5 **Premanufactured support systems:**

Premanufactured support systems must support the PV system and allow the system to stay attached to the structure when exposed to wind or seismic activity. Compliance of the PV support system with appropriate building codes is accomplished through a design specified by a licensed engineer or architect, or through research reports from approved sources as defined in

CBC Section 1703.4.2. Additional requirements may be imposed by the enforcing agency. (CRC Section R301.1.3, CBC Section 1703.4.2)

## 3. **Fire Safety Provisions**

### 3.1 **Fire/roof classification of photovoltaic (PV) panels**

#### 3.1.1 **Solar PV panels installed on top of a building's roof structure:**

3.1.1.1 Solar PV systems installed on top of a roof where the space between the solar PV panels and the roof has no use and no potential use are generally considered to be equipment. Currently, the State's Building Standards Code maintains fire/ roof classification requirements for roof structures, but does not maintain specific requirements regarding fire/roof classification of solar PV panels.

Since no specific requirements or guidance are provided by the State Building Standards Code, local enforcing agencies currently determine whether any fire/roof classification of solar PV panels is required and if so, what fire/roof classification is



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required. The State Fire Marshal is leading an effort to consider specific state code requirements for fire/roof classification of solar panels in the current code adoption process. Until any requirements in this area are standardized on a state basis, agencies generally consider the following when determining any appropriate fire/roof classification to enforce:

- UL 1703, Standard for Flat-Plate Photovoltaic Modules and Panels, is often used for determining the fire/roof classification and listing/certification of solar PV panels. This standard is not currently listed in the CRC or the CBC but is being considered for adoption in the 2013 State Building Standards Code. UL 1703 is subject to change until approved as part of state code. Enforcing agencies may consider this standard as an alternate to UL 790, subject to approval by the building official. (CRC Section R902, CBC Section 1505)
- Local enforcing agencies have used different approaches to determine any appropriate fire/roof classification for solar PV panels. When PV systems cover a significant portion of the roof, some enforcing agencies have determined that the solar PV panels mounted above the roof should match the classification of the roof while others have determined that the panel may be of a lesser classification based on local conditions, panel installation configuration listing/certification, and/or alternate testing information.
- For installations in State Responsibility Areas (SRA) or High Fire Hazard Severity Zones, additional provisions adopted by the local enforcing agency may be applicable. Check with the enforcing agency for any additional requirements.

**3.1.1.2 Solar PV panels used as roofing on an independent (stand-alone) structure:**

Solar PV panels/modules that are designed to be on the roof, and span to structural supports, and have a use or occupancy underneath, shall comply with the minimum fire/roof classification requirements for roof covering as required by CRC Section R902. An example of this type of installation is a carport structure having solar PV panels as the roof.

**3.1.1.3 Solar PV panels installed as a part of a building's roof structure:** Solar PV panels installed as integrated roofing material shall comply with the minimum fire/roof classification requirements for roof covering as required by the current CRC Section R902. An example of this type of installation is PV modules integrated into the roofing shingles (BIPV systems).

**3.1.2 Solar PV systems installed on grade:** Solar PV panels that are part of a stand-alone, ground-mounted solar PV panel structures, with no use and no potential use underneath are generally considered equipment and therefore the fire/roof classification



requirements would not apply. (Based on the definition of a roof assembly in CRC Section R202/CBC Section 1502)

3.2 **Area, height, and story limitations:** Where there is a use between the solar PV panels and the roof/ grade underneath, adding such solar PV structures may constitute additional floor area, story, and/or height. Solar PV panels supported by framing that has sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency, are generally considered equipment. (CBC Section 503 and Table 503, CRC Section 1.1.3, definition of a roof assembly in CBC Section 1502 and CRC Section R202)

3.3 **Location from property line and adjacent buildings:** Solar PV panels and associated framing, with no use and no potential use between the panels and the grade underneath, are generally treated as equipment; when not considered

equipment, they may be considered a structure and shall be located and protected based upon the code required fire separation distance to property lines and adjacent buildings. (CRC Section R302.1, CBC Section 602).

3.4 **Fire proofing of structural support:** Depending on the type of building, support structures of solar PV systems that have a use or have potential for use underneath (such as carports) may be required to be fire proofed in accordance with CBC Section 602.

3.4.1 The following installations are generally considered equipment and are not subject to this requirement provided that the structural members are noncombustible.

A. Stand-alone PV panel structures with no use and no potential use underneath. (Based on definition of a roof assembly in CBC Section 1502)

B. Solar PV panels supported by framing that has sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency. (Based on definition of a roof assembly in CBC Section 1502)

3.4.2 Alternate designs can be considered when approved by the enforcing agency as an alternative material, design, or method of construction pursuant to CBC Sections 1.2.2, 1.8.7, or 1.11.2.4 as applicable.

3.5 **Rooftop structures:** Unenclosed rooftop structures supporting solar PV systems with no use underneath are generally not subject to CBC Section 1509.2.



- 3.6 **Fire sprinklers:** In buildings that are required to be provided with fire sprinklers, the CBC requires that all parts of the building have sprinkler coverage except where an exemption is specifically required. Current code has no exemption for solar PV structures but here are some guidelines (CBC 903.3):
- 3.6.1 Existing exemptions in the code may be used for a solar PV installation if it meets the intent of the exemption. This will be subject to approval by the enforcing agency.
  - 3.6.2 Solar photovoltaic (PV) panels supported by framing that have sufficient uniformly distributed and unobstructed openings throughout the top of the array (horizontal plane) to allow heat and gases to escape, as determined by the enforcing agency, are generally not subject to this requirement. (CBC Section 903.3.3)
  - 3.6.3 Solar PV panels placed above the roof, with no use and no potential use between the panels and the roof, are generally not subject to this requirement. (Based on definition of a roof assembly in CBC Section 1502 and CRC Section R202)
- 3.7 **Other fire safety requirements or guidelines:** The installation of solar PV systems may be subject to additional provisions adopted by the local enforcing agency that may include the State Fire Marshal Solar Photovoltaic Installation Guideline. Check with the enforcing agency for additional requirements. The guideline can be obtained at <http://osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf>
- 4. **Roof drainage:** Roof-mounted solar PV systems shall not cause excessive sagging of the roof that results in water ponding. They shall also not block or impede drainage flows to roof drains and scuppers. (CBC Section 1611, CRC Section R903.4)
  - 5. **Roof penetrations:** All roof penetrations shall be sealed using approved methods and products to prevent water leakage. Such methods include but not limited to caulking, roof jacks, and sheet metal flashing. (CBC Section 1503.2, CRC Section R903.2)
  - 6. **Skylights:** Solar PV panels shall maintain a minimum clearance around the perimeter of skylights as not to interfere with the function of the skylight, as determined by the enforcing agency. (CBC Section 1205, CRC Section R303)
  - 7. **Plumbing vent, mechanical equipment, and mechanical exhaust terminations:** Solar PV panels shall not obstruct or interfere with the function of plumbing vents or mechanical equipment. (CPC Sections 901.1 & 906, CMC Section 304)



8. **Guard rails:** When required by the enforcing agency, guard rails may apply to solar PV systems. (CBC 1013.5).

9. **Disabled access requirements**

9.1 **Nonresidential, hotel, motel buildings, facilities, or structures (See CBC Chapter 11B)**

9.1.1 Scope: Accessibility to solar PV support structures that create a use or occupancy shall be provided for all occupancy classifications in accordance with Chapter 11B.

9.1.2 General: When alterations, structural repairs, or additions are made to existing buildings or facilities, for the purpose of installing a solar PV system, they shall comply with Chapter 11B.

Note: New solar PV systems that do not create or expand a use or occupancy and consist only of installation of the solar PV system, and related electrical work, that does not affect disabled access requirements for existing buildings regulated by Chapter 11B are not considered alterations for the purpose of accessibility and should not be subject to accessibility upgrades.

9.2 **Residential buildings, facilities, or structures**

9.2.1 Scope: New solar PV systems serving covered multifamily dwellings that create a use or occupancy shall comply with the provisions of Chapter 11A.

9.2.2 Existing buildings: The building standards contained in Chapter 11A do not apply to the installation of solar PV systems serving privately funded multifamily dwellings constructed for first occupancy prior to March 13, 1991.

9.3 **Parking**

Required accessible parking spaces shall be provided and maintained in accordance with the applicable provisions of Sections 1109A and Chapter 11B.

Note: Alterations: Where parking lots, parking structures, or parking facilities are re-striped or otherwise altered to accommodate solar PV systems, required accessible parking spaces shall be maintained or shall be provided in accordance with the applicable provisions of Sections 1109A and 11B.



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**PART II: ELECTRICAL CODE REQUIREMENTS**

1. **Product listing (certification):** The solar PV panel/module and other equipment used in the PV system shall be listed/certified by a nationally recognized listing/certification agency in accordance with the applicable standards.
2. **Installation:** The installation of the solar PV system must conform to the requirements of the California Electrical Code (CEC).
3. **Signage:** Signage must conform to the requirements of the (CEC). Signage requirements and location of certain equipment for solar PV systems may be subject to additional provisions adopted by the enforcing agency that may include requirements from the State Fire Marshal Solar Photovoltaic Installation Guideline.

**PART III: LOCAL ELECTRIC UTILITY REQUIREMENTS**

Check with the local utility for any incentives, interconnection, operating, and metering requirements.