	Presidio Trust **Fire Marshal's Office** *1750 Lincoln Blvd. San Francisco, California 94129*	**Date**: August 8, 2023 **Revision**: **Standard**: ***SDS-002***
Title: **Solar Photovoltaic Systems Standard**		**Approved By**: *Tomas Kaselionis*

SCOPE

This standard applies to any newly installed or modified solar photovoltaic (PV) system. Solar photovoltaic systems shall be designed and installed in accordance with the following code requirements:

- National Fire Protection Association, NFPA 70, National Electrical Code, Article 690.

1. REQUIREMENTS

1.1. A direct current (DC) disconnect is installed on the site side of the inverter. Typical systems have an inverter located near the utility service panel. Some inverters (micro inverters and alternating current (AC) modules) are located at the PV module.

1.2. 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, the conduit contains power between the PV modules and the DC disconnect. The systems can produce up to eight amps and up to 600 volts of electricity, which varies by installation. Multiple strings are connected at a combiner box.

2. MARKING

2.1 PV systems must be marked. Marking provides emergency responders with appropriate warning and guidance in working around and isolating the solar electric system. This can facilitate the identification of energized electrical lines that connect the solar modules to the inverter, as these shall not be cut when venting for smoke removal.

2.2 Materials used for marking must be weather resistant. It is recommended that UL Marking and Labeling System 969 (UL969) be used as the standard to determine whether rating is needed (markings are not required to be UL listed).

2.2.1 **Main Service Disconnect**

2.2.1.1 For residential applications, the marking may be placed within the main service disconnect. If the main service disconnect is operable with the service panel closed, the marking shall be placed on the outside cover.

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

2.2.2 **Marking for Direct Current Conduits, Raceways, Enclosures, Cable Assemblies, and Junction Boxes**

2.2.2.1 Marking is required on all interior and exterior DC conduits, raceways, enclosures, cable assemblies, and junction boxes to alert the Fire Service to avoid cutting them.

2.2.2.2 Markings shall be placed on all interior and exterior DC conduits, raceways, enclosures, and cable assemblies every 10 feet, within one foot of turns, at penetrations (above and/or below) and on all DC combiner and junction boxes.

2.2.3 **Marking Content and Format**

WARNING: PHOTOVOLTAIC POWER SOURCE

2.2.3.1 Marking shall contain: "WARNING: PHOTOVOLTAIC POWER SOURCE;"
2.2.3.1.1 Red background

2.2.3.2 White lettering;

2.2.3.3 Minimum 3/8-inch letter height;

2.2.3.4 All capital letters;

2.2.3.5 Arial or similar font, non-bold; and

2.2.3.6 Reflective, weather-resistant material suitable for the environment (durable adhesive materials may meet this requirement)

3. LOCATION OF DIRECT CURRENT (DC) CONDUCTORS

3.1 Conduits, wiring systems, and raceways for photovoltaic circuits shall be located as close as possible to the ridge, hip, or valley and as directly as possible to an outside wall to reduce trip hazards and maximize ventilation opportunities.

3.2 Conduit runs between subarrays and to DC combiner boxes shall use design guidelines that minimize 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 to minimize conduit runs in the pathways between arrays.

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

4. ACCESS, PATHWAYS, AND SMOKE VENTILATION

4.1. Access and spacing requirements shall be observed in order to:

4.1.1. Ensure access to the roof;

4.1.2. Provide pathways to specific areas of the roof;

4.1.3. Provide smoke ventilation areas; and

4.1.4. Provide emergency egress from the roof.

4.2. The Presidio Trust Fire Marshal's Office may create exceptions to this requirement where access, pathway, or ventilation requirements are reduced due to:

4.2.1. Proximity and type of adjacent exposures;

4.2.2. Alternative access points (as from adjoining roofs);

4.2.3. Ground-level access to the roof area;

4.2.4. Adequate ventilation points beneath solar arrays (as with significantly elevated or widely spaced arrays);

4.2.5. Adequate ventilation points afforded by a module set back from other rooftop equipment (e.g., shading or structural constraints may leave significant areas open for ventilation near heating, ventilation, and air conditioning equipment);

4.2.6. Automatic ventilation devices;

4.2.7. New technology, methods, or other innovations that ensure adequate fire department access, pathways, and ventilation points; or

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

4.3. The Presidio Trust Fire Marshal's Office may create exceptions to this requirement where access, pathway, or ventilation requirements are reduced in instances of:

4.3.1. **Residential Systems for One- and Two-Family Dwellings**
Plan review is required if a system is to be installed that will occupy more than 50 percent of the roof area of a residential building.

4.3.1.1. **Access/Pathways**

4.3.1.1.1. Residential Buildings with Hip Roof Layouts: Module locations shall provide a three-foot-wide, clear access pathway from the eave to the ridge on each roof slope where modules are located. The access pathway shall be placed at a structurally strong location on the building (such as a bearing wall).

4.3.1.1.2. Residential Buildings with a Single Ridge: Module locations shall provide two three-foot-wide access pathways from the eave to the ridge on each roof slope where modules are located.

4.3.1.1.3. Hips and Valleys: Modules shall be located no closer than 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 of equal length, then the modules may be placed directly adjacent to the hip or valley.

4.3.1.2. **Smoke Ventilation**

4.3.1.2.1. The modules shall be located no higher than three feet below the ridge.

4.3.2. **Commercial Buildings and Residential Housing Comprising Three or More Units**
Exception: If the Presidio Trust Fire Marshal's Office determines that the roof configuration is similar to residential (such as in the case of townhouses, condominiums, or single-family attached buildings), the Presidio Trust Fire Marshal's Office may apply the residential access and ventilation requirements.

4.3.2.1. **Access**: There shall be, at minimum, a six-foot-wide, clear perimeter around the edges of the roof.

4.3.2.1.1. Exception: If either axis of the building is 250 feet or less, there shall be a minimum four-foot-wide, clear perimeter around the edges of the roof.

4.3.2.2. **Pathways**: Shall be established in the design of the solar installation. Pathways shall meet the following requirements:

4.3.2.2.1. Shall be over areas that are capable of supporting the live load of firefighters accessing the roof;

4.3.2.2.2. Centerline axis pathways shall be provided in both axes of the roof. Centerline axis pathways shall run where the roof structure is capable of supporting the live load of firefighters accessing the roof;

4.3.2.2.3. Shall be a straight line not less than four feet clear to skylights and/or ventilation hatches;

4.3.2.2.4. Shall be a straight line not less than four feet clear to roof standpipes; and

4.3.2.2.5. Shall provide not less than four feet clear around the roof access hatch with at least one clear pathway of not less than four feet to a parapet or roof edge.

4.3.2.3. **Smoke Ventilation**: Arrays should be no greater than 150 by 150 feet in distance in either axis.

4.3.2.3.1. Ventilation options between array sections shall be either:

4.3.2.3.1.1. A pathway eight feet or greater in width, OR

4.3.2.3.1.2. A pathway four feet or greater in width and bordering existing roof skylights or ventilation hatches, OR

4.3.2.3.1.3. A pathway four feet or greater in width and bordering four by eight feet "venting cutouts" every 20 feet on alternating sides of the pathway.

5. NON-HABITABLE BUILDINGS

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

6. GROUND-MOUNTED PHOTOVOLTIAC ARRAYS

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

7. FIRE SAFETY INSPECTION REQUIREMENTS

7.1. Rooftop-mounted PV panels and modules have the proper fire classification rating.

7.2. Conduits, wiring systems, and raceways for photovoltaic circuits are located as close as possible to the ride, 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.

7.3. Conduit runs between subarrays and to DC combiner boxes are installed to minimize the total amount of conduit on the roof by taking the shortest path from the array to the DC combiner box.

7.4. DC combiner boxes are located to minimize conduit runs in the pathways between arrays.

7.5. DC wiring in enclosed spaces in buildings is installed in metallic conduits or raceways. Conduit runs along the bottom of load-bearing members.

7.6. Roofs with slopes greater than 2:12 (except for detached, non-habitable structures) shall have solar panel layouts with access pathways that comply with the approved roof plan and meet the following criteria:

7.6.1. Pathways: Not less than two pathways at least 36 inches wide on separate roof planes, from the lowest roof edge to the 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 pathway at least 36 inches wide from the lowest roof edge to the 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.

7.6.2. Setbacks at ridge: For photovoltaic arrays occupying 33 percent or less of the plan view total roof area, a minimum 18-inch-wide setback is required on both sides of a horizontal ridge. For photovoltaic arrays occupying more than 33 percent of the plan view total roof area, a minimum 36-inch-wide setback is required on both sides of a horizontal ridge.

7.6.3. Alternative setbacks at ridge: Where an automatic sprinkler system is installed within the dwelling in accordance with NFPA 13D (current addition), setbacks at the ridge shall conform with one of the following:

7.6.3.1. For photovoltaic arrays occupying not more than 66 percent of the plan view total roof area, a minimum 18-inch, clear setback is required on both sides of a horizontal ridge.

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

7.6.4. Emergency escape and rescue opening: Panels and modules installed on dwellings shall not be placed on the portion of a roof below an emergency escape and rescue opening. A 36-inch-wide pathway shall be provided to the emergency escape and rescue opening.

7.6.5. Pathways shall be over areas capable of supporting firefighters accessing the roof. Pathways shall be located in areas with minimal obstructions such as vent pipes, conduits, or mechanical equipment.

SEE FIGURES BELOW

DEFINITIONS

AC Disconnect: Alternating current disconnect. Power comes out as AC after going through an inverter. In case of fire, AC disconnects are installed after the inverter, and are usually found mounted on an exterior wall near an electric meter.

Combiner Box: Consolidates incoming power into one main feed that distributes to a solar inverter.

DC Disconnect: Direct current disconnect. Component of a residential solar panel system. There are switches that can disrupt the flow of a direct current.

Inverter: Piece of equipment that switches incoming power from DC to AC.

PV: Photovoltaic system. Used for solar power, to convert light into electricity.

FIGURE – 1

DIAGRAM 1: Cross Gable Roof

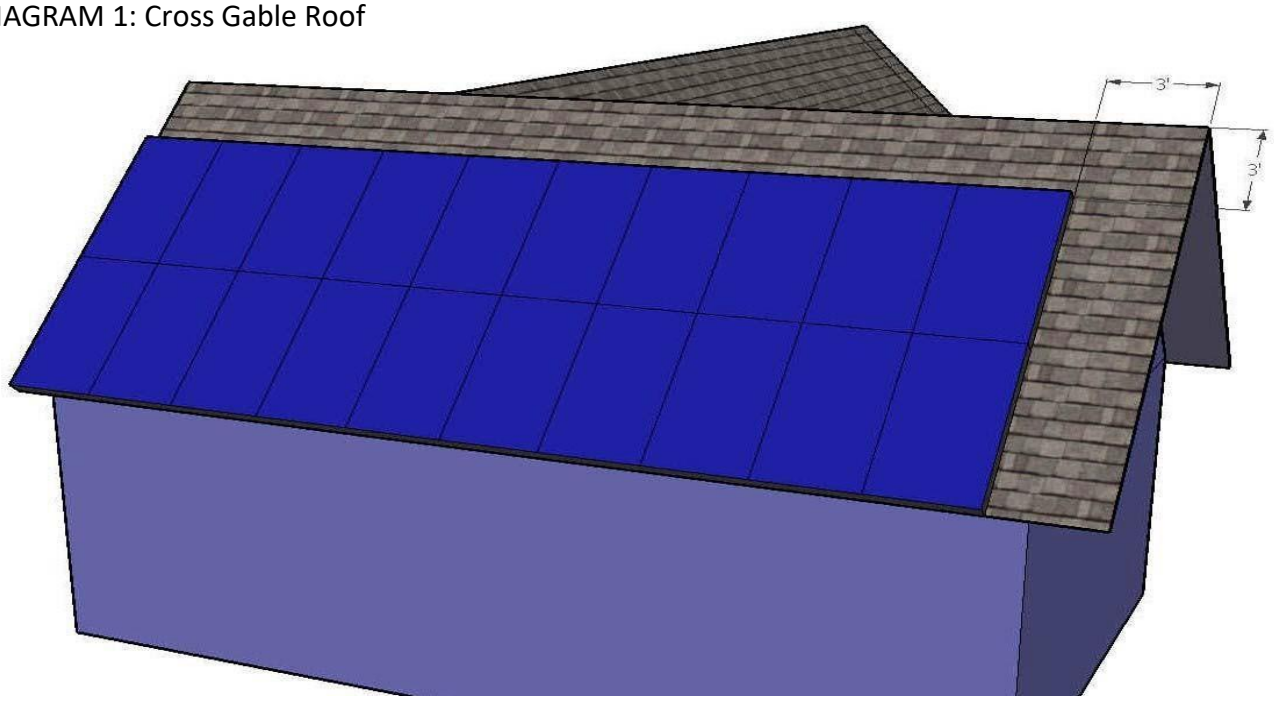


FIGURE – 2

DIAGRAM 2: Cross Gable with Valley

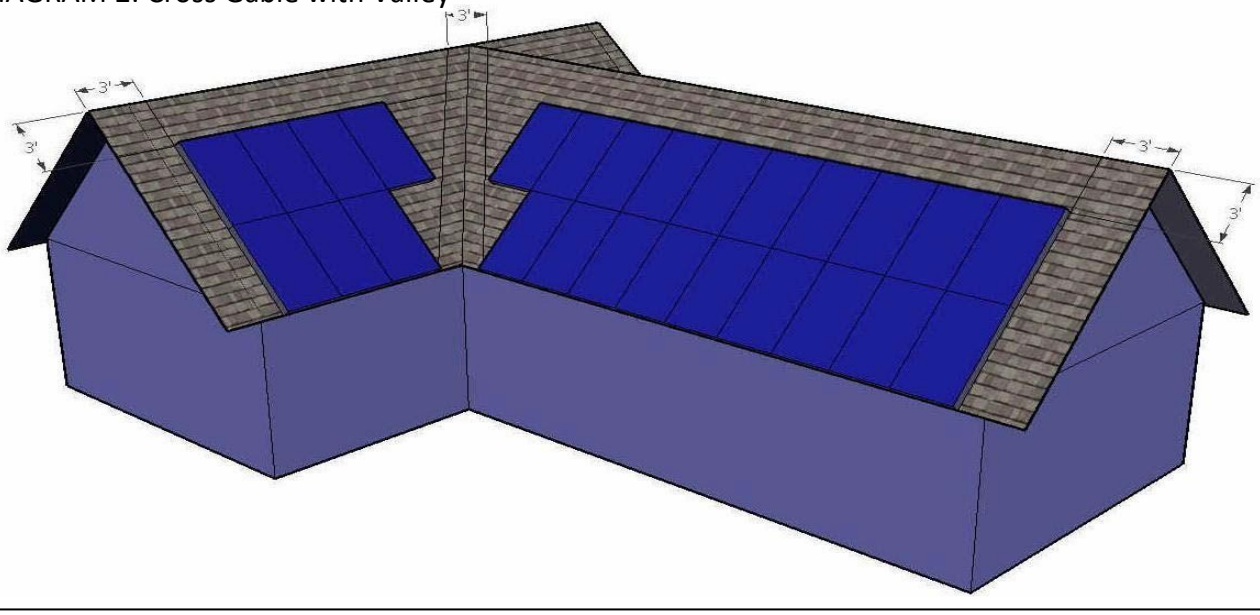


FIGURE – 3

DIAGRAM 3: Full Gable

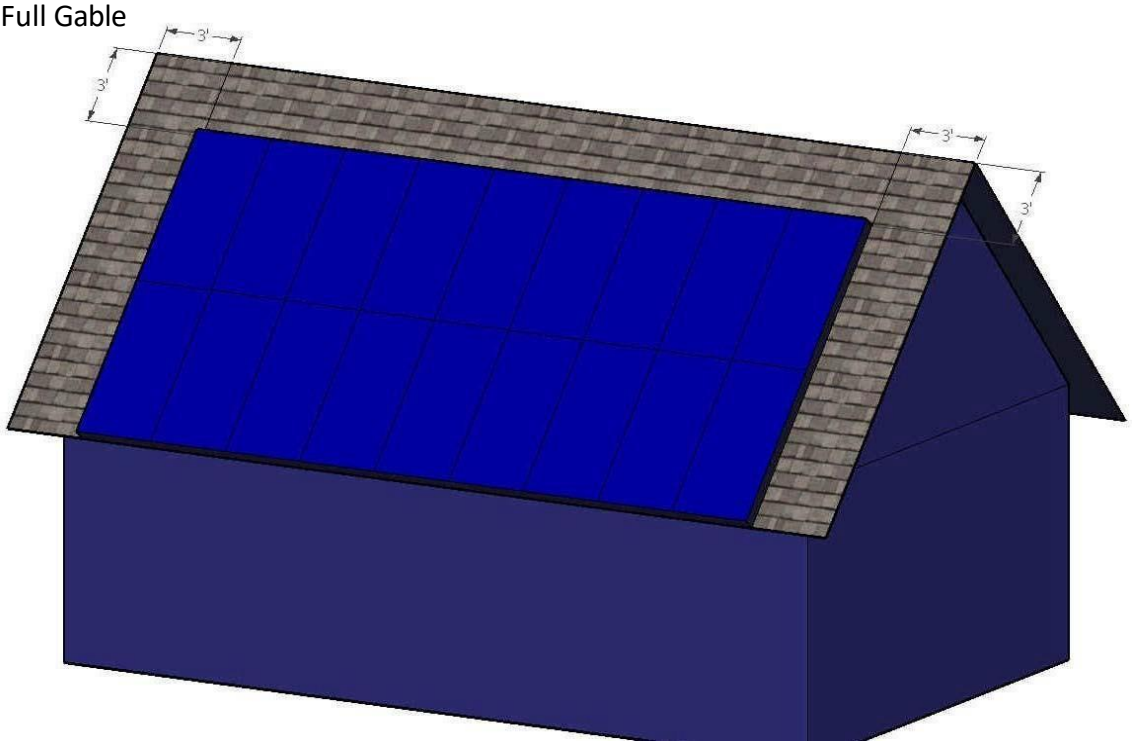


FIGURE – 4

DIAGRAM 4: Full Hip Roof

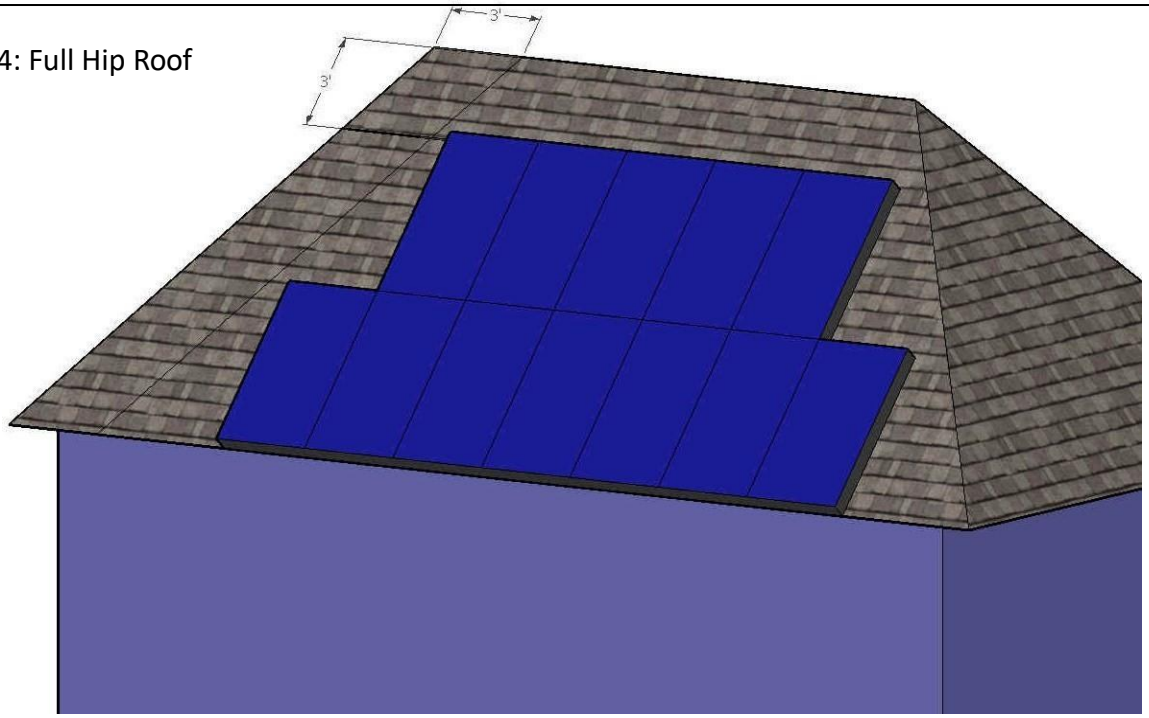


FIGURE – 5

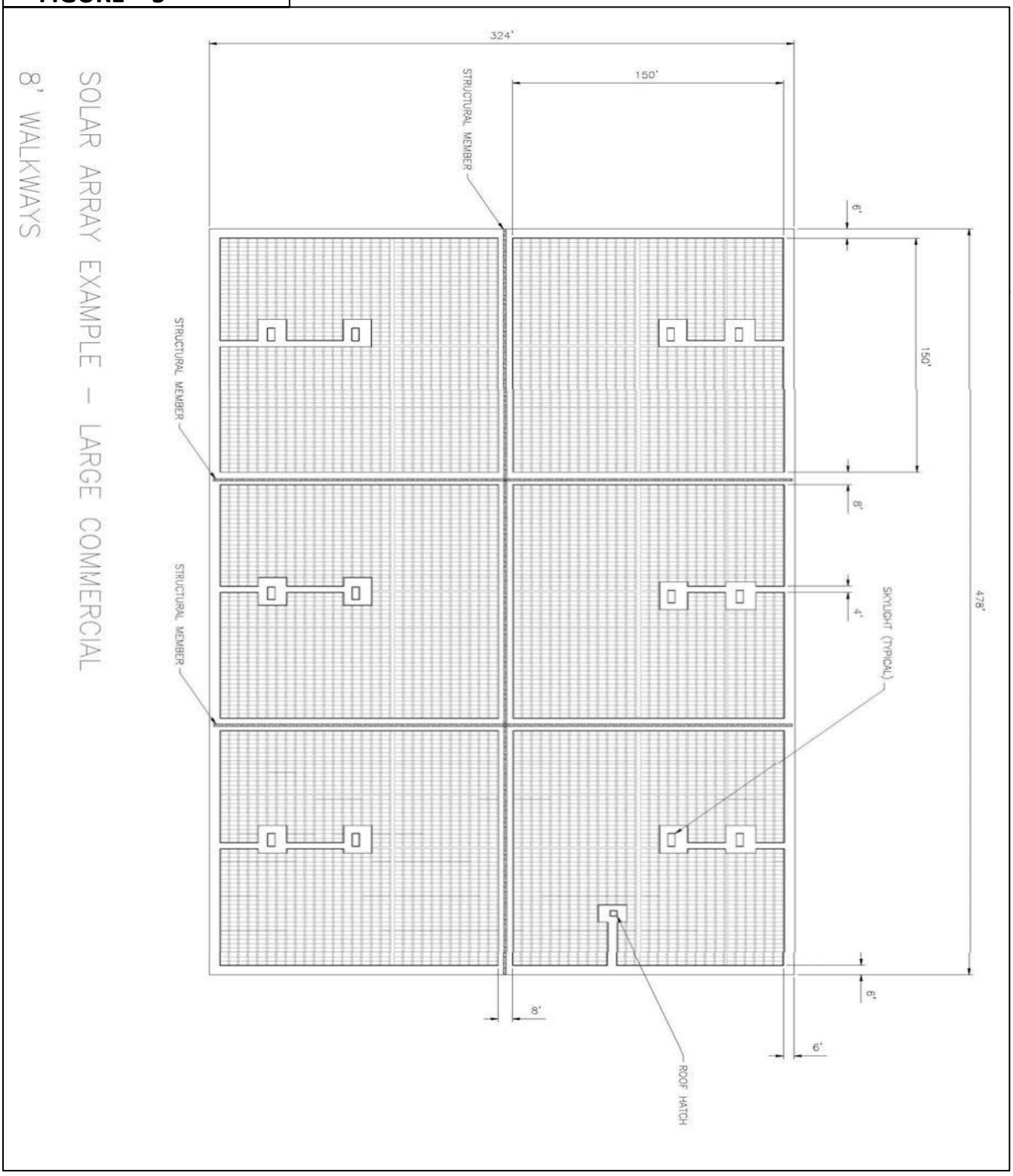

SOLAR ARRAY EXAMPLE – LARGE COMMERCIAL
8' WALKWAYS
324'
150'
STRUCTURAL MEMBER
STRUCTURAL MEMBER
STRUCTURAL MEMBER
6'
150'
8'
4'
478'
SKYLIGHT (TYPICAL)
6'
8'
6'
ROOF HATCH

FIGURE – 6

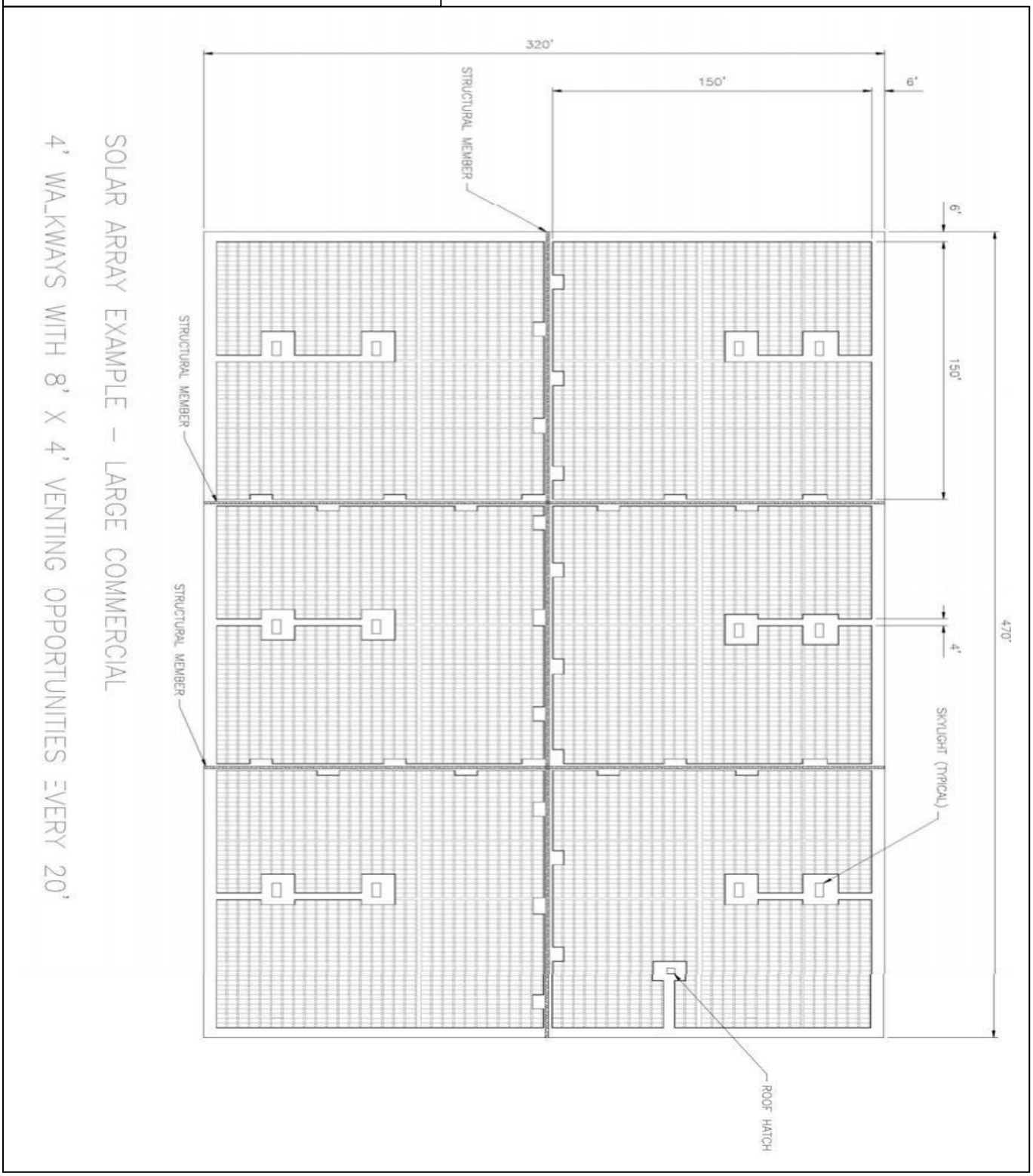
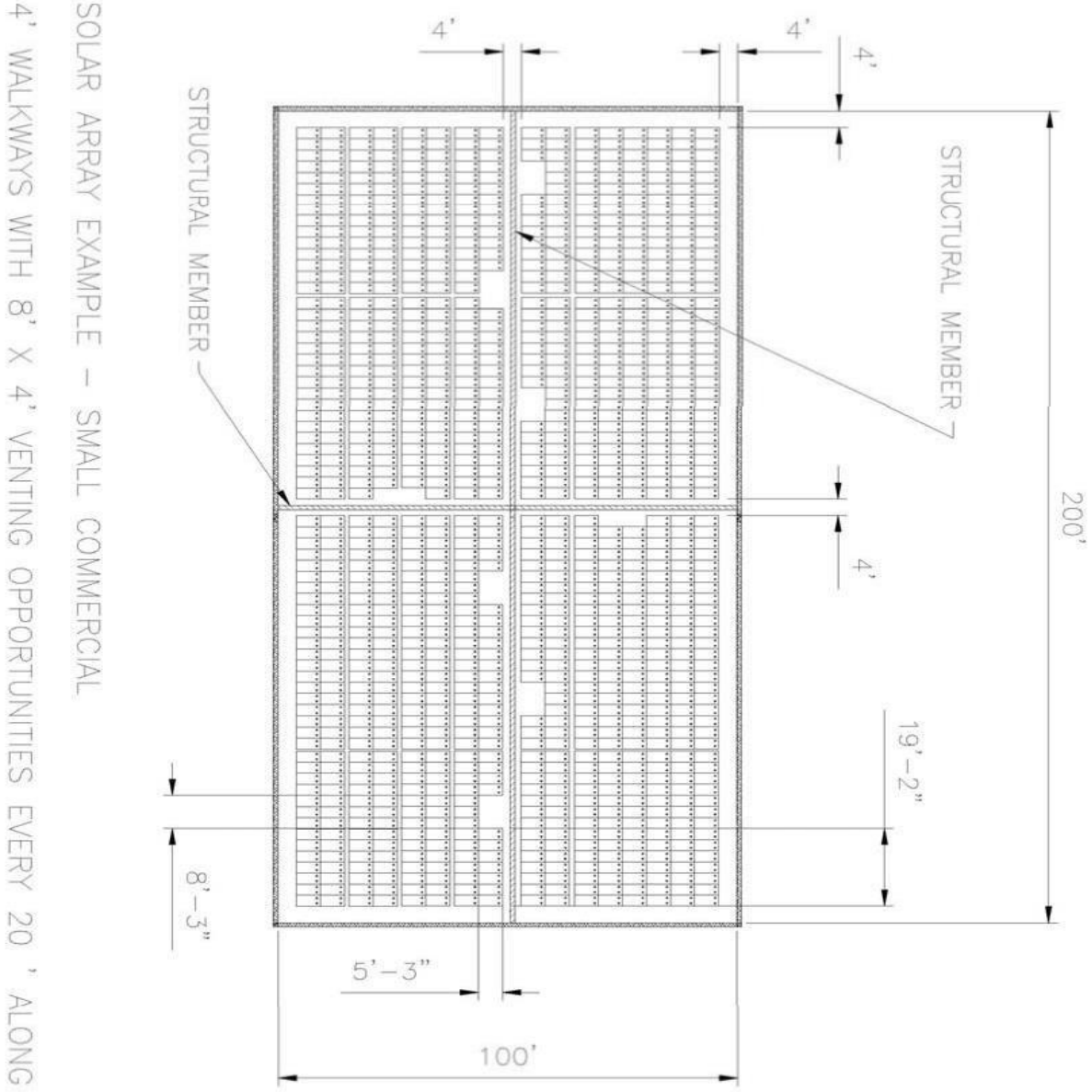

SOLAR ARRAY EXAMPLE – LARGE COMMERCIAL
4' WALKWAYS WITH 8' X 4' VENTING OPPORTUNITIES EVERY 20'
320'
150'
6'
STRUCTURAL MEMBER
6'
150'
4'
470'
SKYLIGHT (TYPICAL)
ROOF HATCH

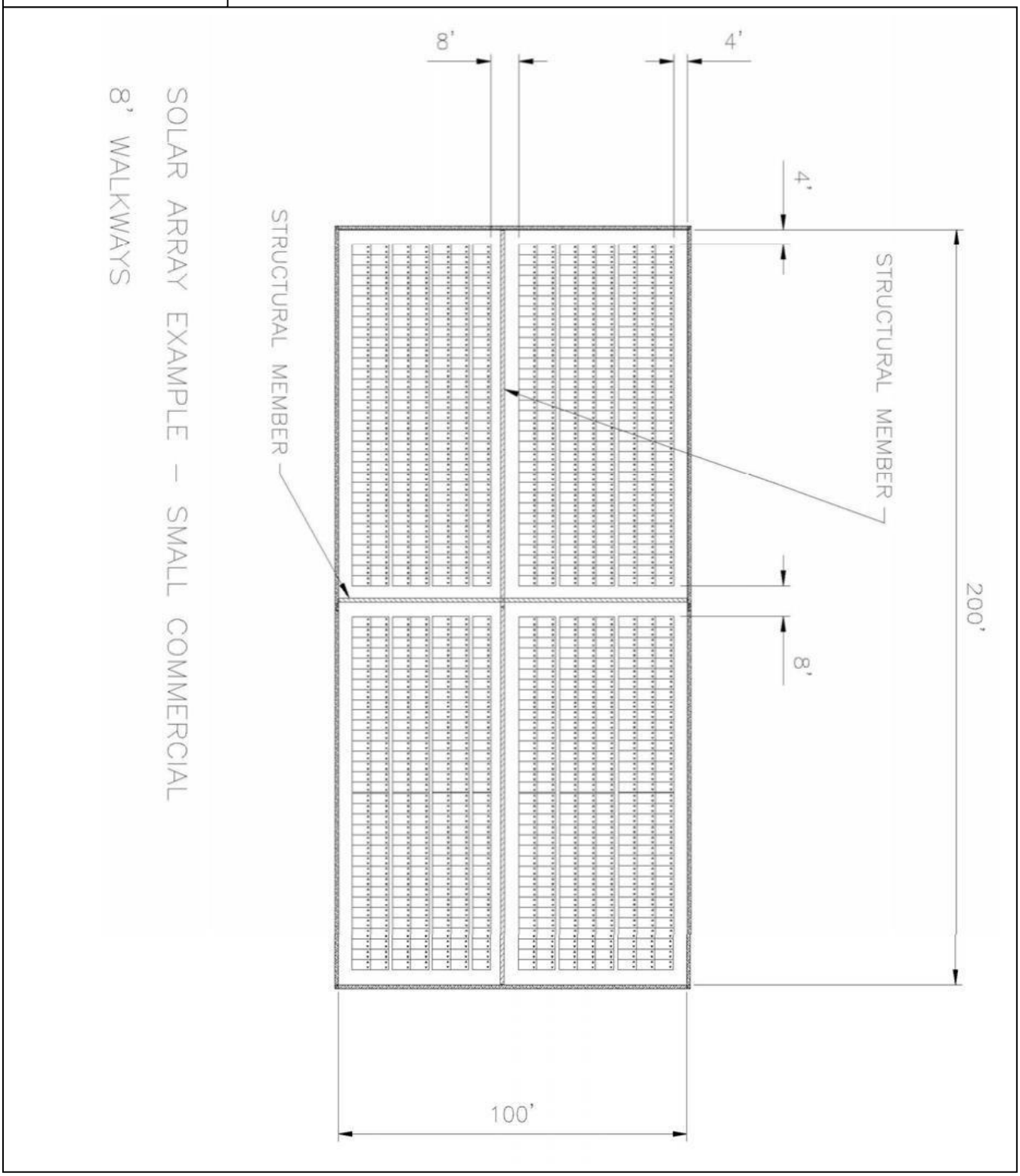
FIGURE – 7



SOLAR ARRAY EXAMPLE – SMALL COMMERCIAL

4' WALKWAYS WITH 8' X 4' VENTING OPPORTUNITIES EVERY 20 ' ALONG WALKW

FIGURE – 8


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