EL DORADO COUNTY REGIONAL FIRE PROTECTION STANDARD

Solar Photovoltaic Installation Standard
STANDARD #H-005 EFFECTIVE 08-20-2009

About the Guideline

This guideline was developed with safety as the principal objective. The solar photovoltaic industry has been presented with certain limitations in roof installations due to firefighting suppression techniques. The intent of this guideline is to provide 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 Fire Service.

The provisions of this guideline, as adopted by the El Dorado County Regional Fire Districts, is meant to apply to the design, construction and installation of solar photovoltaic systems on buildings regulated by Title 24 of the California Building Standards Codes.

A solar contractor should always contact their local fire department to determine if the means or methods to be used will allow for a safe installation that is acceptable to the fire department and meets local code requirements.

General Information about Solar Photovoltaic Systems

Solar photovoltaic systems generate electricity from the sun. As of September 2007, there are roughly 30,000 solar photovoltaic systems installed on homes, commercial buildings and free-standing structures in California. Most systems are connected to the electric grid and provide power to the site. The majority of these systems do not have any battery backup equipment – instead, excess power is sent to the electric utility system.

Solar photovoltaic (PV) systems are installed with an alternating current (AC) disconnect at the service panel. Conduit carrying direct current (DC) power connects the modules to the inverter. The inverter connects the PV system to the utility service panel. AC disconnects are not required in all jurisdictions because the main breaker provides this level of disconnect.

A DC disconnect is installed on the site side of the inverter. Typical systems seen today have an inverter located near the utility service panel. Some inverters (micro inverters, AC modules) are located at the PV module (the solar industry refers to PV panels as “modules”). If the inverter is located at the PV module, the conduit from the modules to the utility power supply is AC. The DC disconnect at the service panel cuts power to the inverter, which is then unable to export power to the utility service panel and prevents any solar electricity from harming service or maintenance workers on the utility side of the panel. During the day, there is power in the conduit between the PV modules and the DC disconnect.

The systems can produce up to 8 amps and up to 600 volts of electricity which varies by installation. Modules connected together are called strings. Multiple strings are connected together at a combiner box. The power output is highest on a bright day with low ambient temperatures and drops as the modules heat up (such as on a very hot day). There is no power output in the dark and there is no stored energy in the modules themselves. Service lights used by fire crews do not provide enough light to develop any harmful power levels.

Modules are mounted on buildings or on ground supported frames. Roof mounted modules, also sometimes known as panels, can be one of these types:

- Directly on a building's roof
- Integral to the roof system of a building
- On a rack with a space above the roof surface
- On a freestanding structure but not on the habitable structure (such as a trellis or other free-standing support structure)

Specifically:

- Modules attached to a mounting system may be attached to the roof or rest on the roof surface.
- Modules integrated to the roof system are commonly referred to as Building Integrated Photovoltaics (BIPV) and are of two types:
  - Physically integrated roofing products resemble roof shingles or tiles and are installed along with standard roof shingles or tiles so that they blend into the overall appearance of the roof. Physically integrated BIPV modules alternate current as part of a defined roofing system.
  - Aesthetically integrated modules also resemble roof shingles or tiles and are installed along with standard roof shingles or tiles to blend into the overall appearance of the roof. Aesthetically integrated modules do not alternate current as part of a defined roofing system.

Modules are located in a manner to provide the best access to sunlight. This means they are typically mounted on the south or west side facing roof façade. In residential applications, the typical roof area used is about 400 square feet. Larger size systems correspond to a higher site electricity demand.

Although it is not advisable to step or walk on any solar system due to slip and/or trip hazards, **the systems should be able to support a firefighter's weight.**

Other PV products, such as those integrated with a curtain wall or as windows are not currently addressed in this guideline. Other types of solar energy systems that might be seen at a site do not generate electricity. These can be broken down into three major types - solar water heating, solar pool heating, and solar space conditioning. In these systems, modules and piping usually

carry water or glycol. Glycol is used in areas where extended periods of freezing temperature levels could cause ice to damage the solar panels and/or distribution pipes.

General

Growing demand for solar photovoltaic products is leading to new products, designs, technologies, and installation methods. As new products and methods become available, local fire departments may encounter solar photovoltaic systems that will require an alternative means of compliance. Solar contractors should contact their local fire department to determine if alternate means or methods would allow for a safe installation that is acceptable to the fire department.

The fire department may approve Alternative Means of Compliance based on their authority, in accordance to California Building Code Sections 108.7 for residential buildings or Section 111.2.4 for occupancies regulated by the Office of the State Fire Marshal. This may be necessary where, for example, new products, designs, technologies or methods become available that provide sufficient alternative protection and access, pathways, and ventilation opportunities for fire crews.

1.0 MARKING

PV systems shall be marked. Marking is needed to provide fire personnel with appropriate warning and guidance with respect to working around and isolating the solar electric system. This can facilitate identifying energized electrical lines that connect the solar modules to the inverter, as these should not be cut when venting for smoke removal.

Materials used for marking must be weather resistant. Use Underwriters Laboratories Marking and Labeling System 969 (UL 969) as a standard to determine the weather rating. (UL listing of markings is not required).

1.1 Main Service Disconnect

For residential applications, the marking shall be placed on the outside breaker panel cover to the main service disconnect. Alternate locations may be approved by the local fire district.

For commercial application, the marking shall be placed adjacent to the main service disconnect in a location clearly visible from the location where the lever is operated.

1.1.1 Marking Content and Format

- MARKING CONTENT: CAUTION: SOLAR ELECTRIC SYSTEM
- RED BACKGROUND
- WHITE LETTERING
- MINIMUM 3/8” LETTER HEIGHT

- ALL CAPITAL LETTERS
- ARIAL OR SIMILAR FONT, NON-BOLD
- REFLECTIVE, WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT (durable adhesive materials may meet this requirement)

CAUTION: SOLAR ELECTRIC SYSTEM

1.2 Marking for DC Conduit, Raceways, Enclosures, Cable Assemblies, and Junction Boxes

Marking is required on all interior and exterior DC conduit, raceways, enclosures, cable assemblies, and junction boxes to alert the Fire Service to avoid cutting them. Marking shall be placed on all interior and exterior DC conduit, raceways, enclosures, and cable assemblies, every 10 feet, at turns and above and/or below penetrations and all DC combiner and junction boxes.

1.2.1 Marking Content and Format

- MARKING CONTENT: CAUTION: SOLAR CIRCUIT
- RED BACKGROUND
- WHITE LETTERING
- MINIMUM 3/8" LETTER HEIGHT
- ALL CAPITAL LETTERS
- ARIAL OR SIMILAR FONT, NON-BOLD
- REFLECTIVE, WEATHER RESISTANT MATERIAL SUITABLE FOR THE ENVIRONMENT (durable adhesive materials meet this requirement)

CAUTION: SOLAR CIRCUIT

1.3 Inverters

The inverter is a device used to convert DC electricity from the solar system to AC electricity for use in the building's electrical system or the grid.

No markings are required for the inverter.

Markings and / or labels are in addition to those required by the National Electrical Code.

2.0 ACCESS, PATHWAYS AND SMOKE VENTILATION

Access and spacing requirements should be observed in order to:

- Ensure access to the roof
- Provide pathways to specific areas of the roof

- Provide for smoke ventilation opportunities area
- Provide emergency egress from the roof

Local jurisdictions may create exceptions to this requirement where access, pathway or ventilation requirements are reduced due to:

- Proximity and type of adjacent exposures
- Alternative access opportunities (as from adjoining roofs)
- Ground level access to the roof area in question
- Adequate ventilation opportunities beneath solar array (as with significantly elevated or widely-spaced arrays)
- Adequate ventilation opportunities afforded by module set back from other rooftop equipment (example: shading or structural constraints may leave significant areas open for ventilation near HVAC equipment)
- Automatic ventilation device
- New technology, methods, or other innovations that ensure adequate fire department access, pathways and ventilation opportunities

Designation of ridge, hip, and valley does not apply to roofs with 2-in-12 or less pitch. All roof dimensions are measured to centerlines.

Roof access points should be defined as areas where ladders are not placed over openings (i.e., windows or doors) and are located at strong points of building construction and in locations where they will not conflict with overhead obstructions (i.e., tree limbs, wires, or signs).

2.1 Residential Systems—Single and Two-Unit Residential Dwellings

The local fire district require a plan review for all residential buildings.

Examples of these requirements appear at the end of this guideline.

2.1.1 Access/Pathways

a. Residential Buildings with hip roof layouts: Modules should be located in a manner that provides one (1) three-foot (3’) wide clear access pathway from the eave to the ridge on each roof slope where modules are located. The access pathway should be located at a structurally strong location on the building (such as a bearing wall).

b. Residential Buildings with a single ridge: Modules should be located in a manner that provides two (2) three-foot (3’) wide access pathways from the eave to the ridge on each roof slope where modules are located.

c. Hips and Valleys: Modules should be located no closer than one and one half (1.5) feet to a hip or a valley if modules are to be placed on both sides of a hip or valley. If the

modules are to be located on only one side of a hip or valley that is of equal length then the modules may be placed directly adjacent to the hip or valley.

2.1.2 Firefighter Emergency Smoke Ventilation Access

The modules should be located no higher than three feet (3') below the ridge.

2.2 Commercial Buildings and Residential Housing Comprised of Three (3) or More Units

Exception: If a local fire district determines that the roof configuration is similar to residential (such as in the case of townhouses, condominiums, or single family attached buildings), the local fire department may make a determination to apply the residential access and ventilation requirements.

Examples of these requirements appear at the end of this guideline.

2.2.1 Access

There should be a minimum six foot (6') wide clear perimeter around the edges of the roof.

Exception: If either axis of the building is 250 feet or less, there should be a minimum four feet (4') wide clear perimeter around the edges of the roof.

2.2.2 Pathways

Pathways should be established in the design of the solar installation. Pathways should meet the following requirements:

a. Should be over structural members
b. Centerline axis pathways should be provided in both axis of the roof. Centerline axis pathways should run on structural members or over the next closest structural member nearest to the center lines of the roof
c. Should be straight line not less than 4 feet (4') clear to skylights and/or ventilation hatches
d. Should be straight line not less than 4 feet (4') clear to roof standpipes
e. Should provide not less than 4 feet (4') clear around roof access hatch with at least one not less than 4 feet (4') clear pathway to parapet or roof edge

2.2.3 Smoke Ventilation

a. Arrays should be no greater than 150 by 150 feet in distance in either axis
b. Ventilation options between array sections should be either:
    1. A pathway 8 feet (8') or greater in width

2. 4 feet (4') or greater in width pathway **and** bordering on existing roof skylights or ventilation hatches
3. 4 feet (4') or greater in width pathway **and** bordering four feet (4') x 8 feet 8' "venting cutouts" every 20 feet (20') on alternating sides of the pathway

3.0 LOCATION OF DIRECT CURRENT (DC) CONDUCTORS

Conduit, wiring systems, and raceways for photovoltaic circuits should 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 should use design guidelines that minimize total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box. The DC combiner boxes are to be located such that conduit runs are minimized in the pathways between arrays.

To limit the hazard of cutting live conduit in venting operations, DC wiring shall be run in metallic conduit or raceways when located within enclosed spaces in a building and should be run, to the maximum extent possible, along the bottom of load-bearing members.

4.0 NON-HABITABLE BUILDINGS

This guideline does not apply to non-habitable structures. Examples of non-habitable structures include, but are not limited to, parking shade structures, solar trellises, etc.

5.0 GROUND MOUNTED PHOTOVOLTIAC ARRAYS

Setback requirements do not apply to ground-mounted, freestanding photovoltaic arrays. A clear brush area of ten feet (10') is required for ground mounted photovoltaic arrays.

*****SEE PAGES 08 – 13 FOR EXAMPLES*****

Diagram 1: Cross Gable Roof

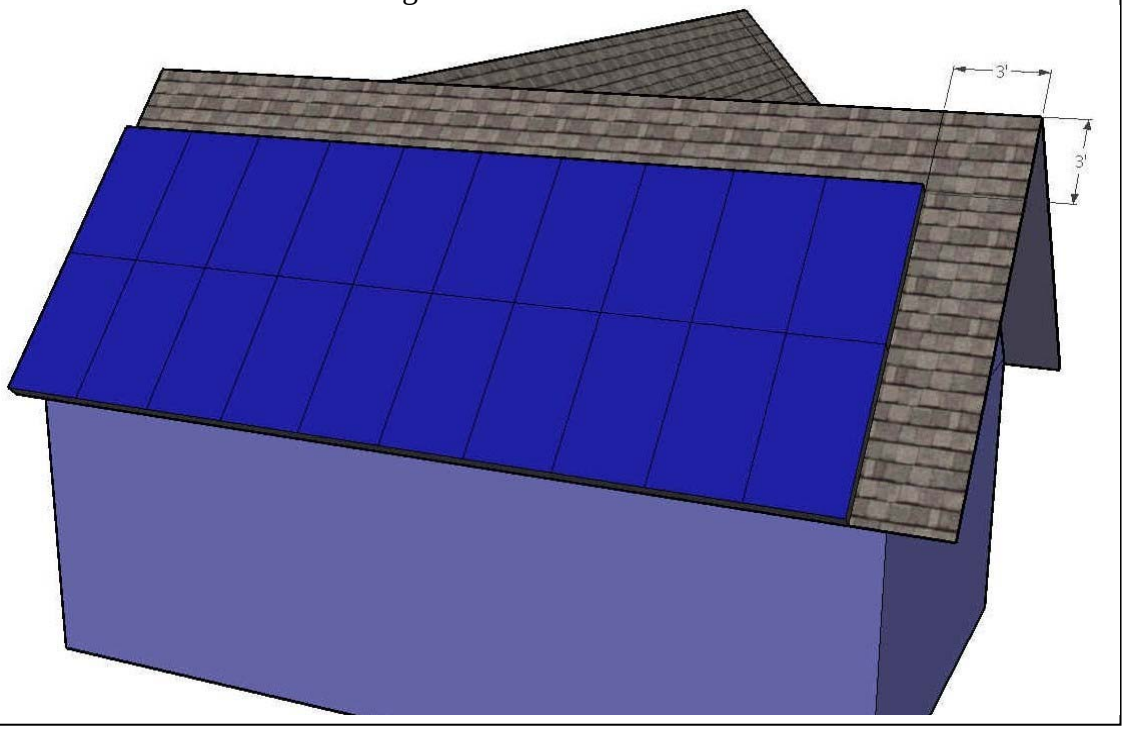


Diagram 2: Cross Gable with Valley

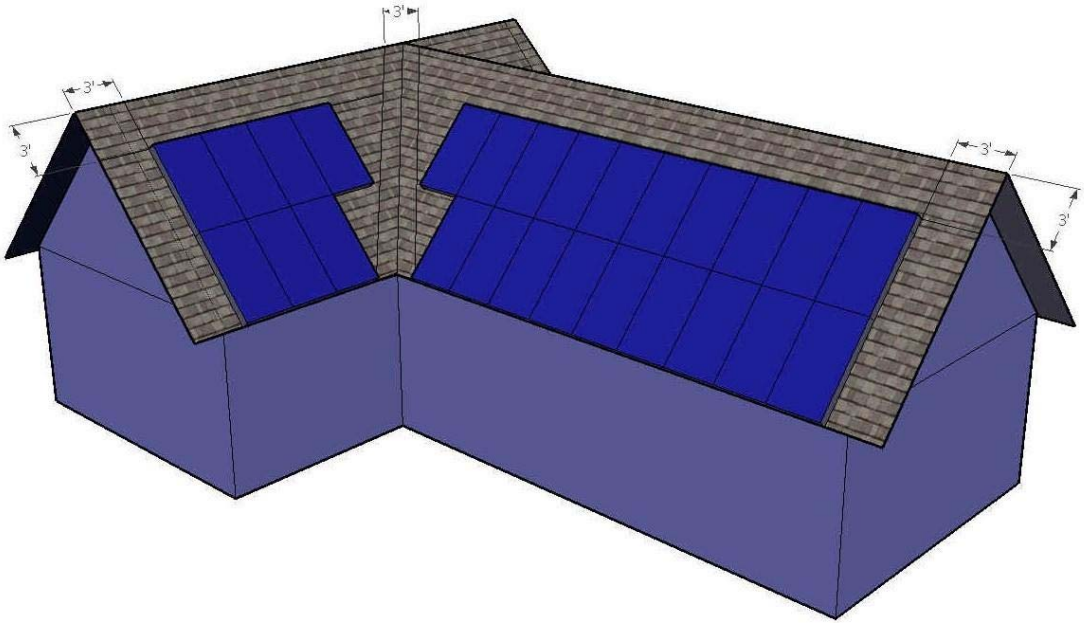
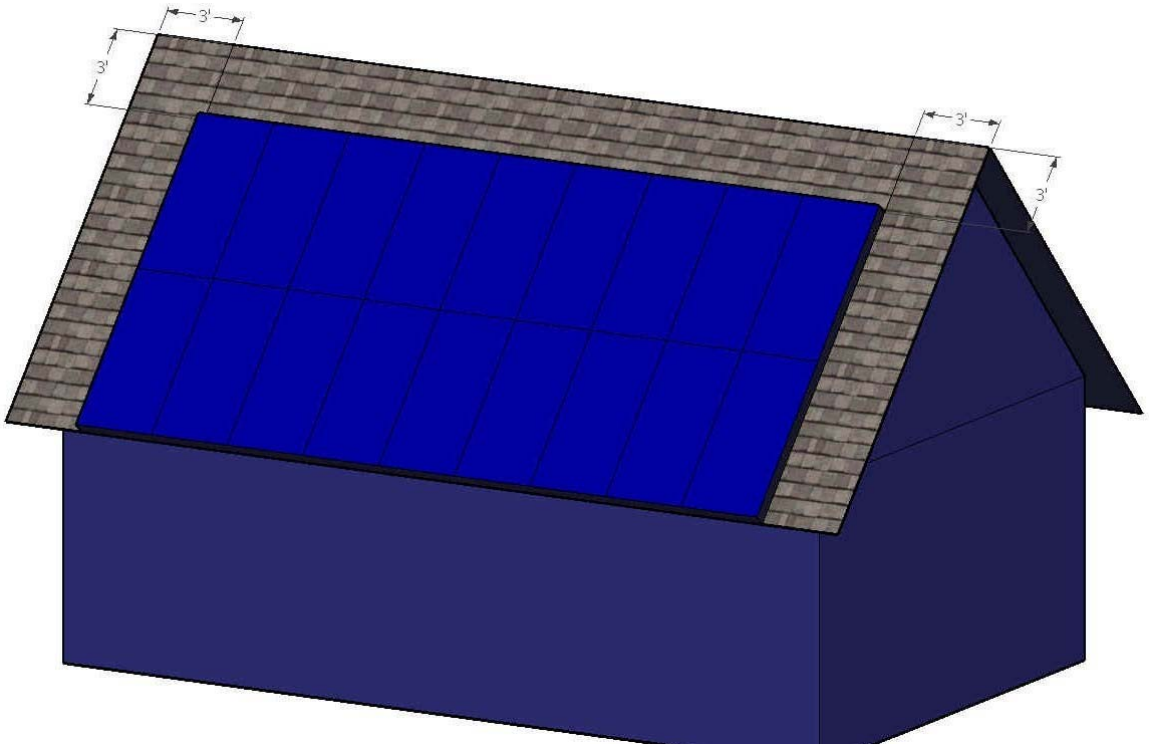
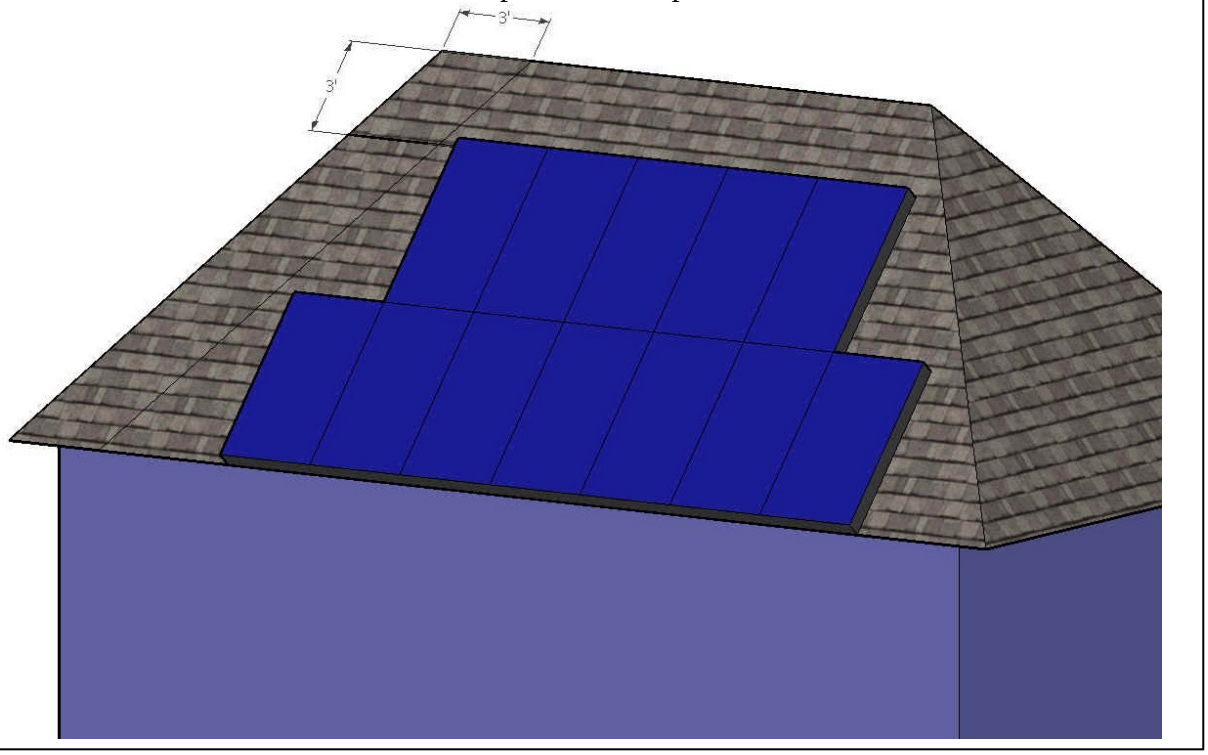
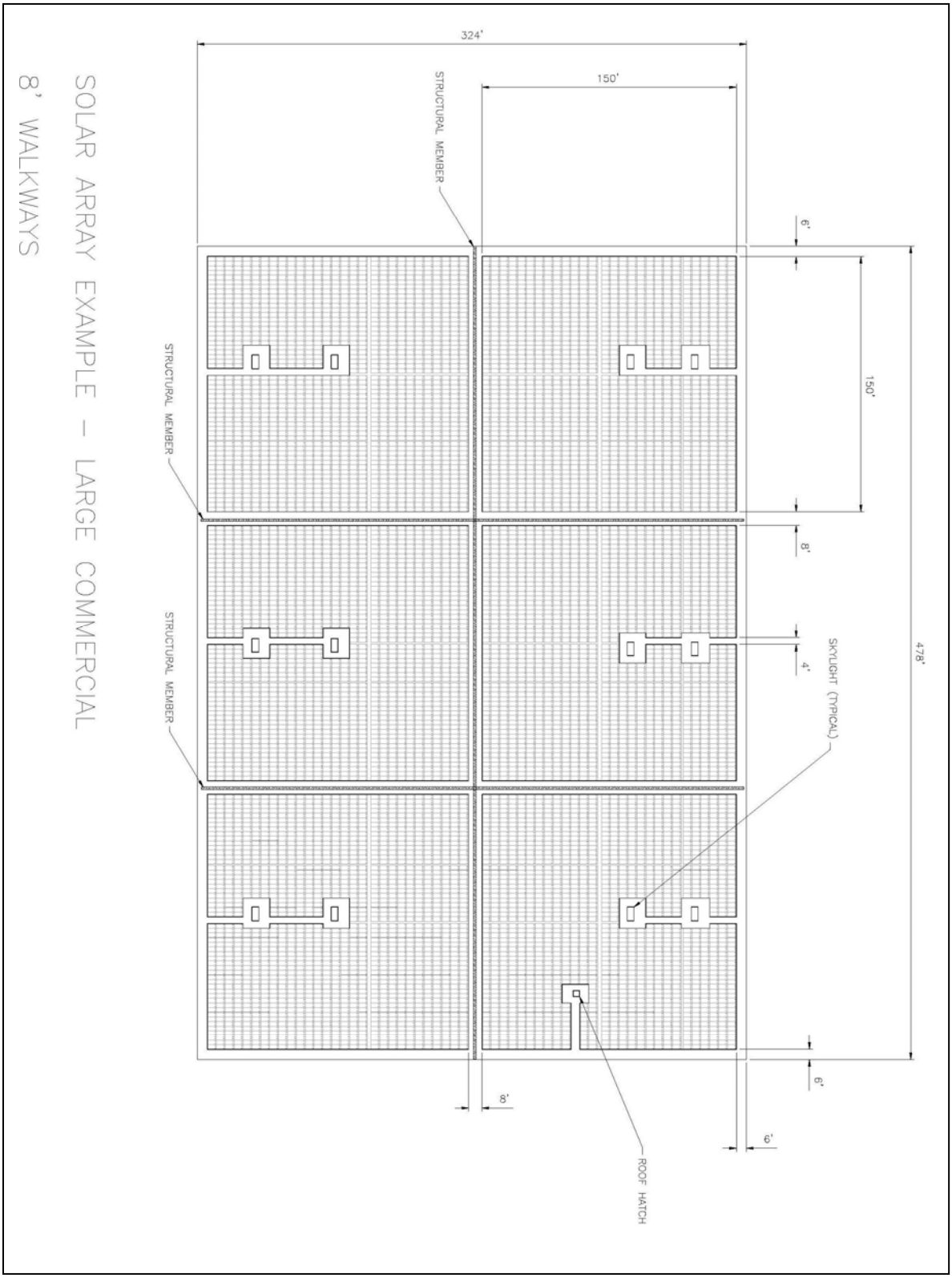


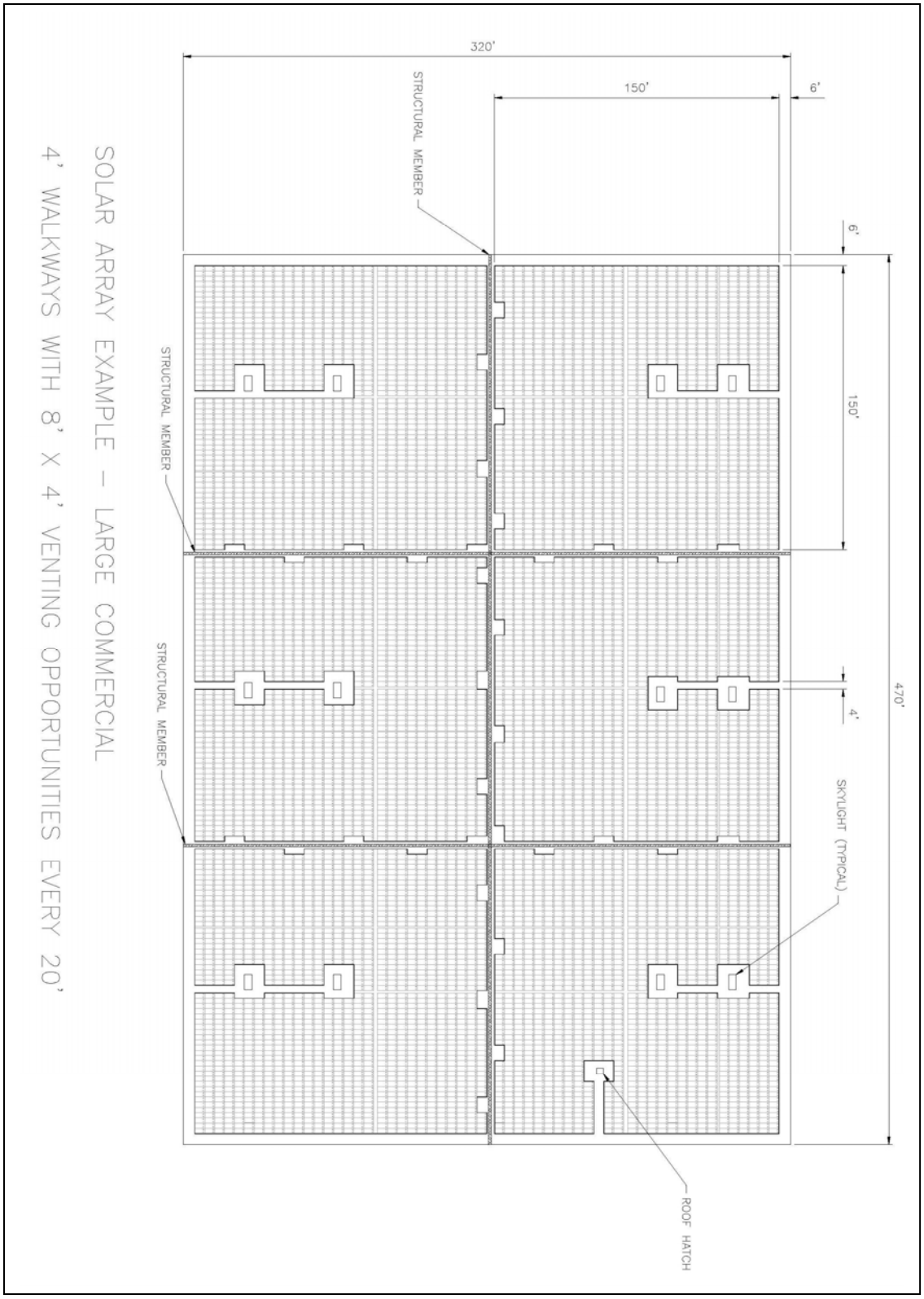
Diagram 3: Full Gable

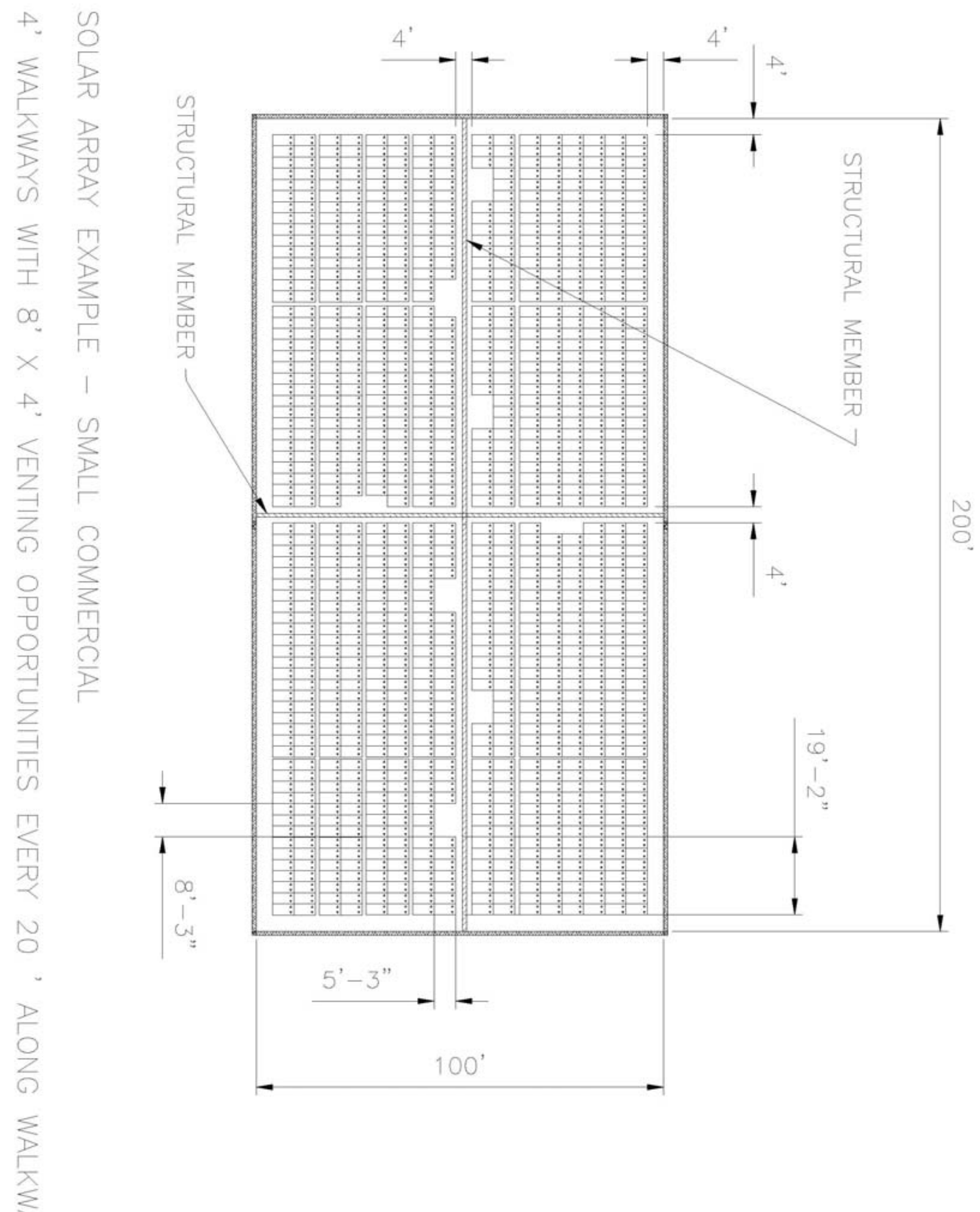


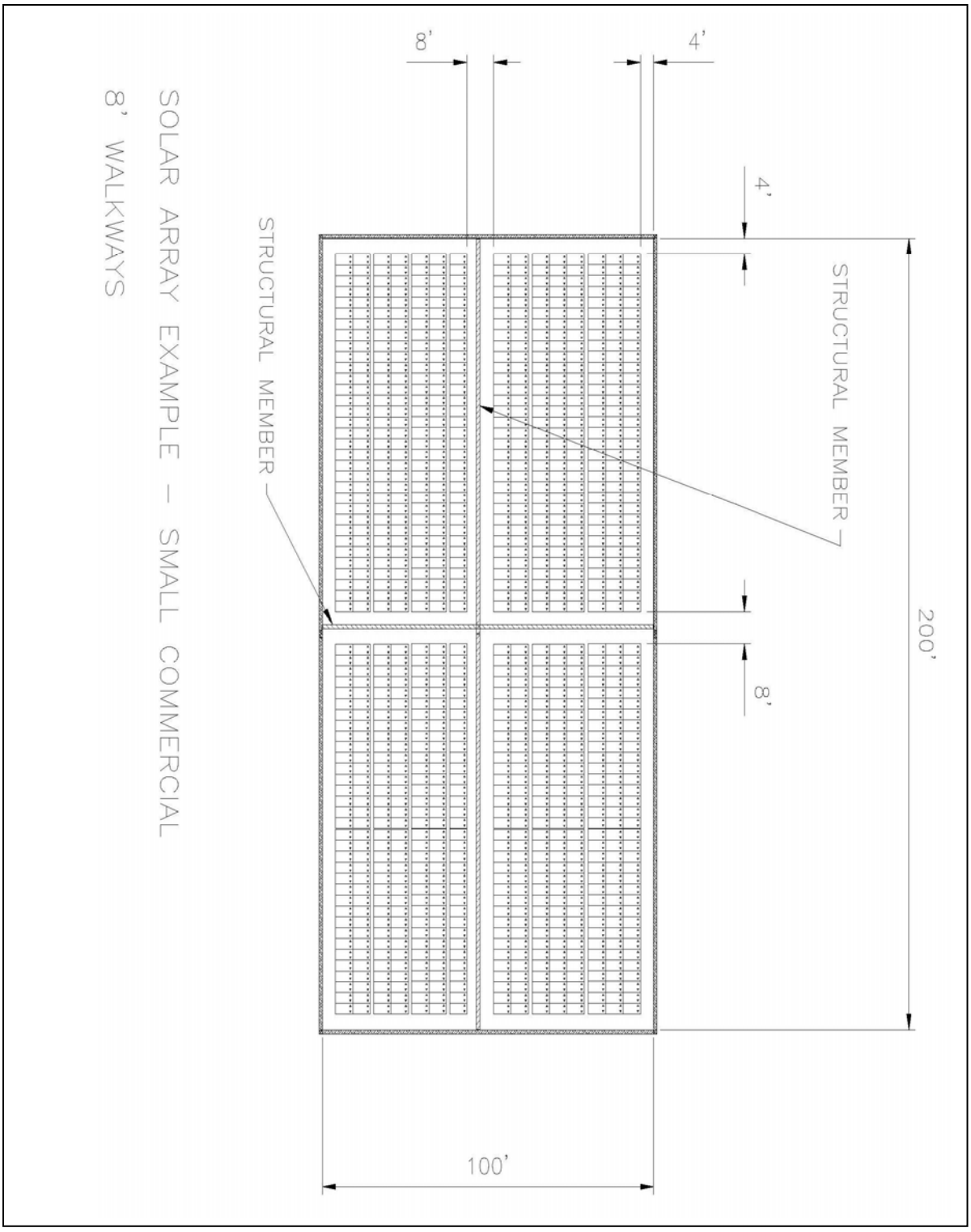
Example 4: Full Hip Roof




SOLAR ARRAY EXAMPLE – LARGE COMMERCIAL
8' WALKWAYS
324'
150'
STRUCTURAL MEMBER
STRUCTURAL MEMBER
STRUCTURAL MEMBER
6'
150'
8'
4'
478'
SKYLIGHT (TYPICAL)
6'
8'
6'
ROOF HATCH


SOLAR ARRAY EXAMPLE – LARGE COMMERCIAL
4' WALKWAYS WITH 8' X 4' VENTING OPPORTUNITIES EVERY 20'
320'
150'
6'
STRUCTURAL MEMBER
6'
150'
4'
470'
STRUCTURAL MEMBER
STRUCTURAL MEMBER
SKYLIGHT (TYPICAL)
ROOF HATCH


SOLAR ARRAY EXAMPLE – SMALL COMMERCIAL
4' WALKWAYS WITH 8' X 4' VENTING OPPORTUNITIES EVERY 20 ' ALONG WALKW
STRUCTURAL MEMBER
STRUCTURAL MEMBER
4'
4'
4'
4'
200'
19'–2"
8'–3"
5'–3"
100'


SOLAR ARRAY EXAMPLE – SMALL COMMERCIAL
8' WALKWAYS
8'
4'
4'
STRUCTURAL MEMBER
STRUCTURAL MEMBER
200'
8'
100'