

GUIDE TO STRUCTURAL PERMITTING OF SOLAR PV SYSTEMS

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This document contains excerpts from Expedited Permit Process for PV Systems written by Bill Brooks and published by Solar America Board for Codes and Standards.

INTRODUCTION

The term “expedited permit process” refers to an organized permitting process by which a majority of small photovoltaic (PV) systems can be permitted quickly and easily. It is not intended to apply to all types of PV systems. The primary need and value for this process is for systems of less than 10-15 kW maximum power output. As PV systems increase in size and complexity, the ability to handle these projects via a standard framework diminishes. This is not to say that larger systems cannot be handled in a straightforward manner. Many larger PV system projects may be approved with minimum review as is required with smaller systems. A key difference between small and large projects is the inability of small projects to absorb engineering review costs. The expedited permit process is intended to simplify the structural and electrical review of a small PV system project and minimize the need for detailed engineering studies and unnecessary delays.

This document focuses on the structural aspects of solar permitting, as the electrical permit is issued through D.O.R.A. Expanded versions covering electrical permitting are available.

It is not the intent of an expedited process to circumvent the engineering process. Rather, the intent is to address the engineering concerns by recognizing the similarities among these smaller systems and establishing guidelines to determine when a PV project is within the boundaries of typical, well engineered systems. To this end, a one-page permit form was devised to outline the process and define what qualifies for expedited permitting. An explanatory document accompanies the permit form so that contractors and local jurisdictions using the form have a description of how to provide the required information.

WHAT QUALIFIES A PV PROJECT FOR EXPEDITED PERMITTING?

The minimum requirements needed for utilizing expedited permitting are summarized below.

The structural installation of the systems meets the following criteria:

1. the array is mounted on a code-compliant structure;
2. an engineered mounting system is used to attach the array to the structure; and,
3. the array has a distributed weight of less than 5 lbs./ft² and less than 45 lbs. per attachment.

The majority of PV systems installed in the U.S. will easily meet these requirements. For projects that do not meet these simplified criteria, additional steps may be necessary. The expedited process identifies steps to complete the review of the structural installation should the array be installed on a roof that is unfamiliar to the jurisdiction, or when a non-typical mounting system is employed. Systems with these unique characteristics may be handled with these additions to the standard form or may require more information depending on the circumstances and on the jurisdiction’s discretion.

The following pages contain forms to use with the Expedited Permit Process. The forms are available as interactive PDF files at www.solarabcs.org/permitting. The forms are fillable PDFs and can be filled out electronically and submitted in either printed form or via email.

PERMIT APPLICATION FOR SMALL-SCALE PV SYSTEMS

The information in this guideline is intended to help local jurisdictions and contractors identify when PV system installations are simple, needing only a basic review, and when an installation is more complex. For projects that fail to meet the simple criteria, resolution steps have been suggested to provide as a path to permit approval.

Structural Review of PV Array Mounting System

Is the array to be mounted on a defined, permitted roof structure? **Yes** **No**

If No due to non-compliant roof or a ground mount, submit completed worksheet for the structure WKS1.

Roof Information:

1. Is the roofing type lightweight (Yes = composition, lightweight masonry, metal, etc...)

If No, submit completed worksheet for roof structure WKS1 (No = heavy masonry, slate, etc...).

2. Does the roof have a single roof covering? **Yes** **No**

If No, submit completed worksheet for roof structure WKS1.

3. Provide method and type of weatherproofing roof penetrations (e.g. flashing, caulk).

Mounting System Information:

1. Is the mounting structure an engineered product designed to mount PV modules with no more than an 18" gap beneath the module frames? **Yes** **No**

If No, provide details of structural attachment certified by a design professional.

2. For manufactured mounting systems, fill out information on the mounting system below:

a. Mounting System Manufacturer _____

Product Name and Model# _____

b. Total Weight of PV Modules and Rails _____ lbs

c. Total Number of Attachment Points _____

d. Weight per Attachment Point (b ÷ c) _____ lbs (if greater than 45 lbs, see WKS1)

e. Maximum Spacing Between Attachment Points on a Rail _____ inches (see product manual for maximum spacing allowed based on maximum design wind speed)

f. Total Surface Area of PV Modules (square feet) _____ ft²

g. Distributed Weight of PV Module on Roof (b ÷ f) _____ lbs/ft²

If distributed weight of the PV system is greater than 5 lbs/ft², see WKS1.

Snow and Wind Information (if required):

1. What is the ground snow load at the system location?

2. What is the designed wind load of the system?

3. For rooftop systems, does the top chord have sufficient capacity to hold point loads produced by the ground snow and wind loads combined with the dead loads of the system and the roofing material? Yes No
4. What is the excess capacity remaining in the top chord taking into consideration dead loads and wind and snow point loads?

5. Express the excess capacity as a percentage of the IRC live load requirements (20 psf):

If the percentage is less than 100, please refer to WKS1

Additional Information Which May be Required for Permit:

1. Site plan showing location of major components on the property. This drawing need not be exactly to scale, but it should represent relative location of components at site.
2. Specification sheets and installation manuals (if available) for all manufactured components including, but not limited to, PV modules, and mounting system.

PERMIT APPLICATION FORM — DETAILED INSTRUCTIONS AND EXPLANATION

1. Is the array to be mounted on a defined, permitted roof structure? **Yes** **No**
(structure meets modern codes)

If No, submit completed worksheet for roof structure WKS1.

Explanation: The reference to a defined, permitted roof structure refers to structures that have a clear inspection history so that verification of structural elements is unnecessary. If structural modifications have been made due to remodeling, those changes should be documented through the permit and review process. It also recognizes the fact that code enforcement for roof structural elements has been much more consistent across the United States in the last 35 years. However, there may be many local jurisdictions who have been carefully reviewing roof structures for a much longer period of time. The local jurisdiction should consider extending this limit based on the period that roofs have been consistently inspected. In areas where jurisdictional reviews have not extended 35 years into the past, the jurisdiction may need to get the information from WKS1 to be sure whether or not the proposed PV system is being installed on a typical roof structure or not.

Roof Information:

1. Is the roofing type lightweight (Yes = composition, lightweight masonry, metal, wood shake, etc.) _____

If No, submit completed worksheet for roof structure WKS1 (No = heavy masonry, slate, etc.).

Explanation: There is a need to distinguish if a roof has a lightweight product. Roof structures supporting heavier roofing materials (e.g. slate, heavy masonry) may not have the assumed dead loading and live loading capacities that are found with lighter weight roofing materials. These are much less common roof types and often justify a further review to clarify whether the roof structure is either in compliance or needs enhancement.

2. If a composition shingle roof, does the roof have a single roof covering? **Yes** **No**
If No, submit completed worksheet for roof structure WKS1.

Explanation: Multiple composition roof layers may be taking a portion or all of the assumed additional weight allowance found in the 5 lbs/ft² allowance at the end of the mounting system section.

3. Provide method and type of weatherproofing roof penetrations (e.g. flashing, caulk.) _____

Explanation: The weatherproofing method needs to be specifically identified so that plan checkers and field inspectors are notified ahead of time of the method being used. Some jurisdictions may constrain weatherproofing methods and materials. Sealant information should confirm that the product is compatible with the roofing material.

Mounting System Information:

1. Is the mounting structure an engineered product designed to mount PV modules with no more than an 18” gap beneath the module frames? **Yes** **No**

If No, provide details of structural attachment certified by a design professional.

Explanation: Non-engineered racking systems have undefined capabilities. PV systems should only be mounted using systems that are engineered and designed for that purpose. Structural loading of a roof is more complex when modules are angled more than 18” above the roof surface. For simplicity, this process has been limited to PV arrays that are mounted parallel to the roof surface or angled with no more than an 18” gap between the module frame and the roof surface. If an installer chooses to mount the PV modules with a larger gap or if they use a mounting system of unique design, then the mounting design would require a review by a design professional.

2. For manufactured mounting systems, fill out information on the mounting system below:

- a. Mounting System Manufacturer _____ Product Name and Model# _____ (self explanatory)
- b. Total Weight of PV Modules and Rails _____ lbs (include total weight of all hardware used along with module weight)
- c. Total Number of Attachment Points _____ (self-explanatory)
- d. Weight per Attachment Point (b ÷ c) _____ lbs (if greater than 45 lbs, see WKS1)

Explanation: 45 lbs has been used by some jurisdictions as a reasonable level below which point loading of roof joists and trusses can be ignored. Most standard mounting systems have point loadings of 25-35 lbs per attachment.

- e. Maximum Spacing Between Attachment Points on a Rail _____ inches (see product manual for maximum spacing allowed based on wind loading)

Explanation: Depending on the wind loading requirements of a particular jurisdiction, the spacing or attachments may be dictated by the manufacturer’s directions. For instance, a particular manufacturer may allow a 72” attachment spacing for a 90 MPH windspeed design, but the spacing reduces to a maximum of 48” when the design windspeed exceeds 100 MPH.

- f. Total Surface Area of PV Modules (square feet) _____ ft²

Explanation: Take the surface area of a single module, and multiply it by the total number of modules in the roof-mounted system.

- g. Distributed Weight of PV System on Roof (b ÷ f) _____ lbs/ft²

If distributed weight of the PV system is greater than 5 lbs/ft², see WKS1.

Explanation: The 5 lbs/ft² limit is based on two things: 1) the roof is typical of standard code-compliant roof structures so that the structure either has the proper spans and spacing, or proper use of engineered trusses (first item under “Step 1: Structural Review”); and, 2) there is a single layer of roofing so that the normal weight allowance for additional roof layers is unused and available for the weight of the PV system. For applications on lightweight masonry roofing materials and other lightweight roofing products (e.g. metal, shake, etc.), these materials do not accept multiple layers and therefore the 5 lbs/ft² allowance is used to identify the maximum allowable additional weight for roofs that are exchanging the allowable live load for a dead load that prevents live load such as people walking on the roof.

SUPPLEMENTAL STRUCTURAL WORKSHEET FOR NON-STANDARD SYSTEMS

Structure Worksheet—WKS1

If array is roof mounted

This section is for evaluating roof structural members that are site built. This includes rafter systems and site built trusses. Manufactured truss and roof joist systems, when installed with proper spacing, meet the roof structure requirements covered in item 2 below.

1. Roof construction: **Rafters** **Trusses** **Other:** _____

2. Describe site-built rafter or or site-built truss system.
 - a. Rafter Size: ___ x ___ inches
 - b. Rafter Spacing: _____ inches
 - c. Maximum unsupported span: _____ feet, _____ inches
 - d. Are the rafters over-spanned? (see the IRC span tables on pages 9-10 .)
 Yes **No**
 - e. If **Yes**, complete the rest of this section.

3. If the roof system has
 - a. over-spanned rafters or trusses,
 - b. the array over 5 lbs/ft² on any roof construction, or
 - c. the attachments with a dead load exceeding 45 lbs per attachment;

It is recommended that you provide one of the following:

- i. A framing plan that shows details for how you will strengthen the rafters using the supplied span tables in B.2.
- ii. Confirmation certified by a design professional that the roof structure will support the array.

If array is ground mounted:

1. Show array supports, framing members, and foundation posts and footings.
2. Provide information on mounting structure(s) construction. If the mounting structure is unfamiliar to the local jurisdiction and is more than six (6) feet above grade, it may require engineering calculations certified by a design professional.
3. Show detail on module attachment method to mounting structure.

SPAN TABLES

A framing plan is required only if the combined weight of the PV array exceeds 5 pounds per square foot (PSF or lbs/ft²) or the existing rafters are over-spanned. The following span tables from the 2009 International Residential Code (IRC) can be used to determine if the rafters are over-spanned. For installations in jurisdictions using different span tables, follow the local tables.

Span Table R802.5.1(1),

Use this table for rafter spans that have conventional light-weight dead loads and do not have a ceiling attached.

10 PSF Dead Load							
Roof live load = 20 psf, ceiling not attached to rafters, L/Δ=180							
Rafter Size			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
Spacing (inches)	Species	Grade	The measurements below are in feet-inches (e.g. 9-10 = 9 feet, 10 inches).				
16	Douglas Fir-larch	#2 or better	9-10	14-4	18-2	22-3	25-9
16	Hem-fir	#2 or better	9-2	14-2	17-11	21-11	25-5
24	Douglas Fir-larch	#2 or better	8-0	11-9	14-10	18-2	21-0
24	Hem-fir	#2 or better	7-11	11-7	14-8	17-10	20-9

Use this table for rafter spans that have heavy dead loads and do not have a ceiling attached.

20 PSF Dead Load							
Roof live load = 20 psf, ceiling not attached to rafters, L/Δ=180							
Rafter Size			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
Spacing (inches)	Species	Grade	The measurements below are in feet-inches (e.g. 9-10 = 9 feet, 10 inches).				
16	Douglas Fir-larch	#2 or better	8-6	12-5	15-9	19-3	22-4
16	Hem-fir	#2 or better	8-5	12-3	15-6	18-11	22-0
24	Douglas Fir-larch	#2 or better	6-11	10-2	12-10	15-8	18-3
24	Hem-fir	#2 or better	6-10	10-0	12-8	15-6	17-11

Span Table R802.5.1(2),

Use this table for rafter spans with a ceiling attached and conventional light-weight dead loads.

10 PSF Dead Load							
Roof live load = 20 psf, ceiling attached to rafters, L/Δ=240							
Rafter Size			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
Spacing (inches)	Species	Grade	The measurements below are in feet-inches (e.g. 9-10 = 9 feet, 10 inches).				
16	Douglas Fir-larch	#2 or better	8-11	14-1	18-2	22-3	25-9
16	Hem-fir	#2 or better	8-4	13-1	17-3	21-11	25-5
24	Douglas Fir-larch	#2 or better	7-10	11-9	14-10	18-2	21-0
24	Hem-fir	#2 or better	7-3	11-5	14-8	17-10	20-9

Use this table for rafter spans with a ceiling attached and where heavy dead loads exist.

20 PSF Dead Load							
Roof live load = 20 psf, ceiling attached to rafters, L/Δ=240							
Rafter Size			2 x 4	2 x 6	2 x 8	2 x 10	2 x 12
Spacing (inches)	Species	Grade	The measurements below are in feet-inches (e.g. 9-10 = 9 feet, 10 inches).				
16	Douglas Fir-larch	#2 or better	8-6	12-5	15-9	19-3	22-4
16	Hem-fir	#2 or better	8-4	12-3	15-6	18-11	22-0
24	Douglas Fir-larch	#2 or better	6-11	10-2	12-10	15-8	18-3
24	Hem-fir	#2 or better	6-10	10-0	12-8	15-6	17-11

Use the conventional light-weight dead load table when the existing roofing materials are wood shake, wood shingle, composition shingle, or light-weight tile. (The rationale for allowing these tables to be used is that the installation of a PV system should be considered as part of the live load, since additional loading will not be added to the section of the roof where a PV array is installed.)

Where heavy roofing systems exist (e.g. clay tile or heavy concrete tile roofs), use the 20 lbs/ft² dead load tables.