TOWN OF MARBLEHEAD FIRE DEPARTMENT

Marblehead Fire Department Installation Guidelines for Photovoltaic/Solar installations

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MARBLEHEAD FIRE DEPARTMENT

Standard Operating Guideline Draft for Photovoltaic/Solar Installations

Photovoltaic 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 Town of Marblehead.

Solar contractors should always contact the 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. Most systems are connected to the electric grid and provide power to the site. The majority of the 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 inverted 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 module 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. 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 Photovoltaic (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 pr 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, we may encounter solar photovoltaic systems that will require an alternative means of compliance. Solar contractors should contact the Marblehead Fire Prevention Division to determine if alternate means or methods would allow for a safe installation that is acceptable to the fire department.

Authorities Having Jurisdiction (AHJ) may approve Alternative Means of Compliance based on their authority, in accordance with Massachusetts General Laws. 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.

Wording
For Ease of use, the below listed installation guidelines are worded as requirements.

Marking
PV systems must be marked. Marking is needed to provide emergency responders with appropriate warning and guidance with respect to working around and isolating the solar electric modules to the inverter, as these should not be cut when venting for smoke removal.

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

Main Service Disconnect
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 should be placed on the outside cover.

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

Marking Content and Format
MARKING CONTENT: CAUTION: SOLAR ELECTRIC SYSTEM CONNECTED
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

Marking for Direct Current 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 should 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.

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

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.

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

The AHJ 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).

Residential Systems-Single and Two-Unit Residential Dwellings

Plan review is required if a system is to be installed that will occupy more than ¼ of the roof area of a residential building.

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 equal length then the modules may be placed directly adjacent to the hip or valley.

Smoke Ventilation

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

Exception one and two family dwellings: In cases where access ways and smoke ventilation corridors reduce the panel array by twenty percent or more, the solar contractor can ask for relief. Relief may be granted by the fire department under the following conditions;

If the solar contractors engineer can attest to by use of plans and or site visit, that reasonable access to the ridge can be gained from other points.

If the solar contractors engineer can attest to, by use of plans and or site visit, that the space below the panel array is common to other roof areas. That this space is unobstructed by patricians or ceilings to an alternative ventilation point.

Denial for relief of access ways and smoke ventilation corridors is not limited to the above conditions, and could be determined by unforeseen issues discovered in the process.
The fire department has overall jurisdiction in giving relief of access ways and smoke ventilation corridors.

Commercial Buildings and Residential Housing Comprised of Three (3) or More Units
Exception: If the Marblehead Fire Department determines that the roof configuration is similar to residential (such as in the case of townhouses, condominiums, or single family attached buildings), the fire department may make a determination to apply the residential access and ventilation requirements.

Access
There should be a minimum six feet (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.

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 the 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
f. Provide Straight line clear path 4 feet (4') to roof fire protection standpipe outlets

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') and alternating sides of the pathway

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 should be run in metallic conduit or raceways when located within enclosed specs in a building and should be run, to the maximum extent possible, along the bottom of load-bearing members.

Ground Mounted Photovoltaic Arrays
An area of ten feet (10') is required for ground mounted photovoltaic arrays and non-habitable structures. They shall not obstruct Fire Department access.

Battery storage in an enclosed room is to be mounted a minimum of 24 inches (24") above the floor. If contained within a cabinet a permanent placard is to be posted. Storage battery rooms shall also comply with the fire and building codes of the State of Massachusetts and the Town of Marblehead.

Roof Information (Rooftop Systems)
Show the following information on the plans,

a. Weight of the arrays (pounds per square foot-including mounting hardware)
b. If the array weight is less than 6 pounds per sq. ft., including the mounting hardware then engineering calculations are un-necessary for roof loading
c. If array weight is 6 pounds per sq. ft. or greater, describe and show the roof structural elements, including:
    a) Rafter size
    b) Rafter span
    c) Rafter spacing
    d) Roof sheathing
    e) Provide additional structural calculations and/or engineer's verification of load capacity of the roof structure.
d. Identify roofing type (e.g. comp shingle, shake, light weight tile, etc.)

e. Provide details of PV panels mounting hardware attachment to the roof framing members.
f. Identify and show method of sealing the roof penetrations (e.g. flashing, urethane caulking, etc.)

Site Plan

a. Provide fully dimensioned site plan drawn to scale. Show lot size, street, alley, easements, parking spaces, division alls, all projections, location, size and use of all structures on the lot and property line walls. Identify property lines, lot dimensions, distances from building to property lines and property line to street centerlines.
b. On the site plan, delineate all projecting elements, and show distance to property line, or adjacent structures.
c. Show the size and location of the service meter
d. Show the required working clearances around the Service meter main, AC Disconnect, Inverters, and DC disconnects.
e. Show the required access, pathways, and smoke ventilation clearances around the arrays.

Supplied Diagrams

Provide a minimum of a single-line diagram with the permit application package showing:

a. Array configuration
b. Array wiring identified
c. Combiner/junction box identified
d. Conduit and size from junction box to PV power source disconnect identified
e. Equipment grounding specified
f. Disconnect specified
g. Conduit and size from disconnect to inverter identified
h. Inverter specified
i. Conduit and size from inverter to AC disconnect to panel identified
j. System grounding specified
k. Point of connection attachment method identified

Equipment Information

Provide cut sheet for inverter
Provide cut sheet for PV Modules