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## 9. Solar Ready

### §110.10

This chapter of the nonresidential compliance manual addresses solar-ready requirements for hotels/motels, nonresidential, and high-rise multifamily buildings. These requirements are in §110.10 and §141.0 and are mandatory for newly constructed buildings, and for additions where the total roof area is increased by at least 2,000 square feet.

The solar ready requirement is implemented when designing the building's rooftop and associated equipment. The intent is to reserve a penetration-free and shade-free portion of the roof for the potential future installation of a solar energy system. There are no requirements to install panels, conduit, piping, or mounting hardware.

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### 9.1 Overview

The solar ready provisions are mandatory; "trade-offs" are not allowed. There are exceptions to the "solar zone" requirements, and these are described in the corresponding sections of this chapter. Because Solar Ready is mandatory, NRCC-SRA-E compliance form must be submitted with the building permit application, even when using an allowable solar zone exception.

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### 9.2 Covered Occupancies

#### §110.10(a)

The nonresidential solar-ready requirements apply to:

- Hotel/motel occupancies with 10 stories or fewer.
- High-rise multifamily buildings with 10 stories or fewer.
- All other nonresidential buildings with three stories or fewer.
- See Example 9-3.

Mixed Occupancy Buildings: The Energy Standards apply to mixed occupancy buildings. Buildings with nonresidential space on the ground floor and multi-family residential floors above are common examples.

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### 9.3 Solar Zone

#### §110.10(b)

The solar zone is a suitable place where solar panels can be installed at a future date - if the owner chooses to do so. A solar zone area is designed with no penetrations, obstructions or significant shade. The solar zone must comply with the access, pathway, smoke ventilation, and spacing requirements in Title 24 Part 9. Requirements from the other parts of Title 24, and those adopted by a local jurisdiction should also be incorporated in the solar zone design.

The solar zone can be located at any of the following locations:

- Roof of building.
- Overhang of the building.
- Covered parking installed with the building project.
- Roof of another structure located within 250 feet (75 meters) of the primary building.
- Overhang of another structure within 250 feet (75 meters) of the primary building.

Other structures include, but are not limited to, trellises, arbors, patio covers, carports, gazebos, and similar accessory structures.

Multifamily buildings: Solar Ready requirements for low-rise multifamily buildings are located in both the Residential and Nonresidential Compliance Manuals. In the 2019 Energy Standards, the solar zone requirements for low-rise multifamily buildings are grouped with high-rise multifamily, hotel/motel and nonresidential in §110.10(b)1B.

### 9.3.1 Solar Zone Minimum Area and Exceptions

#### §110.10(b)1

**Total Area:** The solar zone must have a total area of at least 15% of the total roof area, after subtracting any skylights. See Example 9-4.

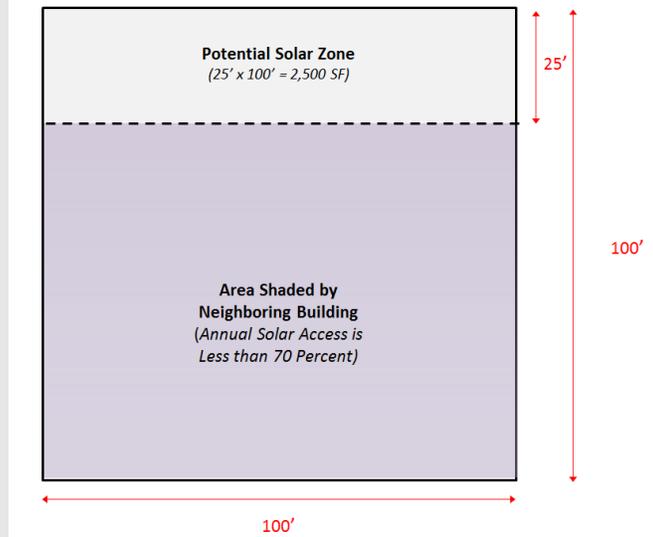
**Multiple areas:** The solar zone may be composed of multiple subareas if they meet the following minimum size specifications:

1. Each subarea dimension must be at least five feet.
2. If the total roof area is equal to or less than 10,000 square feet, each subarea must be at least 80 square feet.
3. If the total roof area is greater than 10,000 square feet, each subarea must be at least 160 square feet.

#### Example 9-1

##### **Question:**

A roof with no skylights has an area of 10,000 sq. ft. A neighboring building shades the roof, so 7,500 sq. ft of the roof has less than 70 percent annual solar access. How big does the solar zone have to be?

**Answer:**

If the entire roof had an annual solar access of 70 percent or greater, the minimum solar zone would be 1,500 sq. ft. or 15 percent of the total roof area (10,000 sq. ft.). However, since the potential solar zone is 2,500 sq. ft., the minimum solar zone can be reduced to half the area of the potential solar zone, or 1,250 sq. ft.

## Example 9-2

**Question:**

The total roof area is less than 10,000 sq. ft., but the potential solar zone is less than the minimum size requirements for any subarea (less than 80 sq. ft. or narrower than 5 feet in the smallest dimension). Does the building still need to comply with the solar-ready requirements?

**Answer:**

No. If half the potential solar zone is less than 80 sq. ft. (if roof is less than or equal to 10,000 sq. ft.) or 160 sq. ft. (if roof is greater than 10,000 sq. ft.), then the building does not need to comply with the solar zone requirements.

## Example 9-3

**Question:**

A portion of an office building will have six stories, and a portion of the building will have two stories. Is the new building subject to the solar zone requirements?

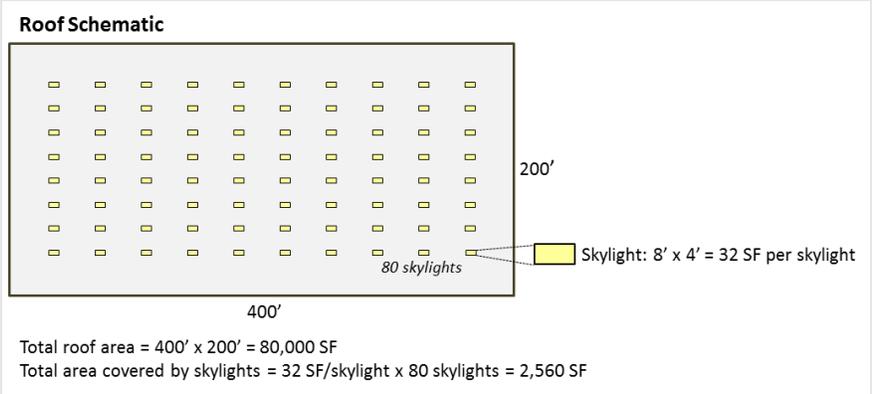
**Answer:**

No, the solar-ready requirements do not apply to office buildings that have more than three stories. The solar-ready requirements apply only to hotel/motel occupancies and high-rise multifamily buildings with 10 or fewer stories and all other nonresidential buildings with 3 or fewer stories.

## Example 9-4

**Question:**

A new warehouse has a total roof area of 80,000 sq. ft. Skylights cover 2,560 sq. ft. of the total roof area. What is the minimum solar zone area?



**Answer:**

The minimum solar zone area would be 11,616 sq. ft

$$\text{Minimum Solar Zone Area} = 15\% \times (\text{Total Roof Area} - \text{Area Covered by Skylights})$$

$$11,616 \text{ sq. ft} = 15\% \times (80,000 \text{ sq. ft} - 2,560 \text{ sq. ft})$$

**Example 9-5**

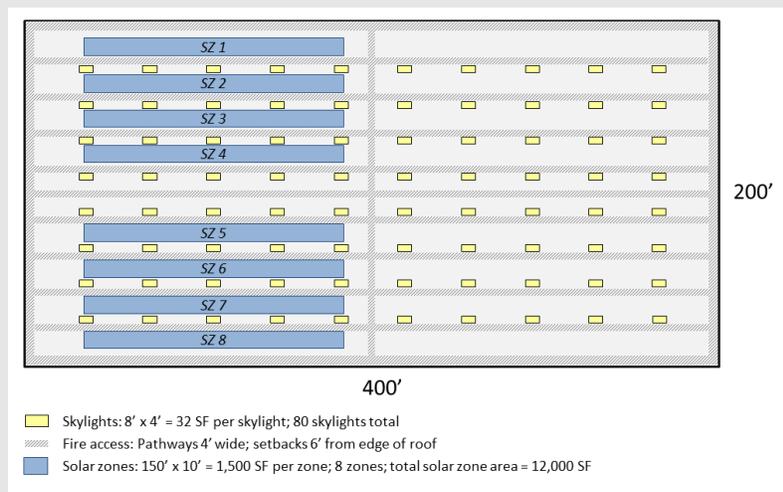
**Question:**

Does the solar zone have to be one contiguous area?

**Answer:**

No, the solar zone does not have to be one contiguous area. The total solar zone can be composed of multiple smaller areas. A subarea cannot be narrower than 5 feet in any dimension. If the total roof area is 10,000 sq. ft or less, each subarea must be at least 80 sq. ft. If the total roof area is greater than 10,000 sq. ft, each subarea must be at least 160 sq. ft.

The image below illustrates a solar zone layout that is composed of eight smaller subareas. The sum of all the smaller areas must equal the minimum total solar zone area. In this case, the sum of all areas must be at least 11,616 sq. ft. The solar zones must also comply with fire code requirements, including, but not limited to, setback and pathway requirements. Current fire code requirements can be found in Title 24 Part 2 § 3111, Title 24 Part 2.5 §R331, and Title 24 Part 9 § 903.3.



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## 9.4 Solar Zone Exceptions

There are five exceptions to the solar zone area requirement described in §110.10(b)1B. Some exceptions are limited to certain buildings, as noted in the individual exception details below. Submit an NRCC-SRA-E, the "Solar Ready Areas" Certificate of Compliance to the enforcement agency for all building projects subject to Solar Ready, even if using a Solar Zone Exception.

Exception 3 allows a reduced-size solar zone when solar access is limited by certain circumstances.

Exceptions 1, 2, 4 and 5 allow alternate efficiency measures instead of a solar zone, so the requirements for zone shading, azimuth and design load; interconnection pathway, and owner documentation do not apply either. Any installations must be inspected and verified prior to final approval by the enforcement agency.

Exception 1: A compliant solar electric system is permanently installed on high-rise multifamily, hotel/motel, and nonresidential buildings. The system must have a nameplate direct current (DC) power rating of no less than 1 watt per sq. ft of roof area. The nameplate rating must be measured under Standard Test Conditions. See Example 9-6. To verify compliance with this exception, NRCI-SPV-01-E Certificate of Installation: Solar Photovoltaic System must be submitted as a condition of final approval.

Exception 2: A solar hot water system (SWH) is permanently installed on high-rise multifamily or hotel/motel. The SWH system must comply with §150.1(c)8Biii, the prescriptive solar requirements for a system serving multiple dwelling units. To verify compliance with this exception, submit NRCI-STH-01-E Certificate of Installation: Solar Water Heating System.

Exception 3: Reduce the solar zone area when the roof is shaded by objects that are not part of the building project, and therefore beyond the designer's control. The designated solar zone may be reduced to  $\geq 50$  percent of the potential solar zone area when solar access is limited as described below. When the "potential" solar zone is smaller than the 250 sq. ft minimum, the solar zone can be reduced to half the area of the potential solar zone. The reduced-size solar zone is called the "designated" solar zone.

### **Exception for Reduced Solar Zone**

**Step 1:** Determine the Annual Solar Access: For the solar ready requirements, solar access is the ratio of solar insolation including shading to the solar insolation without shading. Annual solar access is most easily determined using specialized software.

$$\text{Solar Access} = \frac{\text{Solar Insolation Including Shading}}{\text{Solar Insolation Without Shading}}$$

Solar access does not take into account shading from objects that are included in the building project because the designer has control of potential obstructions. Objects that are not part of the building project cannot be moved or modified as part of the project and include existing buildings, telephone poles, communication towers, trees, or other objects. Objects that are considered part of the building project are objects constructed as part of the building project and include the building itself, its HVAC equipment, outdoor lights, landscape features and other similar objects.

First evaluate whether there are any objects outside the building project that will shade the rooftop (or other prospective solar zone areas such as overhangs or parking shade structures). If an existing object is located north of all potential solar zones, the object will not shade the solar zone. Similarly, if the horizontal distance (“D”) from the object to the solar zone is at least two times the height difference (“H”) between the highest point of the object and the horizontal projection of the nearest point of the solar zone, then the object will not shade the solar zone (See Figure 9-2).

**Step 2:** Determine the Potential Solar Zone Area: On low-sloped roofs, the potential solar zone is the area where annual solar access is  $\geq 70$  percent.

On steep-sloped roofs the potential solar zone is the area where the annual solar access is  $\geq 70$  percent on the portion oriented between 90 and 300 degrees of true north.

**Step 3:** Determine the size of the designated solar zone. The designated solar zone must be  $\geq 50\%$  of the potential solar zone area. If the roof is shaded such that there is no potential solar zone area, then no solar zone is required. Document the method/tools used to demonstrate that the solar access is less than 70 percent in the compliance form NRCC-SRA-E (Minimum Solar Zone Area Worksheet).

**Exception 4:** Allowed for multifamily buildings only. The solar zone, interconnection pathway, and documentation requirements do not apply when compliant thermostats and other energy efficiency features are installed during construction.

In each dwelling unit, the thermostats must have demand responsive (DR) controls that comply with Section 110.12(a). The thermostats must be installed in the dwelling units before the local enforcement agency grants the occupancy permit.

§110.12 is a new section in the 2019 Energy Standards that specifies capabilities for demand responsive controls. A “demand responsive control” is defined in §100.1 as an “automatic control capable of receiving and automatically responding to a demand response signal.” The technical specifications for compliant demand responsive control thermostats are detailed in JA5.

In addition to the demand responsive thermostats, choose option A or option B

(below).

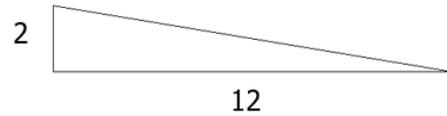
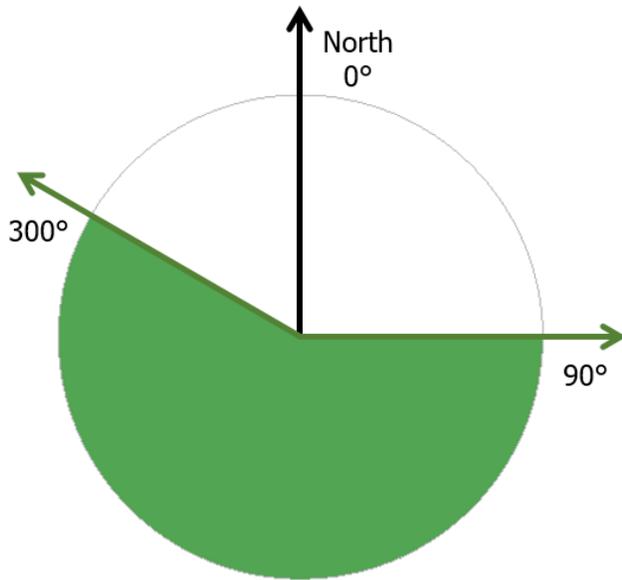
- A.** Each dwelling unit must have one of the following four measures (1 – 4):
1. Install a dishwasher that meets or exceeds the ENERGY STAR® program requirements with either a refrigerator that meets or exceeds the ENERGY STAR program requirements or a whole-house fan driven by an electronically commutated motor.
  2. Install a home automation system that complies with §110.12(a) and capable of, at a minimum, controlling the appliances and lighting of the dwelling and responding to demand response signals.
  3. Install alternative plumbing piping to permit the discharge from the clothes washer and all showers and bathtubs to be used for an irrigation system. It must comply with the California Plumbing Code and local ordinances.
  4. Install a rainwater catchment system that uses rainwater flowing from at least 65% of the available roof area. It must comply with the California Plumbing Code and local ordinances.
- B.** Meet the Title 24 Part 11, Section A4, 106.8.2 requirements for electric vehicle charging spaces.

Exception 5: Applies to multifamily, hotel/motel, and nonresidential buildings. If the roof is designed and approved to be a heliport, or used for vehicular traffic or parking, no solar zone is required. Therefore, interconnection pathway and documentation requirements do not apply.

#### 9.4.1 Solar Zone Azimuth

§110.10(b)2

If the solar zone is on a steep-sloped roof (the roof has a rise to run ratio of greater than 2:12), then the roof must be oriented between 90 degrees and 300 degrees of true north (not magnetic north). The orientation is important because it ensures a reasonable solar exposure if a solar energy system is installed in the future.

**Figure 9-1: Orientation of Roof If Solar Zone Is Located on Steep-Sloped Roof**

If solar zone is located on a sloped roof with a rise to run ratio greater than 2:12 (see above), then the roof must face between 90° and 300°

If a solar zone is located on a low-sloped roof (the roof has a rise to run ratio less than 2:12), the orientation requirements do not apply.

#### 9.4.2 Solar Zone Shading

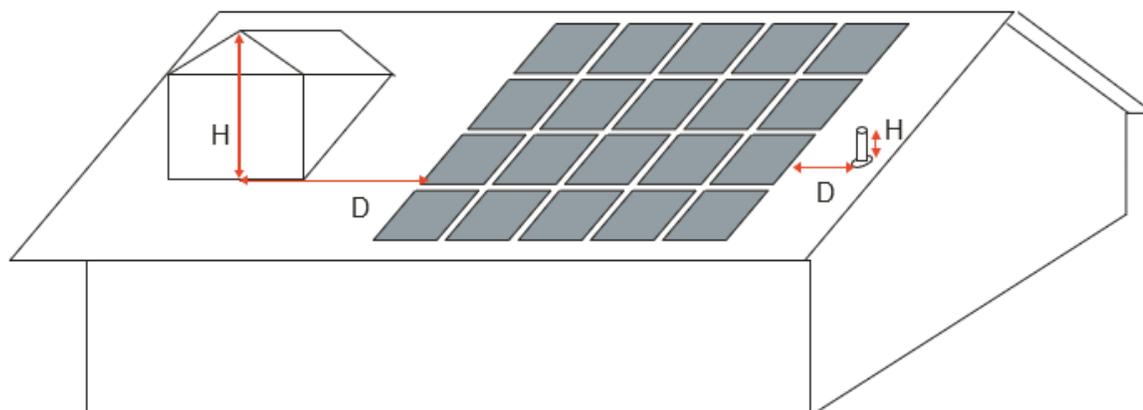
§110.10(b)3

Obstructions such as vents, chimneys, architectural features, or roof-mounted equipment cannot be located in the solar zone. This requirement is in place so the solar zone remains clear and open for the future installation of a solar energy system.

Any obstruction located on the roof or any other part of the building that projects above the solar zone must be located at a sufficient horizontal distance away from the solar zone such that the obstruction will not shade the solar zone. Equation 9-1 and Figure 9.2 describe the allowable distance between any obstruction and the solar zone. For each obstruction, the horizontal distance (“D”) from the obstruction to the solar zone has to be at least two times the height difference (“H”) between the highest point of the obstruction and the horizontal projection of the nearest point of the solar zone.

**Figure 9-2: Schematic of Allowable Setback for Rooftop Obstructions**

$$\text{Equation 9-1: } D \geq 2H$$



Source: California Energy Commission

Obstructions located north of all points of the solar zone are not subject to the horizontal distance requirements. Obstructions not located on the roof or another part of the building, such as landscaping or a neighboring building, are not subject to the horizontal distance requirements.

### 9.4.3 Solar Zone Structural Design Loads

§110.10(b)4

The structural design load requirements apply if any portion of the solar zone is located on the roof of the building. For the areas of the roof designated as the solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents. This is required so that the structural loads are known if a solar energy system is installed in the future.

The Energy Standards do not require estimating the loads of possible future solar equipment.

## 9.5 Interconnection Pathways

§110.10(c)

All buildings that include a solar zone must also include a plan for connecting a PV or SWH system to the electrical or plumbing system of the building. The construction documents must indicate:

1. A location for inverters and metering equipment for future solar electric systems. The allocated space should be appropriately sized for a PV system that could cover the entire solar zone.
2. A pathway for routing conduit from the solar zone to the point of interconnection with the electrical service. The design drawings must show where the conduit would be installed if a system were installed at a future date. There is no requirement to install conduit.

3. A pathway for routing plumbing from the solar zone to the water-heating system connection. The design drawings must show where the plumbing would be installed if a SWH system were installed at a future date. There is no requirement to install piping.

This requirement is not applicable if compliance is achieved by using Exceptions 1, 2, 4 and 5 in lieu of a designated solar zone.

## 9.6 Documentation for the Building Occupant

### §110.10(d)

A copy of the construction documents that show the solar zone, the structural design loads, and the interconnection pathways must be provided to the building occupant. The building occupant must also receive a copy of compliance document NRCC-SRA-E. The document copies are required so that the solar-ready information is available if the occupant decides to install a solar energy system in the future. This requirement is not applicable if compliance is achieved by using Exceptions 1, 2, 4 and 5 in lieu of a designated solar zone.

#### Example 9-6

##### Question:

An office building has a total roof area of 5,000 sq. ft. The total roof area covered by skylights is 200 sq. ft. A solar PV system with a DC power rating (measured under standard test conditions) of 4 kilowatts (kW) will be installed. The collection panels for the 4 kW system will cover 400 sq. ft. Does the building have to include a solar zone in addition to the installed solar PV system?

##### Answer:

Yes. To be exempt from the solar zone requirement, the solar PV system must have a power rating equal to 1 watt for every sq. ft of roof area, or in this case 5 kW (see equation below).

$$\text{Minimum PV System Power Rating} = \text{Total Roof Area} \times 1 \text{ Watt per sq. ft}$$

$$5,000W = 5000 \text{ sq. ft} \times 1W/\text{sq. ft}$$

The minimum solar zone for this building is 720 SF. (See calculation below.) The 400 SF on which the solar PV system is installed does count toward the minimum solar zone area, so an additional 320 sq. ft would need to be allocated to complete the minimum solar zone requirement.

$$\text{Minimum Solar Zone Area} = 15\% \times (\text{Total Roof Area} - \text{Area Covered by Skylights})$$

$$720 \text{ SF} = 15\% \times (5,000 \text{ sq. ft} - 200 \text{ sq. ft})$$

## 9.7 Additions

### §141.0(a)

The solar-ready requirements for additions are covered by the Energy Standards in §141.0(a). Additions do not need to comply with the solar-ready requirements unless the addition increases the roof area by more than 2,000 sq. ft. (200 sq. meters).

## 9.8 California Fire Code Solar Access Requirements

Following regulations established by the Office of the State Fire Marshal, the 2016 version of Parts 2, 2.5, and 9 of Title 24 include requirements for installing rooftop

solar photovoltaic systems. These regulations cover the marking and location of DC conductors, and access and pathways for photovoltaic systems. They apply to residential and nonresidential buildings regulated by Title 24 of the California Building Standards Codes. Provided below is a summary of the fire code requirements for nonresidential buildings.

PV arrays shall not have dimensions in either axis that exceed 150 ft. Nonresidential buildings shall provide a 6-foot wide access perimeter around the edges of the roof. Smoke ventilation options must exist between array installations and next to skylights or smoke and heat vents. Builders shall refer directly to the relevant sections of Title 24 (Part 2: Section 3111, Part 2.5 Section R331, and Part 9 Section 903.3) for detailed requirements.

In addition to the requirements in the fire code, the California Department of Forestry and Fire Protection – Office of the State Fire Marshal (CAL FIRE-OSFM), local fire departments (FD), and the solar photovoltaic industry previously developed the Solar Photovoltaic Installation Guideline to increase public safety for all structures equipped with solar photovoltaic systems. This guideline provides the solar photovoltaic industry with information that will aid in the designing, building, and installation of solar photovoltaic systems in a manner that should meet the objectives of both the solar photovoltaic industry and the requirements set forth in the California Fire Code. The guidelines include illustrations with examples of compliant solar photovoltaic system installations on nonresidential buildings.

The entire Solar Photovoltaic Installation Guideline can be accessed at <http://osfm.fire.ca.gov/pdf/reports/solarphotovoltaicguideline.pdf>

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## 9.9 Compliance and Enforcement

At the time a building permit application is submitted to the enforcement agency, the applicant also submits plans and energy compliance documentation. This section describes the documents and procedures for documenting compliance with the solar-ready requirements of the Energy Standards. The following discussion pertains to the designer preparing construction and compliance documents, and to enforcement agency plan checkers who are examining those documents for compliance with the Energy Standards.

There are four documents to demonstrate compliance with the nonresidential solar ready requirements. Each document is briefly described below.

- NRCC-SRA-E: Certificate of Compliance: Nonresidential Solar Ready Areas

This document is required for every project where the solar-ready requirements apply: newly constructed hotel/motel buildings with 10 or fewer stories, high-rise multifamily buildings with 10 or fewer stories, all other newly constructed nonresidential buildings with 3 or fewer stories, and additions to the previously mentioned buildings that increase the roof area by more than 2,000 sq. ft. This form is required for all covered occupancies, including projects that use any of the solar zone exceptions.

- NRCI-SPV-01-E: Certificate of Installation – Solar Photovoltaic System

This document is required when using solar zone Exception 1 to achieve compliance.

- NRCI-STH-01-E: Certificate of Installation – Solar Water Heating System

This document is required when using solar zone Exception 2 to achieve compliance.