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9. Solar Ready

§110.10

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

Surveys of the existing building stock indicate that fewer than 30 percent of existing nonresidential buildings have suitable locations to install solar photovoltaic (PV) or solar water-heating (SWH) systems. The intent of the solar-ready building requirements is to integrate design considerations that affect the feasibility of installing solar energy systems into the original building design. The Energy Standards require buildings to have an allocated solar zone that is free of obstructions and is not shaded. The solar zone would be a suitable location to install PV or SWH collection panels. In addition, the Energy Standards require that the construction documents depict a plan for connecting a PV and SWH system to the electrical or plumbing system of a building. For areas of the roof designated as a solar zone, the plans must also clearly indicate the structural design loads for roof dead load and roof live load.

There are no infrastructure related requirements in the Energy Standards. Equipment such as solar modules, inverters, and metering equipment do not need to be installed, nor does conduit, piping, or pre-installed mounting hardware. The building structural design does not need to be modified to accommodate the additional loads from solar equipment that might be installed at a future date.

9.1 Overview

The requirements for solar ready buildings are all mandatory. There are no prescriptive and performance compliance paths for solar-ready buildings. Since the provisions are mandatory, there are no tradeoffs allowed, and applicants must demonstrate compliance with each measure. Exceptions to the mandatory measures are described in Section 9.5.

This chapter is organized as follows:

- 9.1 Overview
- 9.2 Covered Occupancies
- 9.3 Solar Zone
- 9.4 Construction Documents
- 9.5 Exceptions
- 9.6 Additions
- 9.7 California Fire Code Solar Access Requirements
- 9.8 Compliance and Enforcement
- 9.9 Instructions for Completing the Certificate of Compliance Documents

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.

9.3 Solar Zone

§110.10(b)

The *solar zone* is an allocated space that is unshaded and free of obstructions. It serves as a suitable place that solar panels can be installed at a future date.

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

- Roof of building.
- Overhang of the building.
- 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.
- Covered parking installed with the building project.

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

The solar zone design must comply with the access, pathway, smoke ventilation, and spacing requirements as specified in Title 24, Part 9 or in any requirements adopted by a local jurisdiction. These additional requirements are located in other parts of Title 24, including Parts 2, 2.5, and 9 that are adopted by the California Building Standards Commission as part of the California Building Standards Code.

9.3.1 Minimum Area

§110.10(b)1

The minimum solar zone area should be calculated using one of the following methods. Method 1 is described in §110.10(b)1B and should be used if shading is not a concern. Method 2 is described in Exception 3 to §110.10(b)1B and should be used if the site has significant shading.

A. Method 1: Minimum Solar Zone Area Based on Total Roof Area

The solar zone must have a total area that is no less than 15 percent of the total roof area after subtracting any area of the roof that is covered by a skylight.

The total area of the solar zone may be composed of multiple subareas. No dimension of a subarea can be less than 5 feet. If the total roof area is equal to or less than 10,000 square feet (1,000 square meters), each subarea must be at least 80 square feet (8 square meters). If the total roof area is greater than 10,000 square feet (1,000 square meters), each subarea must be at least 160 square feet (16 square meters).

B. Method 2: Minimum Solar Zone Area Based on Potential Solar Zone

The minimum required solar zone area may be reduced if the building site is shaded by objects that are not part of the building itself and there is no unshaded area that could accommodate the full solar zone.

For the Energy Standards, the *potential solar zone* is defined as the total area on an eligible space (that is, roof, overhang, roof or overhang of a structure within 250 feet (75 meters) of the building, or on a covered parking structure installed with the building) that has annual solar access of 70 percent or greater. If the potential solar zone is smaller than the minimum solar zone area specified in §110.10(b)1B (15 percent of the roof area of the building, excluding any skylights), then the solar zone can be reduced to half the area of the potential solar zone. If the roof is shaded such that there is no potential solar zone area, then no solar zone is required.

For the solar-ready requirements, *solar access* is the ratio of solar insolation, including shading from objects that are excluded from the building project, to the solar insolation without shading.

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

Objects that are excluded from the building project are objects that will not be moved or modified as part of the building project and include existing buildings, telephone poles, communication towers, trees, or other objects. Objects that are included in the building project are objects that will be constructed as part of the building project and include the building itself, HVAC equipment on the building, parking lot lights, and other similar objects. As mentioned, solar access does not take shading from objects that are included in the building project as the designer has control of the location of these potential obstructions.

Annual solar access is most easily determined using an instrument that is equipped with a camera with a fisheye lens and specialized imagery processing software. The instrument can calculate the annual solar access of any point on a proposed site based on the location of the building and information that is captured in the digital photograph. Since this type of instrument relies on photographs, their most appropriate use is to determine solar access on existing buildings. The instruments are not as useful in the design phase for newly constructed buildings when capturing a digital photograph from the proposed solar zone location is not feasible.

To determine the annual solar access during the design phase, designers will 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 to the 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.)

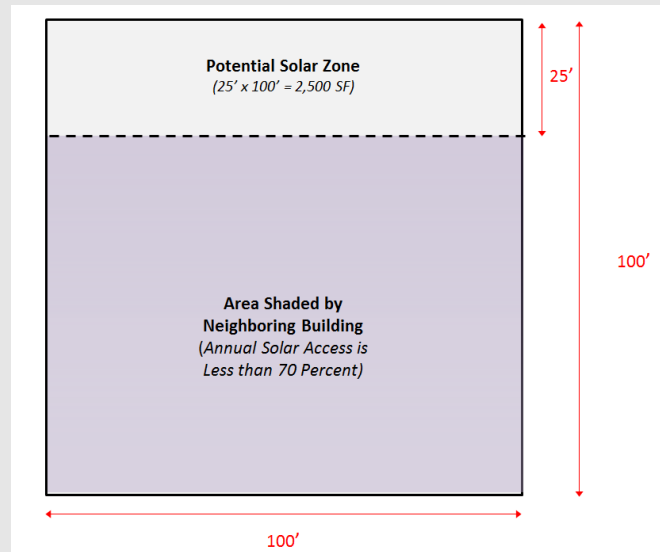
If objects outside the building project could shade the solar zone, annual solar access can be quantitatively determined using several computer-aided design (CAD) software packages that can import a CAD file of the building and perform a shading analysis, or several online solar quoting tools that make use of both overhead and orthogonal aerial

imagery. Annual solar access can be qualitatively determined using several three-dimensional modeling programs.

Example 9-1

Question:

A roof with no skylights has an area of 10,000 ft². A neighboring building shades the roof, so 7,500 SF 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 SF, or 15 percent of the total roof area (10,000 SF). However, since the potential solar zone is 2,500 SF, the minimum solar zone can be reduced to half the area of the potential solar zone, or 1,250 SF.

Example 9-2

Question:

The total roof area is less than 10,000 SF, but the potential solar zone is less than the minimum size requirements for any subarea (less than 80 SF 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 SF (if roof is less than or equal to 10,000 SF) or 160 SF (if roof is greater than 10,000 SF), 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?

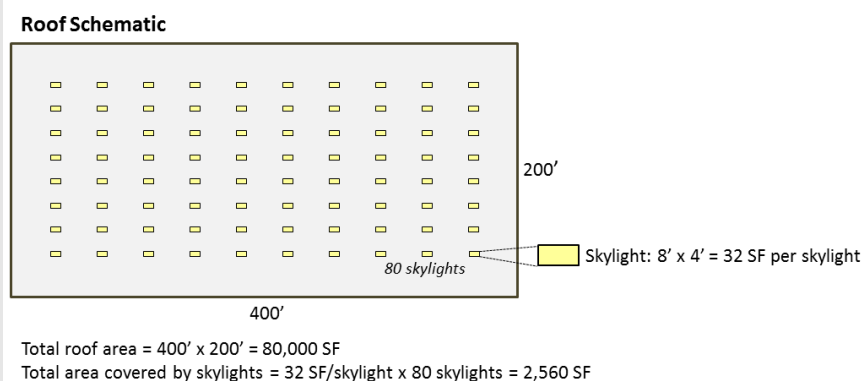
Answer:

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 square feet (SF). Skylights cover 2,560 SF of the total roof area. What is the minimum solar zone area?

**Answer:**

The minimum solar zone area would be 11,616 SF

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

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

Example 9-5

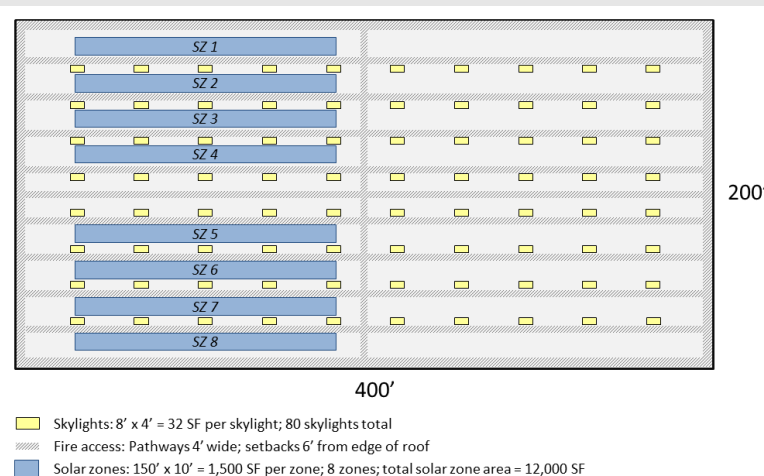
Question:

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 SF or less, each subarea must be at least 80 SF. If the total roof area is greater than 10,000 SF, each subarea must be at least 160 SF.

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 SF. 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.

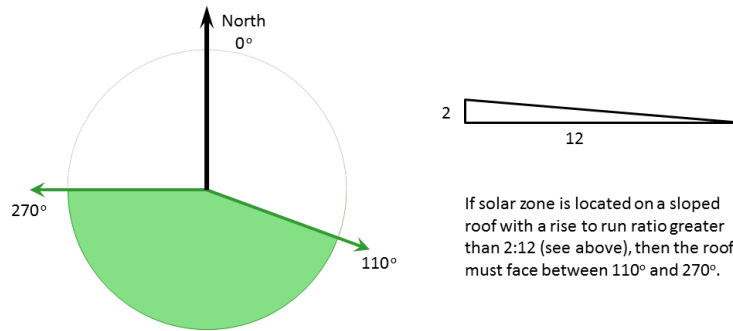


9.3.2 Orientation

§110.10(b)2

If the solar zone is located on a steep-sloped roofs (that is, the roof has ratio of rise to run of greater than 2:12), then the roof must be oriented between 110 degrees and 270 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 a solar zone is located on a low-sloped roof (that is, the roof has a ratio of rise to run less than 2:12), the orientation requirements do not apply.

9.3.3 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.

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

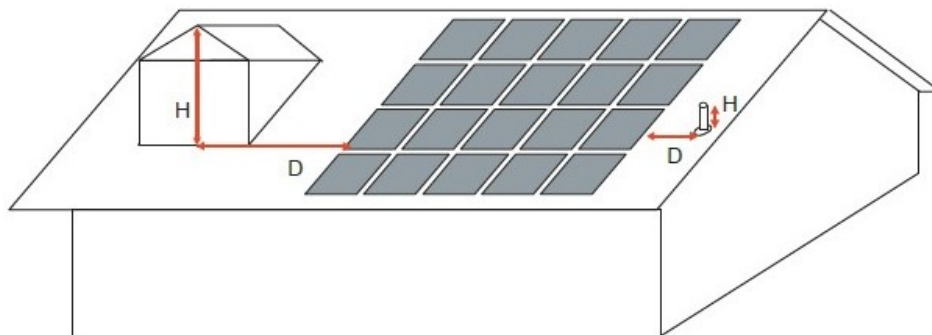


Figure 9-2: Schematic of Allowable Setback From Rooftop Obstructions

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 Construction Documents

Construction documents must include information about the as-designed structural loads and plans for interconnecting a PV and SWH system to the electrical or plumbing systems of the building.

9.4.1 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 the roof on which the solar zone is located to be designed taking the loads of the solar equipment into consideration. In other words, there are no requirements for the inclusion of any collateral loads for future solar energy systems.

9.4.2 Interconnection Pathways

§110.10(c)

All buildings that must 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 would cover the entire solar zone.
2. A pathway for routing conduit from the solar zone to the point of interconnection with the electrical service. There is no requirement to install conduit. Rather, the design drawings must show where the conduit would be installed if a system were installed at a future date.
3. A pathway for routing of plumbing from the solar zone to the water-heating system. There is no requirement to install piping.

9.4.3 Documentation

§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 documents number NRCC-SRA-01-E and NRCC-SRA-02-E. Providing information to the building occupant is required so that the solar-ready information is available if the occupant decides to install a solar energy system in the future.

9.5 Exceptions

There are five exceptions to the solar zone area requirement described in §110.10(b)1B of the Energy Standards. Four of these five exceptions are described below. Although the language in the Standards implies that these four exceptions only apply to the solar zone requirements, the intent of the Energy Standards is for the exceptions to apply to the solar zone requirement, as well as the interconnection pathway requirements described in §110.10(c), and the documentation requirements described in §110.10(d).

1. **PV System Is Permanently Installed (Exception 1 to §110.10(b)1B):** Buildings are exempt from solar zone, interconnection pathway, and documentation requirements if a solar PV system with a nameplate direct current (DC) power rating of no less than 1 watt per square foot of roof area is permanently installed at the time of construction. The nameplate rating must be measured under standard test conditions. The permanently installed solar PV system can be installed anywhere on the building site. To verify compliance with this exception, document *NRCI-SPV-01-E Certificate of Installation: Solar Photovoltaic System* must be submitted.
2. **SWH System Is Permanently Installed (Exception 2 to §110.10(b)1B):** Buildings are exempt from solar zone, interconnection pathway, and documentation requirements if a domestic SWH system is permanently installed at the time of construction. The SWH system must comply with §150.1(c)8Ciii, the prescriptive solar water-heating system requirements when installing a water-heating system serving multiple dwelling units. The permanently installed domestic SWH collectors can be installed anywhere on the building site. To verify compliance with this exception, document *NRCI-STH-01-E Certificate of Installation: Solar Water Heating System* must be submitted.
3. **High-Rise Multifamily Building With Occupant-Controlled Smart Thermostats (OCST) and Efficient Equipment Installations:** High-rise multifamily buildings that comply with Items 1 and 2 below are exempt from solar zone, interconnection pathway, and documentation requirements.
 1. All thermostats in each dwelling unit are *occupant-controlled smart thermostats (OCST)* with communications capabilities enabled to receive and respond to demand response signals. An OCST is a setback thermostat with communication capabilities that enable the occupant to receive demand response-related messages and respond to those signals by automatic adjustment of the thermostat setpoint as described in Joint Appendix JA5 (subject to occupant participation). Enabling communications capabilities requires that the OCST has one of the following: onboard communications capabilities, an installed communications module for OCSTs with removable communications module(s), or an installed communications gateway for an OCST where an external gateway is required for communications.

OCST must be certified by the Energy Commission to meet the requirements described in Joint Appendix JA5.
 2. One of the following additional measures is followed:
 - a. **Efficient Appliances:** Install, in each dwelling unit, a dishwasher that meets or exceeds ENERGY STAR® requirements, along with either a refrigerator that also meets or exceeds ENERGY STAR requirements or a whole-house fan that is driven by an electronically commutated motor.
 - b. **Home Automation:** Install, in each dwelling unit, a home automation system that can (at a minimum) control either the appliances or the lighting and can respond

- to demand response signals. This measure can be met by the same device that performs the OCST functions if that device is also capable of controlling lighting or appliances.
- c. Graywater Irrigation: Install alternative plumbing (piping) to permit the discharge from any clothes washers (whether in individual dwelling units or communal laundry rooms) and all showers and bathtubs to be used for an irrigation system. This graywater system must comply with the California Plumbing Code and any applicable local ordinances.
 - d. Rainwater Catchment: Install a rainwater catchment system that is able to capture water flowing from at least 65 percent of the roof area of the building. This catchment system must comply with the California Plumbing Code and any applicable local ordinances.
4. **Roof Designed for Vehicle Traffic or Heliport (Exception 5 to §110.10(b)1B):** Buildings are exempt from solar zone interconnection pathway and documentation requirements if the roof is designed for vehicle traffic (parking lot) or if the roof is designed as a helicopter landing zone.
5. **Exception:** Exception 3 to §110.10(b)1B allows the minimum solar zone area to be reduced if the solar access at the building site is limited. Exception 3 to §110.10(b)1B is detailed above in the minimum solar zone area section of this chapter (Section 9.3.1).

Example 9-6

Question:

An office building has a total roof area of 5,000 SF. The total roof area covered by skylights is 200 SF. 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 SF. Does the building have to 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 square foot of roof area, or in this case 5 kW (see equation below).

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

$$5,000W = 5000 \text{ SF} \times 1W/\text{SF}$$

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 SF would need to be allocated to complete the minimum solar zone requirement.

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

$$720 \text{ SF} = 15\% \times (5,000 \text{ SF} - 400 \text{ SF})$$

9.6 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 square feet (200 square meters).

9.7 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 feet. 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>

9.8 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 associated with the nonresidential solar ready requirements. Each document is briefly described below.

- NRCC-SRA-01-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 increases roof area by more than 2,000 SF.

- NRCC-SRA-02-E: Certificate of Compliance: Minimum Solar Zone Area Worksheet

This document is required when buildings comply with the solar-ready requirement by including a solar zone. That is, an appropriately sized solar PV system is not installed, an appropriately sized solar water heating system is not installed, the roof is not designed for vehicle traffic or a heliport, or the building is not a high-rise multifamily building that complies with all the OCST and high-efficacy lighting requirements in Exception 4 to §110.10(b)1B.

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

This document is required when the building is exempt from the solar zone requirements because an appropriately sized solar PV system has been installed.

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

This document is required when the building is exempt from the solar zone requirements because an appropriately sized solar water-heating system has been installed.

