



Solar Water Heating and Photovoltaic Electric Generators Installed on Commercial Buildings

Category: Commercial Construction

Revised: January 12, 2018 [Rebecca Esau] , Director

Responsible Bureau Section: Development Services Center
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503-823-7310

I. BACKGROUND

Incorporating solar energy into commercial buildings is an increasingly common way for businesses to display environmental stewardship. With large financial incentives available at the local, state and federal level, it can be a sound business investment.

This program guide outlines the application and review procedures for obtaining the necessary permits to install a solar energy system on a new or existing commercial building. The Program Guide also describes what system siting or design elements may trigger the need for additional review.

II. SOLAR ENERGY SYSTEM DESCRIPTION

For the purpose of this program guide a solar energy system is defined as a solar water heating or solar electric (also known as a photovoltaic or PV) system.

A. Solar Water Heating

A solar water heating system reduces a business' energy consumption by preheating water so that the water heater or boiler does less work. The system consists of two primary components:

1. Solar collectors, which are commonly installed on the roof; and
2. A storage tank, which is typically co-located with the water heater and in which potable water is preheated by the solar collectors via a heat exchanger.

B. Solar Electric

A solar electric system produces electricity that is distributed to the building via an electrical panel, offsetting electric energy that would otherwise be purchased from the utility. It consists of two primary components:

1. Photovoltaic panels, which are commonly installed on the roof; and
2. One or more inverters, which convert the direct current electricity produced by the panels into alternating current electricity that can be used by the building.

C. Commercial Solar Pool Heating

A commercial solar pool heating system consists of light-weight unglazed polymer (plastic) solar collectors, typically mounted on a roof, through which swimming pool water is circulated during the summer months to capture the sun's heat. This type of system is not subject to the requirements of this Program Guide, and may be installed by obtaining a mechanical permit. In some cases an electrical permit may also be necessary to install the control system for the solar collectors.

III. SCOPE

This program guide is designed to provide guidelines and permitting requirements to those interested in solar hot water heaters or photovoltaic solar electric panels on commercial construction. This may include adding a solar system on to an existing structure by addition or alteration, or incorporating a solar system into new building construction. The intent of these guidelines is to streamline the permitting process for solar energy systems. The Bureau of Development Services (BDS) may require additional information be submitted to ensure proper compliance with code requirements.

IV. INSTALLATION REQUIREMENTS

For a typical commercial installation, the following requirements apply. For installations that do not comply with this program guide, contact BDS for installation requirements.

A. Land Use

Solar installations must comply with the Zoning Code. Specific zoning information regarding a site can be obtained from the BDS Planning and Zoning Section by calling 503-823-7526.

1. Height

In all instances, installations of solar equipment, including the rails and panels, are subject to the building height limitations of the specific zone where they are being installed.

Roof-mounted solar panels may exceed the maximum building height of the zone if the following are met:

- a. For flat roofs or the horizontal portion of mansard roofs, the panels may extend up to 5 feet above the highest point of the roof.

- b. For pitched, hipped, or gambrel roofs, the panels must be mounted no more than 12 inches from the surface of the roof at any point, and may not extend above the ridgeline of the roof. The 12 inches is measured from the upper side of the solar panel.

2. Setbacks for Ground Mounted Installations

- a. Installations on sites with non-residential uses are allowed in a street setback, but not in a required setback from an abutting residential zone.
- b. On sites where all the floor area is in residential use, installations no larger than 3 feet in width, depth or diameter and not exceeding 8 feet in height are allowed in required building setbacks. Installations that do not meet the above dimensions are allowed in side and rear setbacks if all of the following are met:
 - (1) The structure is at least 40 feet from a front lot line, and if on a corner lot, at least 20 feet from a side street lot line;
 - (2) The structure has dimensions that do not exceed 24 feet by 24 feet;
 - (3) No part of the finished structure exceeds 10 feet above finished grade;
 - (4) The portion of the structure within the setback must be screened from adjoining lots by a fence or landscaping, unless it is enclosed within the setback by a wall. Screening is not required for enclosed structures. Screening must comply with the L3 or F2 standards of Chapter 33.248, Landscaping and Screening; and
 - (5) The structure does not have a rooftop deck.

Installations that exceed the above allowances are not allowed in a required setback unless they are approved through a land use review adjustment process.

3. Design and Historic Resource Review

Installations in design overlay zones, historic districts, conservation districts, or individual historic or conservation landmarks are subject to additional requirements. A proposal may meet exemptions, may be eligible to meet non-discretionary development standards, the Community Design Standards, or may require a land use review-either design review or historic resource review.

- a. **Exemptions:** If a proposal meets specific requirements, it may be exempt from the regulations of the Design Overlay Zone or Historic Resource Overlay Zone chapters.

- (1) In design overlay zones, roof-mounted solar systems are exempt from design review if specified requirements of Zoning Code Section 33.420.045.Y are met.
- (2) In historic districts or conservation districts roof-mounted solar systems are exempt from historic resource review if specified requirements of Zoning Code Section 33.445.320.B.11 or 33.445.420.B.11, respectively, are met.

b. Community Design Standards: If exemptions to design or historic resource Review are not met, the proposal may be eligible to meet specific development standards called Community Design Standards.

- (1) In some design overlay zones, a design review will not be required if the project is eligible to use the Community Design Standards. See Zoning Code Sections 33.420.055-60 for when Community Design Standards may be used.
- (2) In conservation districts and for some conservation landmarks, historic resource review will not be required if the project is eligible to use the Community Design Standards. See Zoning Code Sections 33.445.710-720 for when Community Design Standards may be used.

The Community Design Standards for solar energy systems are found in Zoning Code Chapter 33.218.

c. Design and Historic Resource Review: If a proposal is not exempt and is not eligible or does not meet the Community Design Standards, design review or historic resource review is required. Design review and historic resource review are discretionary land use reviews that analyze the aesthetics of a project in order to conserve or enhance special scenic, architectural or cultural areas of the City.

- (1) Design review and historic resource review are reviews that require public notice and generally take about 8-10 weeks to complete.
- (2) The design review or historic resource review fee for a solar installation will be based on the current Land Use Services Fee Schedule for a 'Minor C' review.

Contact BDS Planning and Zoning Section at 503-823-7526 if you are unsure if the project is exempt from design review or historic resource review, or is eligible to use the Community Design Standards.

4. Upgrades to Non-conforming Development

Upgrades to non-conforming development will only be required as part of the solar installation when other modifications to the building are made (such as increasing the structural capacity of the roof system), and the valuation of the building permit for those modifications excluding the valuation of the solar system exceeds the dollar threshold of Section 33.258.070.D.2.a of the Zoning Code.

B. Structural

The solar collectors and underlying substructure (mounts, rails, etc.) must be designed and installed in accordance with the requirements of the latest version of the Oregon Structural Specialty Code (OSSC). A solar installation that meets the prescriptive requirements as described in section 3111.5.3 of OSSC are assumed to meet the requirements of the OSSC and therefore will not require the system be designed by a registered Oregon engineer. Use the checklist attached to the back of this code guide to determine if your system would qualify for the prescriptive path. All other systems that do not meet the prescriptive requirements are required to be designed by an engineer registered in Oregon. The roof framing supporting the solar installation must be designed for all load combinations specifies in the OSSC.

1. Requirements for Snow and Dead Loads for Solar Installations not Meeting the Prescriptive Requirements

- a. The weight of solar installation, their support system, and any ballast must be considered as dead load;
- b. The design snow load for solar photovoltaic arrays must be based on the requirements of the latest edition of the OSSC. When applicable, snow drift loads created by the PV panels or modules shall be included; and
- c. Roof systems that provide support for the solar installation must be designed or their adequacy verified considering concentrated loads from support frames for dead and snow. In addition, roof systems that provide support for solar installations shall be designed for uniform and concentrated roof live and snow loads assuming that the PV panels or modules are not present.

2. Requirements for Wind Design for Solar Installations not Meeting the Prescriptive Requirements

The design wind loads for solar installations are not covered by prescriptive methods contained in ASCE 7 or the current provisions of the OSSC. In the absence of detailed guidance from ASCE 7 or the OSSC for wind loads, designers often use a hybrid approach of the ASCE 7 components and cladding tables for enclosed buildings and main force resisting system tables

for open structures which could lead to un-conservative results particularly considering the size of the edge and corner roof zones; or

For low profile solar photovoltaic array on flat roofs, the Structural Engineers Association of California (SEAOC) has produced two reports PV1-12 addressing the seismic structural design and Report PV2-2012 addressing the wind design. The City of Portland will accept designs based on the methodologies outlined in these two documents.

3. Requirements for Solar Installations Designed Utilizing Wind Tunnel Tests and Peer Review

- a. Wind loads on roof-mounted solar installations are permitted to be determined by using wind tunnel tests as generic loads applicable to a range of buildings. Wind tunnel tests must satisfy ASCE 49, “Wind Tunnel Testing for Buildings and Other Structures.”;
- b. Solar installations designed using this method will require an independent peer review. The peer review shall be an independent and objective technical review by knowledgeable reviewer(s) who must be:
 - (1) Experienced in performing wind tunnel studies on buildings and similar systems, and in properly simulated atmospheric boundary layers;
 - (2) Familiar with the technical issues and regulations governing the wind tunnel procedures of ASCE 49 as it is applied to systems similar to solar photovoltaic arrays that use generalized wind tunnel data for design;
 - (3) Independent from the wind tunnel laboratory that performed the test and report and shall bear no conflict of interest; and
 - (4) Acceptable to the Bureau of Development Services; and
- c. The peer reviewer shall submit a report which must include, at a minimum, statements regarding the following:
 - (1) Scope of peer review with limitations defined;
 - (2) The status of wind tunnel test at the time of review;
 - (3) Conformance of wind tunnel study with requirements of ASCE 49;
 - (4) Conclusion of the reviewer identifying areas that need further review, investigation and/or clarification; and
 - (5) Stated opinion of the reviewer that the results of the wind tunnel tests have correctly been applied to the specific situation/project and the final design conforms to the requirements of ASCE 7.

A source for peer reviewers is the American Association for Wind Engineering’s (AAWE) boundary layer wind tunnels list

(http://www.aawe.org/info/wind_tunnels.php). The following is a summary of the AAWWE list with other known boundary layer wind tunnels added. This is not a comprehensive list, but is provided as an aid.

Cermak Peterka Petersen (CPP), Inc.
Colorado State University
Concordia University, Montreal
Force Technology
I.F.I Institute
Rowan, Williams, Davies & Irwin (RWDI)
Texas Tech.
University of California Davis
University of Iowa
University of Maryland
University of Minnesota
University of Washington
University of Western Ontario.

Other sources of peer reviewers are the ASCE “Wind Loads on Solar Collectors subcommittee” or the voting members of the ASCE 7 “Subcommittee on Wind Loads”.

4. Requirements for Seismic Design

Rooftop solar installation shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity, except that solar photovoltaic arrays without attachment to the roof structure are permitted, provided that they comply with the following:

- a. The maximum roof slope supporting the array is less than or equal to 5 degrees;
- b. The height above the roof surface of the center of mass of the solar array is less than the smaller of 3 feet and half the least plan dimension of the supporting base of the array;
- c. The arrays must be designed to accommodate the seismic displacement of the array relative to the roof surface as required by ASCE 7-10;
- d. Each array must be interconnected with the strength to slide as an integral unit; otherwise each portion of the array must have the minimum separations to accommodate seismic displacements; and

- e. The coefficient of friction between the array and the roof must be determined based on testing considering weather conditions, including the effects of ice or cold weather on friction.

C. Plumbing and Electrical

All portions of the installation of solar systems governed by the plumbing or electrical code shall comply with the respective requirements of each code at the time of completion of the project. In general, plumbing or electrical plan review is not required for the installation of solar systems in commercial buildings.

Plumbing and electrical plan review is only required for those solar systems that are being added to complex systems as defined by the State of Oregon in Administrative Rules OAR 918-780-0040 and OAR 918-311-0040 (1), cert ef. 10-01-06. In all instances, field inspection is required to verify code compliance.

V. PERMITS

A. General

When a solar system is added to an existing building, the installation is considered an “alteration”. Solar panels that are part of new construction will be processed in conjunction with the new commercial construction permit. Under the provisions of the OSSC, all alterations must meet the requirements for new construction. All necessary permits shall be obtained prior to installation of the system. Where plumbing and electrical permits are required as noted below, they must be obtained as separate permits.

B. Specific Permits required

1. **Building Permits** A building permit is required for all solar systems including support structures and collector panels.
2. **Electric Permits** A separate electrical permit is required for the connection of a photovoltaic system to the building’s electrical system.
3. **Plumbing Permits** A separate plumbing permit is required for all systems that exchange energy with and are attached to the building’s potable water system.

C. Application Process

All permit applications for solar installations shall be submitted for review at the BDS Development Services Center (DSC) located at 1900 SW 4th Avenue, Portland, Oregon on the first floor. At that time, DSC staff will determine if the project needs to be taken in for review or if the solar system can be reviewed over the counter.

Where a solar system is installed under another program such as the Facility Permit Program (FPP), the application process for that program will be followed.

D. Permit Submittal Requirements

1. General

In all cases, solar systems being installed in commercial buildings need the following reviews:

- a. Planning and Zoning;
- b. Fire/Life Safety; and
- c. Structural.

In addition, all permit applications must clearly indicate the type of solar system to be installed. The information noted in items 2 through 4 must be submitted for each permit.

2. Construction Drawings and Calculations

Construction drawings are required as indicated below. Structural drawings and calculations may be required to bear the stamp and signature of an Oregon registered engineer.

a. Structural

(1) Prescriptive system If the system meets all the prescriptive requirements of the OSSC, no structural calculations will be required. However, a simple structural plan showing the roof framing and system racking attachment details are required. See figures 1 through 4 for sample drawings. In addition, complete and attach the checklist for prescriptive installations found at the end of this document; or

(2) Designed system

- (a) If the system does not qualify for the prescriptive path, then structural calculations prepared by an Oregon registered engineer are required. At a minimum, structural calculations verifying adequacy of the structure's roof framing, strut or frame supporting the rails (where used), attachment of the rail to the support /strut frame and the attachment to the building's roof framing are required. For ballasted systems, calculations including but not limited to design of ballast, attachment of the ballast to the system, wind screens and other elements that are part of the load path for resisting wind and seismic loads are required. Calculations must

be based on the latest version of the OSSC or other nationally accepted standards. In some cases, manufacturer's information and installation details may be substituted for required calculations and details;

- (b) Drawings must include a roof framing plan (member size, type, span and spacing) and any additional framing required to reinforce the existing framing. The plans must include the layout of the module system and its mounting points and the layout of the ballast where applicable, overlaid on the roof framing plan. Drawings must also provide information on any support strut or frame that supports the rails including frame member sizes, lateral bracing where required and their attachments. Details and information on the attachment of the system to the building structure are also required; and
- (c) For PV installation based on Wind Tunnel testing, the wind tunnel report satisfying ASCE 49, "Wind Tunnel Testing for Buildings and Other Structures" must be submitted as part of the permit submittal. The report must be accompanied by a peer review report satisfying the requirements noted in section IV(B) above

When S5 clips or similar clips are used at standing seam metal roof decks the capacity and spacing of the clips, the size and thickness of the standing seam roofing panels and attachment of the standing seam metal panel to the roof, must be per section 3115.3 of the OSSC.

Submittal Requirements

In addition to requirements for standard installations, solar installation permits utilizing S-5-U Mini Clips shall contain the following additional information:

- Roof framing plan indicating framing member size and spacing, type of roofing, roofing attachment of metal roofing to framing, location and spacing of S-5-U Mini Clips; and
- Structural calculations demonstrating that uplift demand on the S-5-U Mini Clip is less than allowable uplift load.

2. Other Drawings

- a. **Site plan** A site plan is required showing building footprints, property lines, location and dimensions of solar collectors, ridgeline of roof, Fire fighter access and a description of the solar system. System must be shown in sufficient detail to assess whether requirements of section 304.9 or one of the exceptions of OSISC have been met. For ground mounted

solar installations, the site plan must also show the size, species and location of all existing trees with a diameter of 12” or greater.;

- b. Elevation** An elevation drawing must show the height of the building and the height of the solar installation above the roof, but does not need to show other building details, unless Design Review is required; and
 - c. Details** Roof penetration detail including water proofing, curbs, flashing, etc.
- 4. Electrical and Plumbing Plans**
Plumbing or electrical plans are only required for those installations that fall under the definition of complex structure as defined by the State of Oregon in OAR 918-780-0040 and OAR 918-311-0040 respectively. Plumbing or electrical plans are not required for other solar system installations.

After all plans and necessary information has been approved by all reviewers, and applicable permit fees have been paid, the permits shall be issued.

VI. INSPECTIONS

Inspections are required for all permits issued for solar systems as indicated below:

A. Building

Building inspections will be determined based upon the scope of the entire project on a project by project basis.

B. Plumbing

Plumbing inspections are required where the solar apparatus attaches to the potable water system, usually a water heater. The inspections will verify that the collection system is properly attached, so that no contamination of the potable system can occur. Two plumbing inspections, listed in order, are required to verify that the system has been installed properly:

1. IVR Code 340: Water Heater; and
2. IVR Code 399: Final Plumbing.

C. Electrical

Electrical inspections are required to verify the circuits and feeders have been installed properly and the system has been connected properly. Three electrical inspections, listed in order, are required to verify that the system has been installed properly:

1. IVR Code 145: Circuits/Feeders;

2. IVR Code 120: Permanent Electrical Service/ Reconnect; and
3. IVR Code 199: Final Electrical.

VII. FEES

Fees for all required building, plumbing or electrical permits will be calculated using the current and applicable BDS fee schedules available online at <http://www.portlandoregon.gov/bds> or in the BDS Development Services Center at 1900 SW 4th Avenue, Portland, Oregon.

A. General

In general, building permit fees will be based on the valuation of the structural elements for the solar panels, including the mounting brackets and rails and the cost of labor to install them. Excluded from the permit valuation is the cost of the solar equipment, including the solar collector panels, inverters and preheat tanks.

$$\text{Valuation of Project} = \text{Total Project Price} - \text{Solar Equipment Value}$$

B. Design Review

Where Design Review is required, the fee will be for a 'Minor C' Design Review, based on the current Land Use Services Fee Schedule.

VIII. ENFORCEMENT

All code requirements shall be in accordance with applicable permitting and inspection procedures established by BDS.

Updates June 1, 2017 edition
Updates August 15, 2016 edition for removal of gender-specific language only
Updates December 1, 2010 edition
Updates April 26, 2010 edition
Updates April 24, 2009 edition
New May 1, 2008

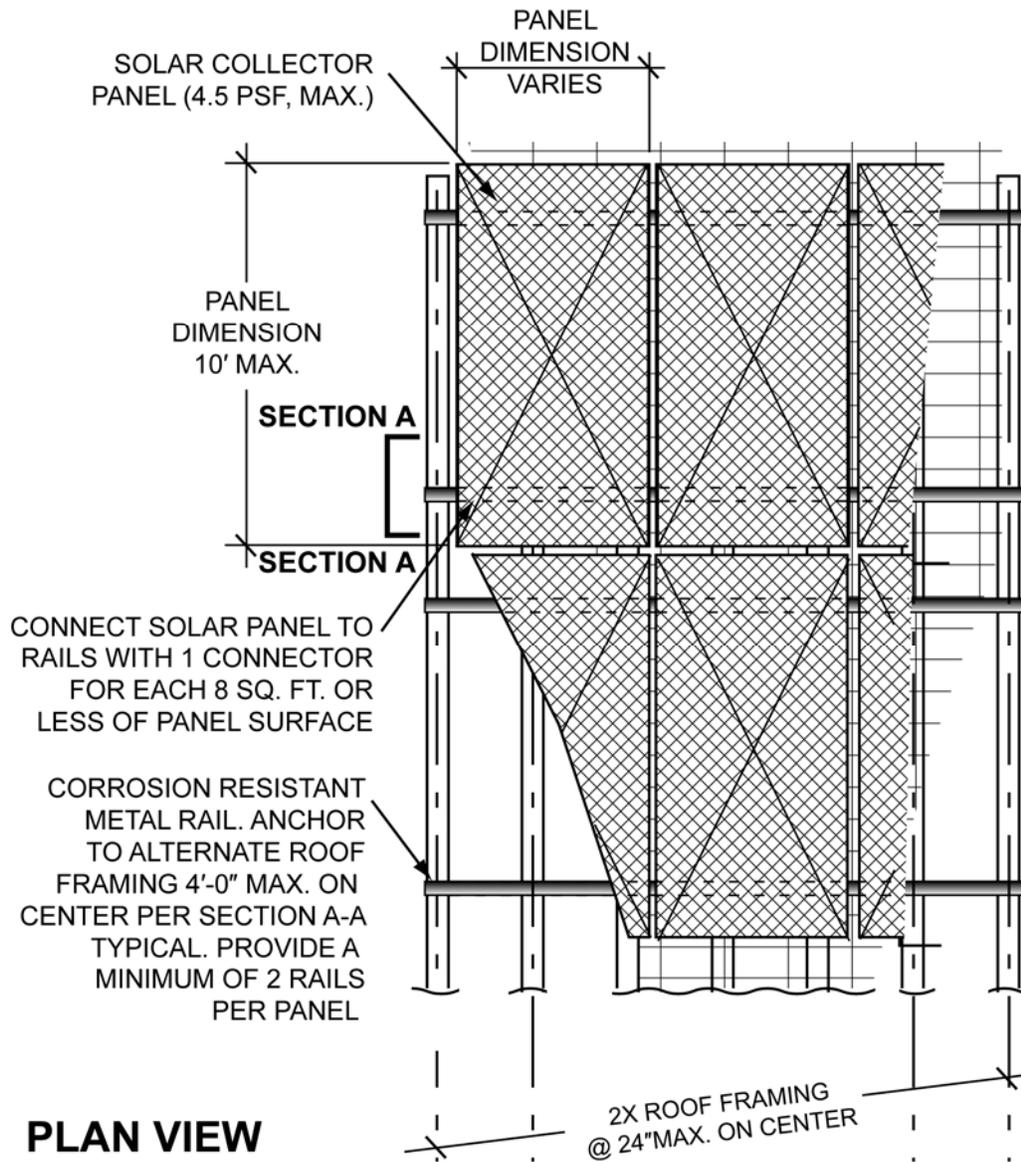
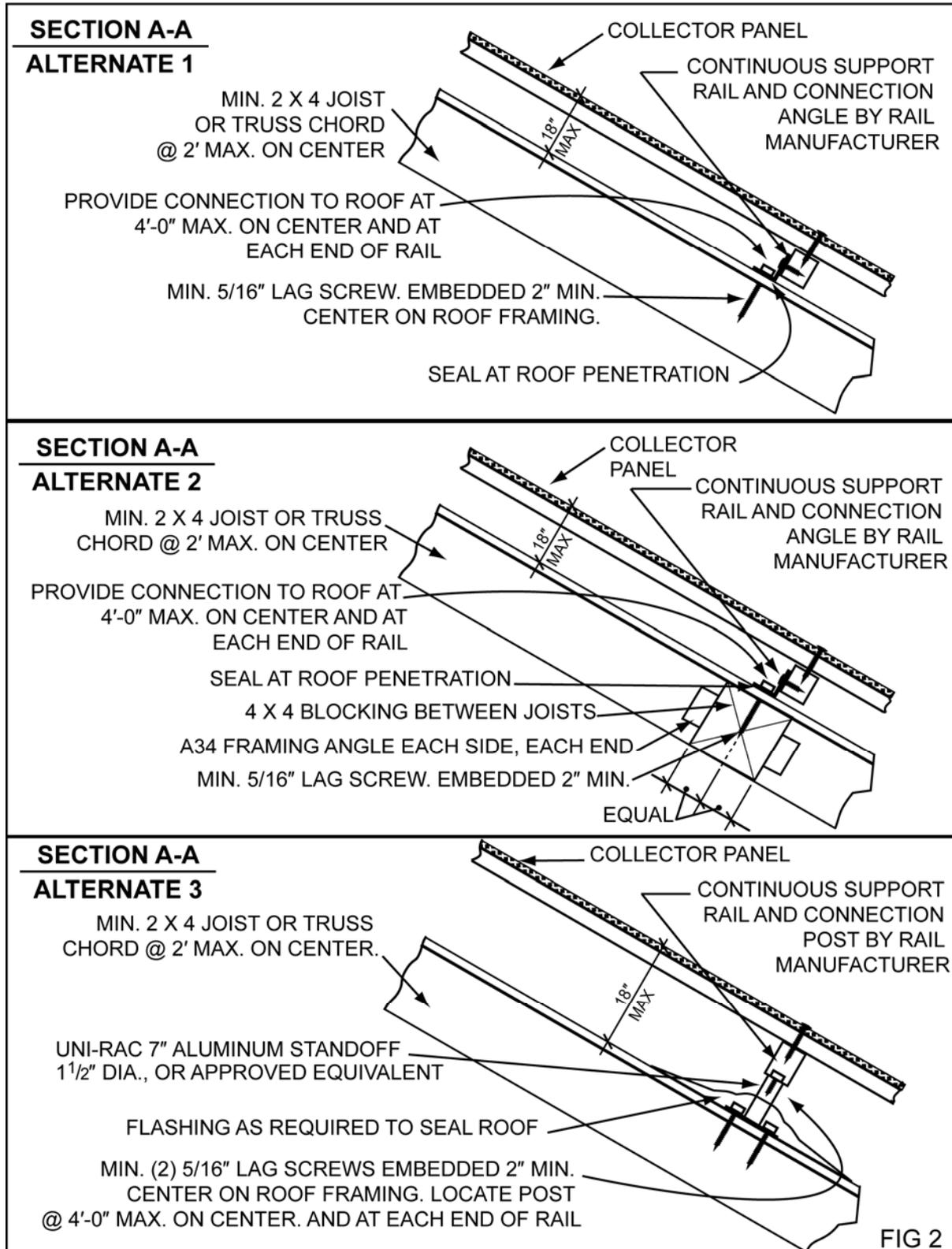
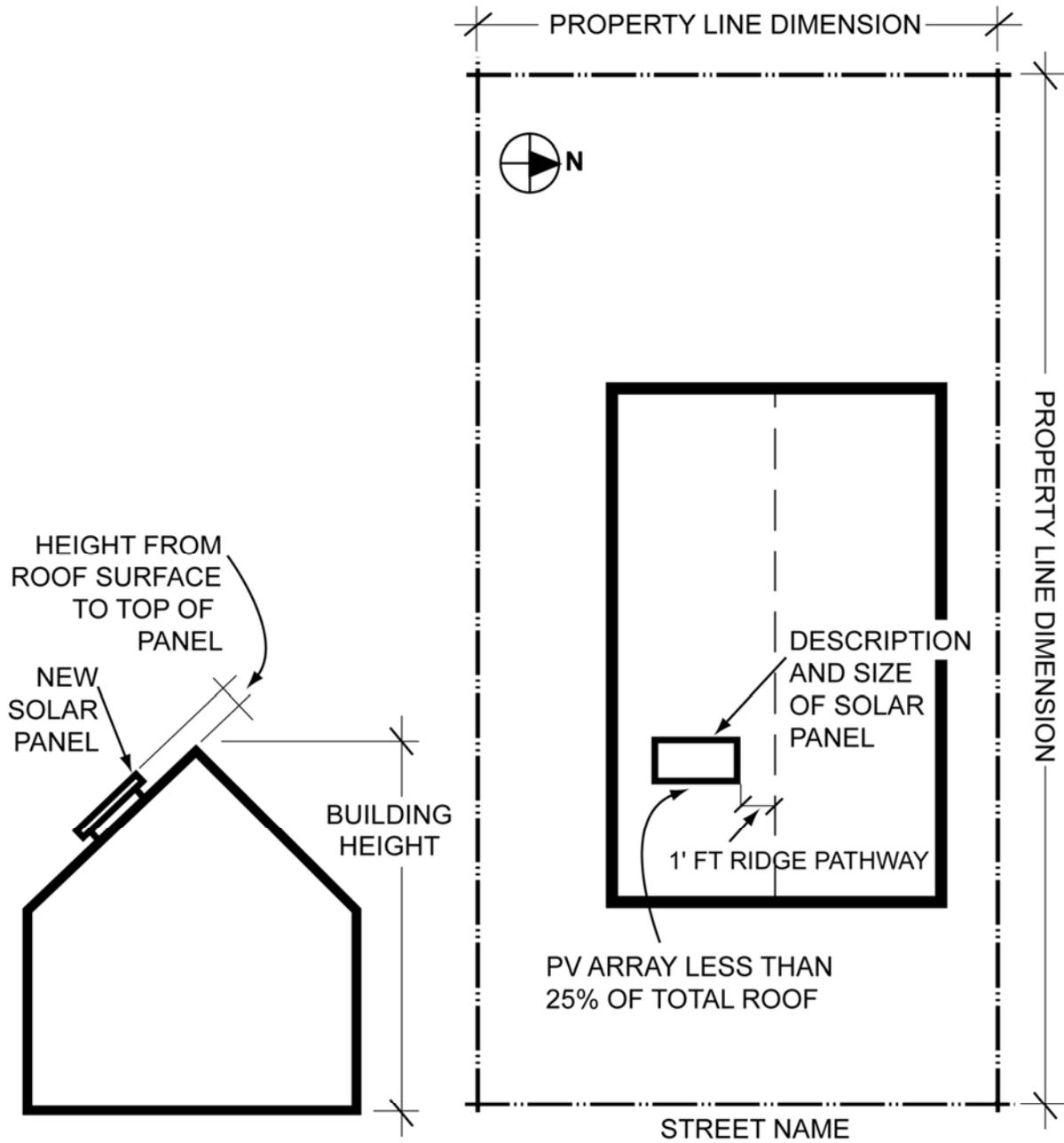


FIG. 1





SAMPLE ELEVATION

FIG. 3

SAMPLE SITE PLAN

FIG. 4

Appendix – Solar Permits: Prescriptive Installations Checklist



City of Portland, Oregon - Bureau of Development Services

1900 SW Fourth Avenue · Portland, Oregon 97201 | 503-823-7300 | www.portlandoregon.gov/bds



Checklist and Submittal Requirements for Prescriptive Installations of Solar Photovoltaic in accordance with Oregon Solar Installation Specialty Code (OSISC) and Solar Water Heating Systems

Instructions

Complete the following with all the information requested. This form must be submitted along with the application for installation.

Property Owner Information

Property Owner Name: _____ Installation Address: _____

Day Phone: _____ Evening Phone: _____ Email: _____

Contractor: _____ CCB#: _____

Day Phone: _____ Evening Phone: _____ Email: _____

PV Modules or Solar Water Heating Collectors

Manufacturer: _____ Model Number: _____ Listing Agency: _____

Site Plan and Structural Plan

- Attach a simple site plan showing the location of the PV or solar water heating system in relation to buildings, structures, property lines, and, as applicable, flood hazard areas.
- Attach a simple structural plan showing the roof framing (rafter size, type and spacing) and PV module system racking attachment. Plans must be shown in sufficient detail to assess whether the requirements of section 304.9 of OSISC or one of the exceptions have been met.
- Attach simple building elevation.
- The plans must be on 8.5 x 11 or larger paper.

Structural Information

Roof Design and Attachment

- Roof rafter size: ____ x ____ inches OR Manufactured Trusses
- Rafter or manufactured roof truss spacing _____ inches o.c.
- For roof rafters, maximum rafter span allowed per table 305.4.1 (Appendix "B") of the Oregon Solar Installation Specialty Code (OSISC) (www.oregonbcd.org/programs/solar/solar_code/100110_OSISC.pdf) for the size and spacing of roof rafters is ____ ft ____ inches.

Checklist to determine if your installation qualifies for prescriptive path

Yes No Is this conventional light framed wood construction?

Yes No Does the structure have pre-engineered trusses?

OR

Does structure have roof framing members spaced at 24" o.c. maximum AND comply with the applicable allowable span in table 305.4.1 (Appendix "B") of the Oregon Solar Installation Specialty Code (OSISC)?

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-
- Yes No Is the roofing material metal, single layer wood shingle, or not more than two layers of composition shingle?
- Yes No Is the weight of the modules and racking less than 4.5 pounds per square foot?
- Yes No Is the module height less than 18 inches above the roof in accordance with section 305.4?
- For Standing Seam Metal Roofs Only (If not applicable please skip this section)**
- Yes No Is the metal gauge 26 or heavier?
- Yes No Clamp design: Are clamps designed to withstand uplift of at least 115 pounds for clamps spaced at 60 inches on center or less or at least 75 pounds for clamps spaced at 48 inches on center or less?
- Yes No Is the spacing of the clamps as measured along the seam greater than or equal to 24" o.c. and less than 60" o.c. AND the spacing perpendicular to the seam not greater than 24" o.c.?
- Yes No Is the roofing panel width 18-inches or less?
- Yes No Is the roofing panel attached with at least #10 screws at 24" o.c.?
- Yes No Is the roofing panels installed over minimum 1/2-inch nominal wood structural panels attached to framing with 8d nails at 6" o.c. at panel edges and 12" o.c. field nailing?

If you have indicated "No" on any of these requirements above, the project may not be submitted using the prescriptive path.

Fire Fighter Access and Escape

Access and escape pathways are not required when the array is located on a non-occupied accessory structures that is separated from occupied structures by a 6 foot minimum separation distance or by a minimum two-hour fire rated assembly.

General Requirements: For all other roof mounted systems, a minimum 36" wide pathway is required along three sides of the solar roof, located over a structurally supported area. Any roof with a slope greater than 2:12 can not use the bottom roof edge as a pathway. Pathways and solar panels shall be located outside 12" of the low point of a valley.

If the array is greater than 150 feet in length or width, additional 36" wide intermediate pathways and cutouts are required. See code for details.

If the roof has smoke and/or heat vents, a 36" pathway shall be provided to and around each vent.

Exceptions to General Requirements:

- Yes No Is the roof slope greater than 2:12?
- Yes No Is the array area 1,000 sq ft or less?
- Yes No Is the array 150 feet or less in length or width?

If you have indicated "No" to any of the items above, exceptions do not apply, provide a simple plan conforming with the general requirements.

If you have indicated "Yes" to all of the items above, see below for reduced access and escape pathway requirements.

Is the array 25% or less of the roof area? Yes No

- If Yes, a 12" pathway along each side of any horizontal ridge is required.
- If No, a 12" pathway along each side of any horizontal ridge is required and a minimum of one 36" pathway is required from ridge to eave over a structurally supported area.

Provide a simple plan showing conformance to the reduced access pathway requirements.

As the property owner or authorized representative of the above listed property, I certify that I have verified the information provided above and that the roof rafters (if applicable to the project), meet the span requirements of Table 305.4.1 (Appendix B) of the Oregon Solar Installation Specialty Code.

Applicant name (please print) _____ Signature _____ Date _____