



COUNTY OF SANTA CRUZ

PLANNING DEPARTMENT

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Residential Comprehensive Standard Solar Photovoltaic Application Requirements

Reference Information:

- 2016 California Electrical Code (CEC)
- 2016 California Building Code and Residential Code (CBC & CRC)
- 2016 County of Santa Cruz adopted Fire Code

Exception to Fire code: Detached Group U non-habitable structures such as garages, parking shade structures, carports, solar trellises, and similar type structures are not subject to the rooftop setback requirements of the Fire Code.

Required Application Submittal Information:

- Photovoltaic permit applications and installations shall be completed by “Qualified Personnel”. The installation of equipment and all associated wiring and interconnections shall be performed only by qualified persons, as defined by the 2016 CEC article 100, definitions of a “qualified person”, CEC 690.4(C)
This includes the following personnel as stated by the California State Licensing Board, a General contractor, Electrical contractor and Solar Photovoltaic contractor.
- Application submittals shall show the location of the structure with the rooftop solar system on a parcel map, or the location of the ground mounted solar system and the back-fed structure on a parcel map.
- Provide a plan view for both rooftop mounted and ground mounted arrays to show the location and where required fire setbacks, all equipment configurations and locations, the point of utility connection and the rapid shut down equipment where applicable.
- Provide two copies for application submittal on a minimum 11”x17” format, equipment specification sheets may be included on 8.5” x 11” format.
- Provide an electrical three-line diagram, which shall state all equipment such as modules, micro-inverters, DC to DC combiners, output combiners, central inverters, dc and ac electrical panels, conductor types, sizes and where present raceway installation height above the rooftop, disconnecting means, overcurrent devices, utility connection points and rapid shutdown equipment. Include equipment electrical values for sizing conductors, overcurrent devices, inverters, electrical panels and other equipment present.

- Provide manufacturer specification sheets for modules, combiner boxes, dc to dc combiners, micro-inverters, inverters, rapid shutdown equipment, solar module racking systems and any other electrical equipment present. Equipment shall be identified and listed for the application.
- Grounded dc photovoltaic arrays shall be provided with dc ground-fault protection (GFP) as required by CEC 690.5(A - C). Inverter specifications shall indicate integral GFP protection.
- Arc-Fault circuit protection shall be provided for Photovoltaic systems with dc source circuits, dc output circuits, or both, operating at a PV system maximum of 80 volts or greater, shall be protected by a listed dc arc-fault circuit interrupter, PV type, or other system components listed to provide equivalent protection meeting the requirement of CEC 690.11(1-3).
- Rapid Shutdown of PV systems on buildings shall include a rapid shutdown function that controls specific conductors in accordance with 690.12(1 – 5). Equipment that performs the rapid shutdown shall be listed and identified.
 - 1) Requirements for controlled conductors shall apply only to PV system conductors of more than 5 feet in length inside a building, or more than 10 feet from a PV array on the exterior (lengths may not be added together).
 - 2) Controlled conductors shall be limited to not more than 30 volts and 240 volt-amperes within 10 seconds of rapid shutdown initiation.
(Amended by NFPA TIA 14-10 to extend the shut down time required to 30 seconds)
 - 3) Voltage and power shall be measured between any two conductors and between any conductor and ground.
 - 4) The rapid shutdown initiation methods shall be labeled in accordance with 690.56(B). (Plaque or directory)
 - 5) Equipment that performs the rapid shutdown shall be listed and identified.
- Specify module weight (including array racking) per square foot for roof loading evaluation.
- Include a detail for the roof framing layout to specify framing material, size, spacing and slope.
- State calculations for VOC per CEC Table 690.7 with a correction factor of 1.14 minimum. When open-circuit voltage temperature coefficients are supplied in the instructions for listed PV modules, the calculation shall be based on the module stated factor for the maximum PV system voltage instead of using Table 690.7.
- Maximum allowable system design (BOS) and application shall not exceed 600V dc based on maximum system VOC for one and two-family dwellings. For systems over 600V see Art. 690 Part IX.
- State calculations for the dc source circuit(s) and output circuit(s) ampacity and sizing based on module Isc values to carry not less than the larger of 690.8(B)(1) or (2).
- State calculations for the ac conductor(s) ampacities and sizing based on central inverter or micro-inverter rated output ampacity times the continuous load factor 1.25% per 690.8(A)(3).
- If conductors are installed in raceways or cables and located on rooftops, specify raceway or cable height above the rooftop and apply an additional ambient temperature adjustment using CEC Table 310.15(B)(3) (c) to the 2013 Ashrae highest monthly 2% DB design temp at 74.8°F.

- Equipment listings shall provide terminal termination temperatures for modules, dc to dc combiners, combiner boxes, overcurrent devices, micro-inverters, central inverters, disconnects and any other equipment present. If rooftop combiner boxes are located in direct sunlight, manufacture specifications will be required for adjustments above 40°C for overcurrent devices per CEC 110.3(B).
- Provide a plan view for the array rack mounting attachment points. The roof mounted racking system shall include attachment and flashing details, along with the required rooftop fire rating in combination with the proposed modules fire class “type” per Cal Fire requirements.
- Back-fed PV ac Calculations shall be applied per CEC **705.12(D)(2) Bus or Conductor Ampere Rating**. One hundred twenty-five percent of the inverter output circuit current shall be used in ampacity calculations for the following:
 - (1) **Feeders**. Calculate back-fed per CEC **705.12(D)(2)(1)(a) & (b)**.
 - (2) **Taps**. Calculate back-fed per CEC **705.12(D)(2)(2)**.
 - (3) **Busbars**. One of the methods that follows shall be used to determine the ratings of busbars in panelboards. **CEC 705.12(D)(2)(3)**.
 - (a) The sum of 125 percent of the inverter(s) output circuit and the rating of the overcurrent device protecting the busbar shall not exceed the ampacity of the busbar.
 - (b) Where two sources, one a utility and the other an inverter, are located at opposite ends of a busbar that contains loads, the sum of 125 percent of the inverter(s) output circuit current and the rating of the overcurrent device protecting the busbar shall not exceed 120% of the ampacity of the busbar. The busbar shall be sized for the loads connected in accordance with Article 220.
 - (c) The sum of the ampere ratings of all overcurrent devices on panelboards, both load and supply devices, excluding the rating of the overcurrent device protecting the busbar, shall not exceed the ampacity of the busbar. The rating of the overcurrent device protecting the busbar shall not exceed the rating of the busbar.
 - (d) Connections shall be permitted on multiple-ampacity busbars or center-fed panelboards where designed under engineering supervision that includes fault studies and busbar load calculations.
(Amended by NFPA TIA 14-12 to allow the 120% rule to apply at either end but not both ends of a center-fed bus).
- Supply side connections shall be made using an approved and listed method and shall not void the manufacturer listing of equipment, CEC 110.3(B).
 - In lieu of a panel listing when modifying, a field certification for panel modifications from a NRTL such as UL, shall be stated on the application submittal and provided at the time of inspection.
- Equipment grounding conductors for photovoltaic source and output circuits shall be sized per CEC 250.122 and shall not be smaller than 14 AWG per CEC 690.45. For arrays, equipment grounding conductors smaller than 6 AWG shall comply with 250.120(C) for protection CEC 690.46.

- Grounding electrode requirements for dc systems shall be provided as required per CEC 690.47(B) in accordance with 250.166 for grounded systems or 250.169 for ungrounded systems. Systems with both ac and dc grounding requirements shall apply CEC 690.47(C)(1), (2) or (3).

*Additionally, rod, pipe and plate electrodes shall be supplemented by an additional electrode specified in CEC 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following: CEC 250.52(A)(2)

- 1) Rod, pipe or plate electrode
- 2) Grounding electrode conductor
- 3) Grounded service entrance conductor
- 4) Non-flexible grounded service raceway
- 5) Any grounded service enclosure

Exception: If a rod, pipe or plate grounding electrode has a resistance to earth of 25 ohms or less than, the supplemental electrode shall not be required. CEC 250.53(A)(2) Exception

- Where PV source and output circuits operating at maximum system voltages greater than 30 volts that are installed in readily accessible locations, shall have circuit conductors guarded or installed in a raceway. CEC 690.31
Ground mount PV systems shall state conductor guarding where readily accessible.

Include CEC Photovoltaic Required Labeling in submittal as applicable to system:

- On the photovoltaic disconnect (Inverter) the following shall be labeled, “Rated Maximum power-point current (I_{pm}) _____, Rated maximum power-point voltage (V_{pm}) _____, Maximum system voltage (V_{oc}) _____, Short circuit current (I_{sc}) _____, Maximum rated output current of the charge controller _____” CEC 690.53
- A permanent plaque or directory, denoting all electric power sources on or in the premises, shall be installed at each service equipment location and at locations of all electric power production sources capable of being interconnected. CEC 705.10
- At interactive points of interconnection, usually the main service, provide labeling stating “Power Source ac operating current _____, ac operating voltage _____”. CEC 690.54
- At all disconnects where terminals 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: CEC 690.17(E)

*“Warning
Electric Shock Hazard
Do Not Touch Terminals.
Terminals on both the line
and load sides may be energized
in the open position”.*

Labeling Continued

- Marking and labeling is required on all exposed **dc** raceways, enclosures, cable assemblies and junction boxes. The equipment shall be marked with materials permanently affixed or other approved permanent markings. The marking shall contain the words *“PHOTOVOLTAIC POWER SOURCE”*. Marking shall be placed every 10 feet, above and below all penetrations of roof/ceiling assemblies and all walls and or barriers. The labels shall be reflective, and all letters shall be capitalized and shall be a minimum height of 3/8” in white on a red background. CEC 690.31(G)(4)
- The PV power source system shall be labeled with the following warning at each junction box, combiner box, disconnect, and device where energized, ungrounded circuits may be exposed during service: CEC 690.35(F)

*“WARNING
ELECTRIC SHACK HAZARD, THE DC CONDUCTORS OF THIS
PHOTOVOLTAIC SYSTEM ARE UNGROUNDED AND MAY BE
ENERGIZED”*

- A warning label shall appear on the utility-interactive inverter or be applied by the installer near the ground-fault indicator at a visible location, stating the following: CEC 690.5(C)

*“Warning
Electric Shack Hazard
If a Ground Fault Is Indicated,
Normally Grounded Conductors May
Be Ungrounded and Energized”*

When the PV system also has batteries, the same warning shall also be applied by the installer in a visible location at the batteries. The warning sign(s) or label(s) shall comply with 110.21(B).

- Rapid Shut Down Labeling. Buildings or structures with both utility service and a PV system, complying with CEC 690.12 shall have a permanent plaque or directory including the following words:

“PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN”

The plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 3/8”, in white on red background. CEC 690.56(C)

- A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the inverter that displays the following or equivalent wording: CEC 705.12(D)(2)(3)(b)

*“Warning
Inverter Output Connections
Do Not Relocate This Overcurrent Device”*

- Where panelboards are back-fed by multiple sources a permanent warning label shall be applied to the distribution equipment that displays the following or equivalent wording: 705.12(D)(2)(3)(c)

*“Warning:
This Equipment Fed by Multiple Sources.
Total Rating of all Overcurrent Devices,
Excluding Main Supply Overcurrent Device,
Shall Not Exceed Ampacity of Busbar”*

Labeling Continued

- A permanent warning label shall be applied to the distribution equipment adjacent to the back-fed breaker from the inverter that displays the following or equivalent wording: CEC 705.12(D)(2)(3)(b)

*“Warning
Inverter Output Connections
Do Not Relocate This Overcurrent Device”*

- Where panelboards are back-fed by multiple sources a permanent warning label shall be applied to the distribution equipment that displays the following or equivalent wording: 705.12(D)(2)(3)(c)

*“Warning:
This Equipment Fed by Multiple Sources.
Total Rating of all Overcurrent Devices,
Excluding Main Supply Overcurrent Device,
Shall Not Exceed Ampacity of Busbar”*

2018 CRC July 1st Code Supplemental for Rooftop Setback Requirements

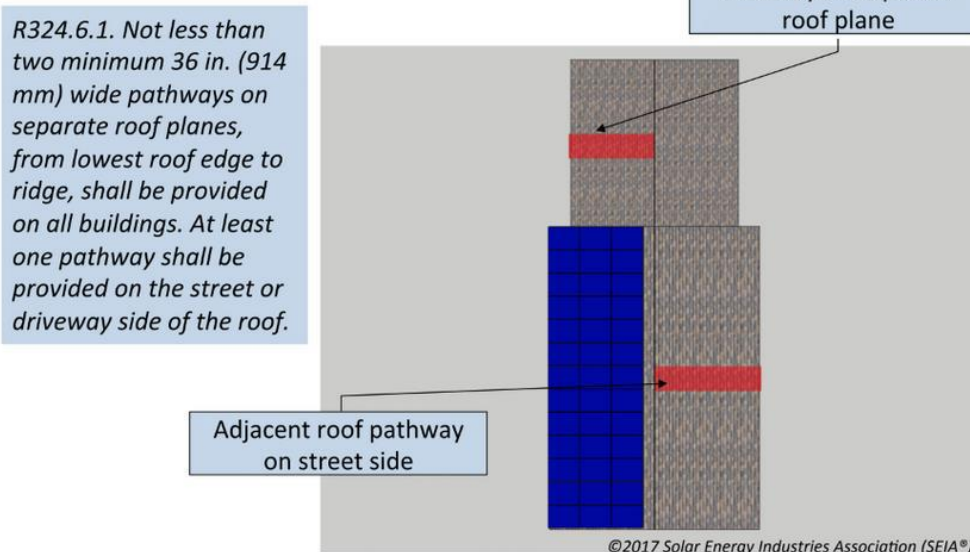
R324.6 Roof access and pathways. Roof access, pathways, and setback requirements shall be provided in accordance with Sections R324.6. 1 through R324.6.2.1. Access and minimum spacing shall be required to provide emergency access to the roof, to provide pathways to specific areas of the roof, to provide for smoke ventilation opportunity areas, and to provide emergency egress from the roof.

Exceptions:

1. Detached, non-habitable structures, including but not limited to detached garages, parking shade structures, carports, solar trellises, and similar structures, shall not be required to provide roof access.
2. Roof access, pathways, and setbacks need not be provided where fire code official has determined that rooftop operations will not be employed.
3. These requirements shall not apply to roofs with slopes of 2 units vertical in 12 units horizontal (2: 12) or less.

R324.6.1 Pathways. Not less than two minimum 36-inch-wide (914 mm) pathways on separate roof planes, from lowest roof edge to ridge, shall be provided on all buildings. At least one pathway shall be provided on the street or driveway side of the roof. For each roof plane with a photovoltaic array, a minimum 36-inch-wide (914 mm) pathway from the lowest roof edge to ridge shall be provided on the same roof plane as the photovoltaic array, on an adjacent roof plane, or straddling the same and adjacent roof planes. Pathways shall be over areas capable of supporting fire fighters accessing the roof. Pathways shall be located in areas with minimal obstructions such as vent pipes, conduit, or mechanical equipment.

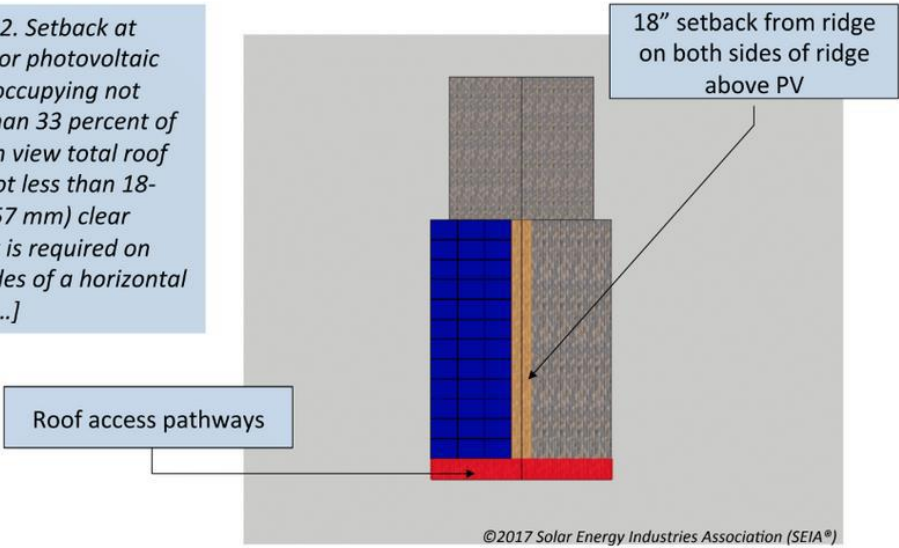
Pathways to Ridge – Street Access 2016 CA Intervening Code Cycle (Supplement)



R324.6.2 Setback at ridge. For photovoltaic arrays occupying not more than 33 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear set back is required on both sides of a horizontal ridge. For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear set back is required on both sides of a horizontal ridge.

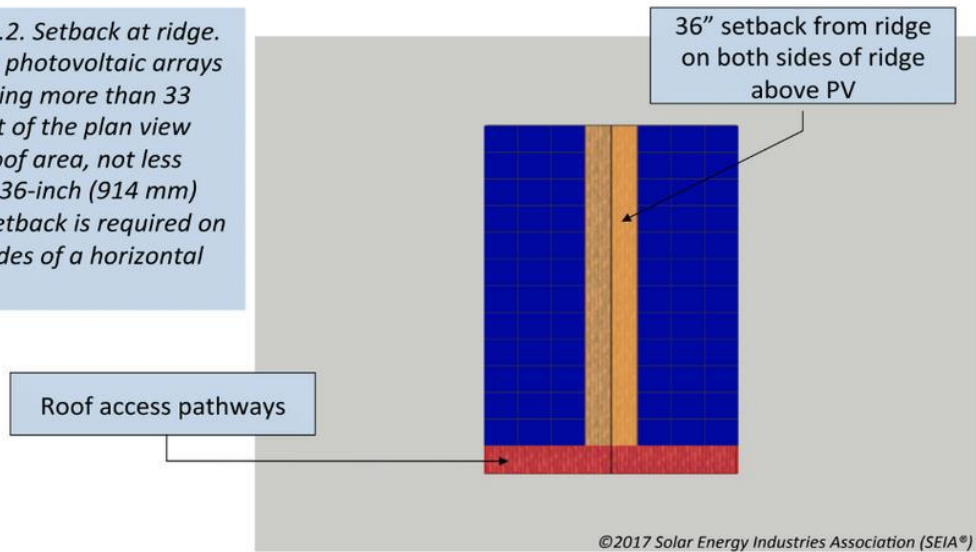
Ridge Setbacks – Not Sprinkled, <33% Total Roof Area 2016 CA Intervening Code Cycle (Supplement)

R324.6.2. Setback at ridge. For photovoltaic arrays occupying not more than 33 percent of the plan view total roof area, not less than 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge. [...]



Ridge Setbacks – Not Sprinkled, >33% Total Roof Area 2016 CA Intervening Code Cycle (Supplement)

R324.6.2. Setback at ridge. [...] For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.



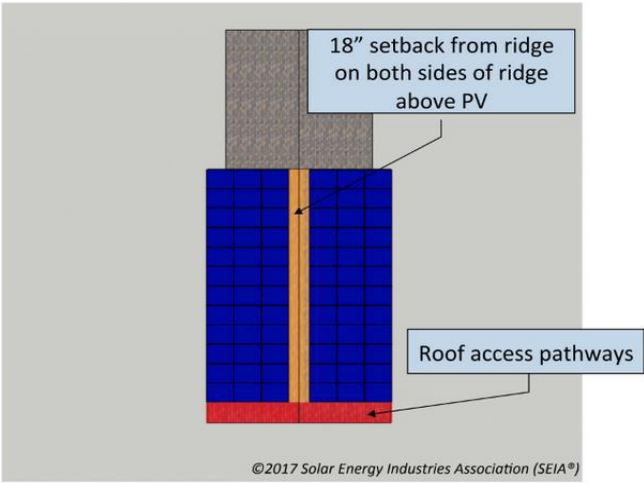
R324.6.2.1 Alternative setback at ridge. Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D setbacks at ridges shall conform with one of the following:

1. For photovoltaic arrays occupying not more than 66 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge.

Ridge Setbacks – Sprinkled, <66% Total Roof Area 2016 CA Intervening Code Cycle (Supplement)

R324.6.2.1. Alternative setback at ridge. Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D or Section P2904, setbacks at ridges shall conform with one of the following:

- 1. For photovoltaic arrays occupying not more than 66 percent of the plan view total roof area, not less than an 18-inch (457 mm) clear setback is required on both sides of a horizontal ridge.*



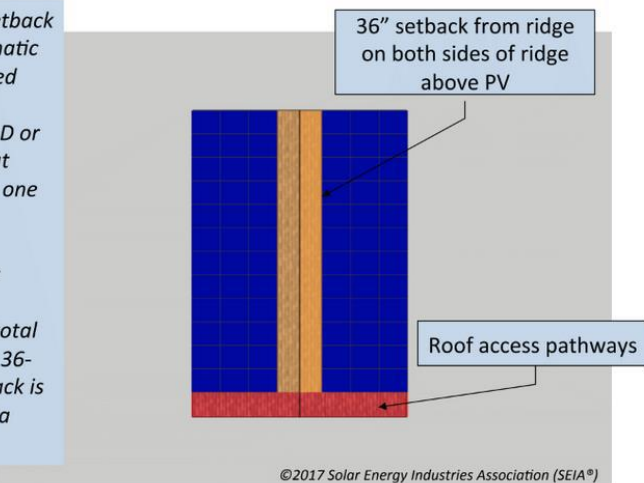
2. For photovoltaic arrays occupying more than 66 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.

Ridge Setbacks – Sprinkled, >66% Total Roof Area 2016 CA Intervening Code Cycle (Supplement)

R324.6.2.1. Alternative setback at ridge. Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D or Section P2904, setbacks at ridges shall conform with one of the following:

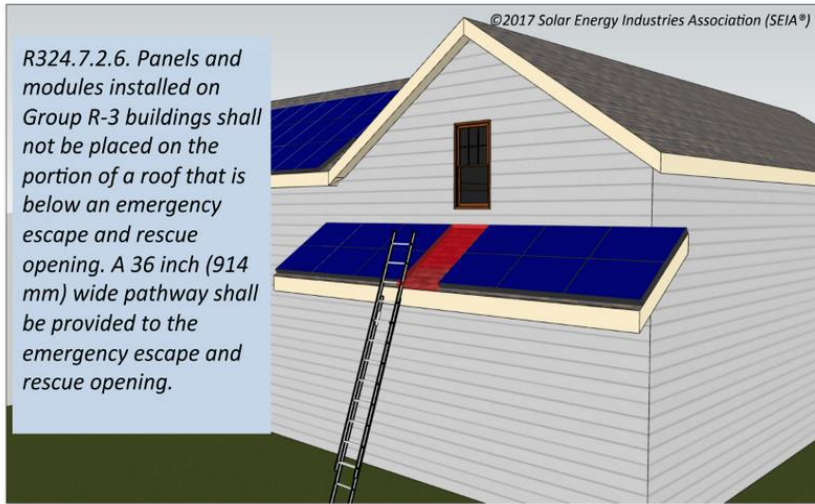
[...]

- 2. For photovoltaic arrays occupying more than 66 percent of the plan view total roof area, not less than a 36-inch (914 mm) clear setback is required on both sides of a horizontal ridge.*



R324.6.4 Emergency escape and rescue opening. Panels and modules installed on dwellings shall not be placed on the portion of a roof that is below an emergency escape and rescue opening. A 36-inch-wide (914 mm) pathway shall be provided to the emergency escape and rescue opening.

Emergency Escape & Rescue Opening 2016 CA Intervening Code Cycle (Supplement)



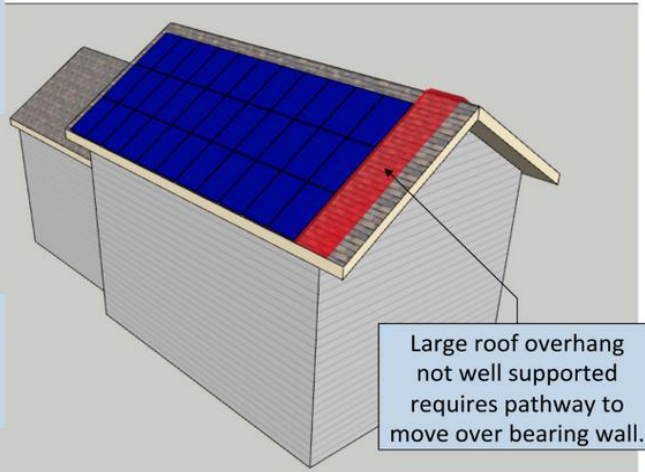
R324.7.3 Locations of DC conductors. Conduit, wiring systems, and raceways for photovoltaic circuits shall be located as close as possible to the ridge or hip or valley and from the hip or valley as directly as possible to an outside wall to reduce trip hazards and maximize ventilation opportunities. Conduit runs between sub arrays and to DC combiner boxes shall be installed in a manner that minimizes the total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box. The DC combiner boxes shall be located such that conduit runs are minimized in the pathways between arrays. DC wiring shall be installed in metallic conduit or raceways when located within enclosed spaces in a building. Conduit shall run along the bottom of load bearing members.

R324.6.1 Pathways, Continued

Structural Support of Pathways 2016 CA Intervening Code Cycle (Supplement)

Pathways may have to be located in middle of roofs. Treat them like “pathways” instead of “setbacks.”

R324.6.1. Pathways shall be over areas capable of supporting fire fighters accessing the roof.



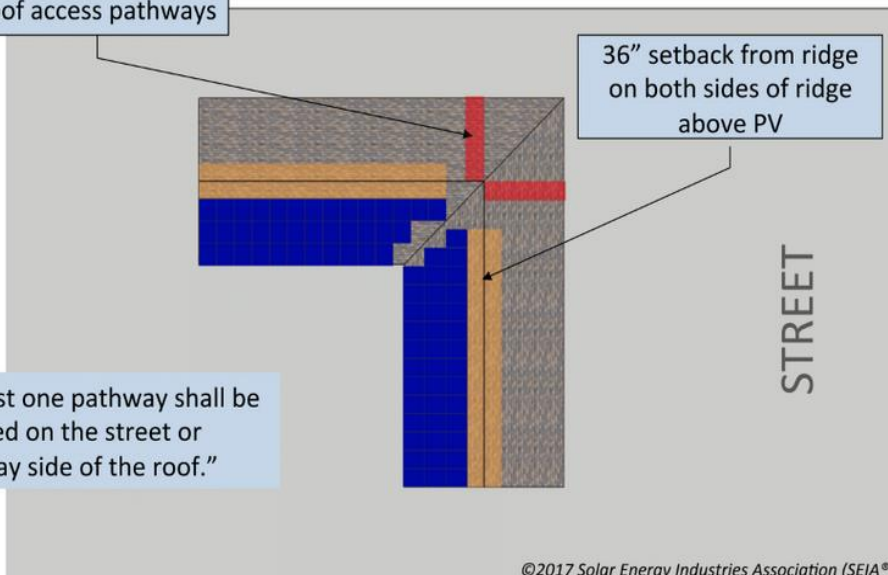
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Setbacks & Pathways Involving Hips & Valleys 2016 CA Intervening Code Cycle (Supplement)

Roof access pathways

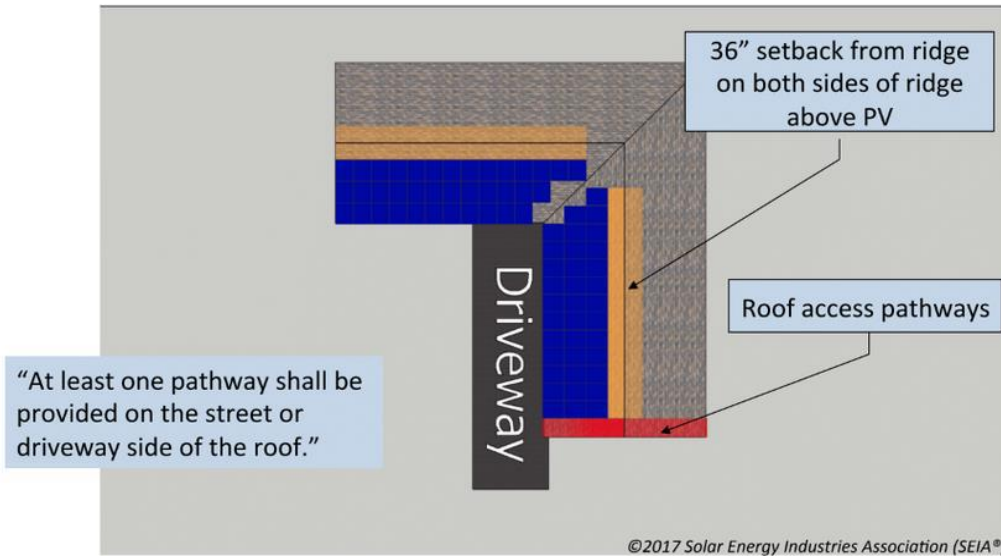
36" setback from ridge on both sides of ridge above PV

“At least one pathway shall be provided on the street or driveway side of the roof.”



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Setbacks & Pathways Involving Driveways 2016 CA Intervening Code Cycle (Supplement)



Setbacks & Pathways with Hips, Valleys & Driveways 2016 CA Intervening Code Cycle (Supplement)

