The following Wood Joist/Rafter Maximum Span Tables can be used to determine the adequacy of an existing wood framed roof structure to support the additional dead load created by PV panel installation. The tables include three wood species. The actual wood species used for roof framing may be determined by checking the grade stamps on the wood members. If the grade stamps cannot be found, then the species of the lumber should be assumed to be Spruce-Pine-Fir, No. 2.

The span tables are based upon a snow live load of 25 psf on a flat roof and the horizontal projection on sloped roofs listed and a variable snow load as per CBC Section 13-52-280(b) for slopes of 8:12 to 14:12. These tables do not include consideration of snow drifting that may occur with various roof configurations and adjacent taller buildings.

The span tables apply to joists or rafters supporting uniform loads and one or two rows of PV panels set at the midspan of the member. For joists or rafters on roofs with a slope of 2 inches per foot or less, the maximum span is based upon the members acting as simple span elements. Simple span members are those that are supported vertically at either end to carry the gravity load. (See Illustration No. 1) For rafters with a slope of 4 inches per foot or greater, the maximum span is based upon the condition where the rafters bear against one another at the ridge but are not supported by a beam at the ridge. In essence, the rafters form a simple truss or triangle where the rafters have both axial and bending stresses. In addition, the rafters are tied to the ceiling (or attic floor joists), at their ends, to transmit the horizontal tensile force through the ceiling or attic floor joists. The rafters and joists are parallel to one another and the connections between the two are sufficient to transfer the axial tensile force from one side of the roof (or attic) to the other. (See Illustration No. 2) All dimensions are in decimal feet.

Tables 1 through 4 are based upon the support rails being perpendicular to the joists or rafters and the PV panels being attached to the members at 32 inches on center and therefore the dead load is carried by every other joist or rafter. Tables 5 through 8 are based upon the PV panels being attached to the members at 48 inches on center and the panel dead load is carried by every third joist or rafter. All of the tables are based on the long dimension of the panels oriented vertically (or parallel to the joists or rafters). For the tables based upon double rows of panels, the overall dimension of the two rows is 11'-1". As the PV panels can also be installed horizontally, the tables for double rows can also be used for three rows of panels oriented horizontally provided that the sum of the width of the 3 panels and spaces does not exceed 11'-1".

The tables for double rows of PV panels are also based upon both rows being attached to the same joists or rafters. That is, the attachment of the rows of PV panels is not staggered. If however, the attachment of the rows of PV panels is to be staggered such that no joist or rafter carries more than one row, the span tables for one row may be used.

Where joists or rafters have span or load conditions that differ from that listed in the tables, a separate analysis and design must be made of those members using accepted engineering practice and the provisions of the National Design Specification for Wood Construction of the American Forest and Paper Association, as well as the requirements of the Chicago Building Code.

TABLE 1: WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH SINGLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 32" o.c. — **DEAD LOAD: 14 PSF**

	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	12.8	12.7	11.3	11.3	11.3	11.2	10.9	10.7	11.6	11.9	12.1	12.1
		No. 2	11	11	10.1	10.1	10	9.9	9.7	9.5	10.3	10.6	10.7	10.8
	Spruce Pine Fir	No. 1	10.5	10.5	9.4	9.4	9.4	9.3	9.1	8.9	9.7	9.9	10.1	10.1
		No. 2	9.9	9.8	8.9	8.9	8.9	8.8	8.6	8.4	9.1	9.4	9.5	9.6
	Douglas Fir Larch	No. 1	11.3	11.2	10.2	10.2	10.2	10	9.8	9.6	10.4	10.7	10.8	10.9
		No. 2	10.7	10.6	9.7	9.7	9.7	9.5	9.3	9.1	9.9	10.1	10.3	10.3
2x8	Southern Pine	No. 1	16.2	16.1	14.5	14.5	14.5	14.3	14	13.7	14.9	15.3	15.5	15.6
		No. 2	14.4	14.4	13.2	13.2	13.1	12.9	12.7	12.4	13.5	13.8	14.1	14.1
	Spruce Pine Fir	No. 1	13.4	13.3	12.2	12.2	12.1	12	11.7	11.5	12.5	12.8	13	13.1
		No. 2	12.6	12.5	11.5	11.5	11.5	11.3	11.1	10.8	11.8	12.1	12.3	12.3
	Douglas Fir Larch	No. 1	14.4	14.4	13.1	13.1	13.1	12.9	12.6	12.3	13.4	13.8	14	14.1
		No. 2	13.6	13.6	12.5	12.5	12.4	12.2	12	11.7	12.7	13.1	13.3	13.4
2X10	Southern Pine	No. 1	19.3	19.2	17.6	17.6	17.5	17.3	16.9	16.5	18	18.5	18.8	18.9
		No. 2	17.3	17.2	16	16	15.9	15.7	15.4	15	16.3	16.8	17.1	17.2
	Spruce Pine Fir	No. 1	16.5	16.4	15.1	15.1	15.1	14.8	14.5	14.2	15.4	15.9	16.1	16.2
		No. 2	15.5	15.4	14.3	14.3	14.2	14	13.7	13.4	14.6	15	15.2	15.3
	Douglas Fir Larch	No. 1	17.7	17.7	16.3	16.3	16.2	16	15.6	15.3	16.6	17.1	17.4	17.5
		No. 2	16.8	16.7	15.5	15.5	15.4	15.1	14.8	14.5	15.8	16.2	16.5	16.6
2x12	Southern Pine	No.1	23.1	23.1	21.2	21.2	21.1	20.8	20.3	19.9	21.6	22.3	22.6	22.8
		No. 2	20.4	20.3	19	19	18.9	18.6	18.2	17.8	19.4	19.9	20.3	20.4
	Spruce Pine Fir	No.1	19.1	19.1	17.7	17.7	17.6	17.3	17	16.6	18.1	18.6	18.9	19.1
		No. 2	18	18	16.8	16.8	16.7	16.4	16.1	15.7	17.1	17.6	17.9	18
	Douglas Fir Larch	No.1	20.6	20.6	19.1	19.1	19	18.7	18.3	17.9	19.5	20.1	20.4	20.6
		No. 2	19.5	19.5	18.2	18.2	18	17.8	17.4	17	18.5	19	19.4	19.5

TABLE 2:	WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH DOUBLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 32" o.c.	DEAD LOAD: 14 PSF

	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	12.4	12.4	11	11	11	10.8	10.6	10.3	11.3	11.5	11.6	11.6
		No. 2	***	***	***	9.9	9.8	9.6	9.4	9.2	10	10.2	10.3	10.3
	Spruce Pine Fir	No. 1	***	***	***	***	9.2	9	8.8	8.6	9.4	9.6	9.7	9.7
		No. 2	***	***	***	***	***	8.6	8.4	8.2	8.9	9.1	9.2	9.2
	Douglas Fir Larch	No. 1	11	11	***	10	9.9	9.2	9.5	9.3	10.1	10.3	10.4	10.4
		No. 2	***	***	***	***	9.4	9.7	9	8.8	9.6	9.8	9.9	9.9
2x8	Southern Pine	No. 1	15.7	15.7	14.1	14.1	14.1	13.9	13.6	13.2	14.4	14.8	14.9	15
		No. 2	14	14	12.8	12.8	12.8	12.5	12.3	12	13.1	13.4	13.5	13.6
	Spruce Pine Fir	No. 1	13	13	11.9	11.9	11.8	11.6	11.4	11.1	12.1	12.4	12.5	12.5
		No. 2	12.3	12.2	11.2	11.2	11.2	11	10.7	10.5	11.4	11.7	11.8	11.8
	Douglas Fir Larch	No. 1	14	14	12.8	12.8	12.7	12.5	12.2	11.9	13	13.3	13.5	13.5
		No. 2	13.3	13.2	12.2	12.2	12.1	11.9	11.6	11.3	12.4	12.6	12.8	12.8
2X10	Southern Pine	No. 1	18.8	18.7	17.1	17.1	17.1	16.8	16.4	16.1	17.5	17.9	18.2	18.3
		No. 2	16.8	16.8	15.6	15.6	15.5	15.2	14.9	14.6	15.9	16.2	16.5	16.6
	Spruce Pine Fir	No. 1	16	16	14.7	14.7	14.6	14.4	14.1	13.8	15	15.3	15.5	15.6
		No. 2	15.1	15	13.9	13.9	13.8	13.6	13.3	13	14.1	14.5	14.7	14.7
	Douglas Fir Larch	No. 1	17.2	17.2	15.9	15.9	15.7	15.5	15.2	14.8	16.1	16.5	16.8	16.9
		No. 2	16.3	16.3	15.1	15.1	14.9	14.7	14.4	14.1	15.3	15.7	15.9	16
2x12	Southern Pine	No.1	22.5	22.5	20.6	20.6	20.6	20.2	19.8	19.4	21.8	21.6	21.9	22.1
		No. 2	19.8	19.8	18.5	18.5	18.3	18	17.7	17.3	18.8	19.3	19.6	19.7
	Spruce Pine Fir	No.1	18.6	18.6	17.3	17.3	17.1	16.9	16.5	16.2	17.6	18	18.3	18.4
		No. 2	17.5	17.5	16.3	16.3	16.2	15.9	15.6	15.3	16.6	17	17.3	17.4
	Douglas Fir Larch	No.1	20.1	20	18.6	18.6	18.5	18.2	17.8	17.4	19	19.4	19.7	19.9
		No. 2	19	18.9	17.7	17.7	17.5	17.2	16.9	16.5	18	18.4	18.7	18.8

*** Member is not long enough to accommodate two rows of PV panels. (Member length = span/cos(α) where α is the angle of the roof slope.) (The PV panel length used is 5'-6" with a 1" space between the rows.)

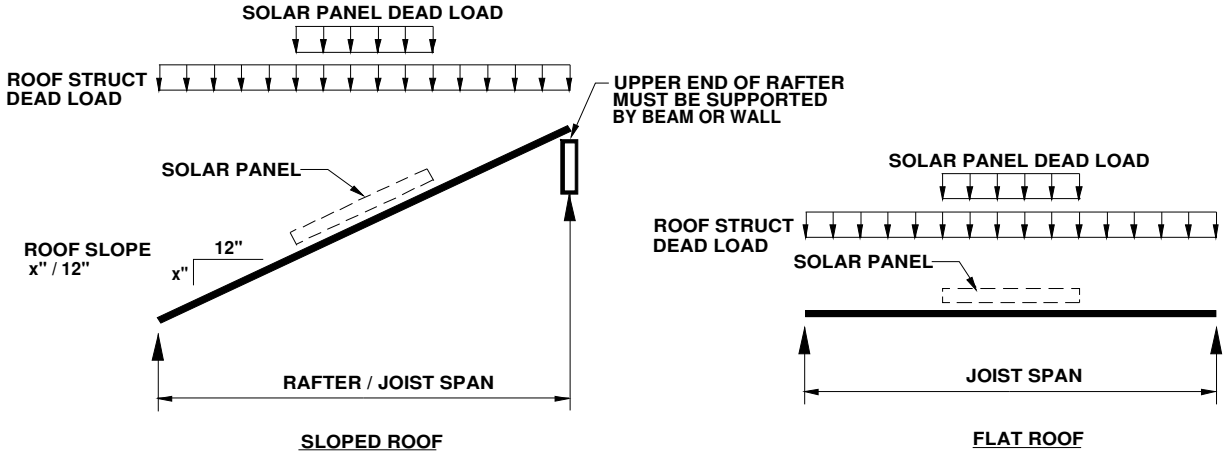


ILLUSTRATION No. 1 – SIMPLE SPAN JOISTS OR RAFTERS

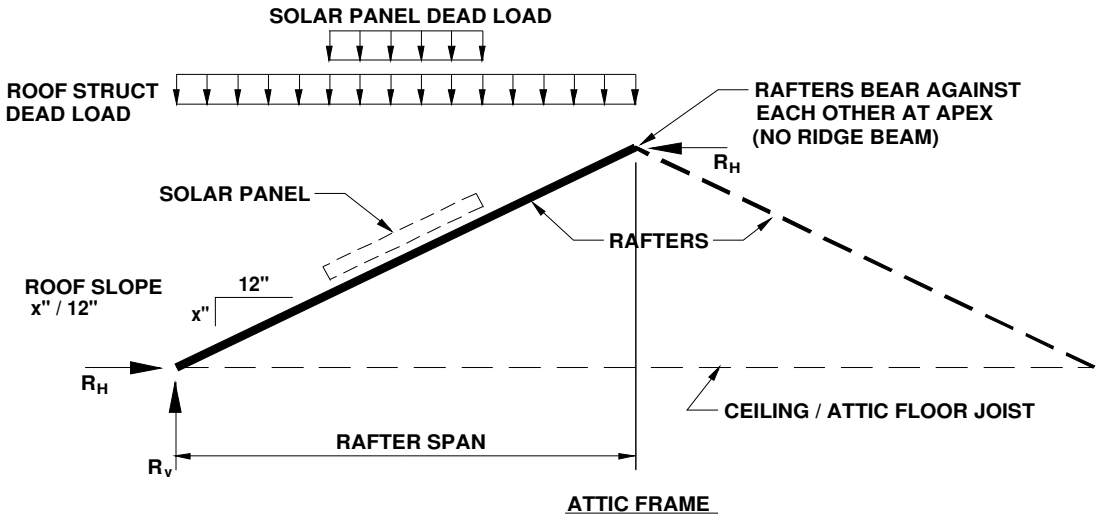


ILLUSTRATION No. 2 – ATTIC FRAME

Tables 3 & 4 are similar to Tables 1 & 2, respectively, except that the dead load of the existing roof structure is reduced to include only the roofing, roof sheathing and joists or rafters.

TABLE 3: WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH SINGLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 32" o.c. — **DEAD LOAD: 8 PSF**

Joist/Rafter Size	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	13.8	13.8	12.1	12.1	12.1	12.2	11.9	11.4	12.7	13.2	13.5	13.8
		No. 2	11.9	11.9	10.9	10.9	10.9	10.8	10.6	10.2	11.2	11.7	12	12.3
	Spruce Pine Fir	No. 1	11.3	11.3	10.2	10.2	10.2	10.1	10	9.6	10.5	11	11.3	11.5
		No. 2	10.6	10.6	9.6	9.6	9.6	9.6	9.4	9.1	10	10.4	10.7	10.9
	Douglas Fir Larch	No. 1	12.2	12.1	11	11	11	10.9	10.7	10.3	11.4	11.8	12.2	12.4
		No. 2	11.5	11.5	10.4	10.4	10.4	10.4	10.2	9.8	10.8	11.2	11.6	11.8
2x8	Southern Pine	No. 1	17.5	17.4	15.6	15.6	15.6	15.6	15.3	14.7	16.2	16.9	17.4	17.8
		No. 2	15.6	15.5	14.2	14.2	14.2	14.1	13.9	13.4	14.7	15.3	15.8	16.2
	Spruce Pine Fir	No. 1	14.5	14.4	13.1	13.1	13.1	13.1	12.9	12.4	13.6	14.2	14.6	14.9
		No. 2	13.6	13.6	12.4	12.4	12.4	12.3	12.1	11.7	12.9	13.4	13.8	14.1
	Douglas Fir Larch	No. 1	15.6	15.5	14.1	14.1	14.1	14.1	13.8	13.3	14.7	15.3	15.8	16.1
		No. 2	14.7	14.7	13.4	13.4	13.4	13.3	13.1	12.7	13.9	14.5	15	15.3
2X10	Southern Pine	No. 1	20.9	20.9	19	19	19	18.9	18.6	17.9	19.7	20.6	21.2	21.7
		No. 2	18.7	18.7	17.3	17.3	17.3	17.2	16.9	16.3	17.9	18.7	19.3	19.8
	Spruce Pine Fir	No. 1	17.8	17.8	16.3	16.3	16.3	16.2	15.9	15.4	16.9	17.6	18.2	18.6
		No. 2	16.7	16.7	15.4	15.4	15.4	15.3	15.1	14.5	16	16.6	17.2	17.6
	Douglas Fir Larch	No. 1	19.2	19.1	17.6	17.6	17.6	17.5	17.2	16.6	18.2	19	19.6	20.1
		No. 2	18.1	18.1	16.7	16.7	16.7	16.6	16.3	15.7	17.3	18	18.6	19.1
2x12	Southern Pine	No.1	25	25	22.9	22.9	22.9	22.7	22.4	21.5	23.7	24.8	25.6	26.2
		No. 2	22.1	22	20.6	20.6	20.6	20.3	20	19.3	21.2	22.2	22.9	23.5
	Spruce Pine Fir	No.1	20.7	20.7	19.2	19.2	19.2	19	18.7	18	19.8	20.7	21.4	21.9
		No. 2	19.5	19.5	18.1	18.1	18.1	17.9	17.7	17.1	18.7	19.6	20.2	20.7
	Douglas Fir Larch	No.1	22.3	22.3	20.7	20.7	20.7	20.5	20.2	19.5	21.4	22.3	23.1	23.6
		No. 2	21.1	21.1	19.7	19.7	19.7	19.4	19.2	18.5	20.3	21.2	21.9	22.4

TABLE 4:	WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH DOUBLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 32" o.c.												DEAD LOAD: 8 PSF
	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	13.4	13.3	11.8	11.8	11.8	11.7	11.5	11.3	12.2	12.6	12.9	13.1
		No. 2	11.6	11.6	10.6	10.6	10.5	10.4	10.2	10	10.8	11.2	11.5	11.6
	Spruce Pine Fir	No. 1	11	11	9.9	9.9	9.9	9.8	9.6	9.4	10.2	10.5	10.7	10.9
		No. 2	***	***	***	***	9.4	9.3	9.1	8.9	9.6	9.9	10.2	10.3
	Douglas Fir Larch	No. 1	11.8	11.8	10.7	10.7	10.7	10.5	10.3	10.1	11	11.3	11.6	11.8
		No. 2	11.2	11.2	10.1	10.1	10.1	10	9.8	9.6	10.4	10.8	11	11.1
2x8	Southern Pine	No. 1	16.9	16.9	15.1	15.1	15.1	15	14.8	14.5	15.7	16.3	16.7	17
		No. 2	15.1	15	13.8	13.8	13.8	13.6	13.4	13.1	14.2	14.7	15.1	15.4
	Spruce Pine Fir	No. 1	14	14	12.7	12.7	12.7	12.6	12.4	12.1	13.1	13.6	13.9	14.2
		No. 2	13.2	13.2	12.1	12.1	12.1	11.9	11.7	11.5	12.4	12.8	13.1	13.4
	Douglas Fir Larch	No. 1	15.1	15	13.7	13.7	13.7	13.6	13.3	13.1	14.1	14.7	15	15.3
		No. 2	14.3	14.2	13	13	13	12.9	12.7	12.4	13.4	13.9	14.3	14.5
2X10	Southern Pine	No. 1	20.2	20.2	18.4	18.4	18.4	18.3	18	17.6	19	19.8	20.4	20.8
		No. 2	18.1	18.1	16.8	16.8	16.8	16.6	16.3	16	17.3	17.9	18.5	18.9
	Spruce Pine Fir	No. 1	17.2	17.2	15.8	15.8	15.8	15.6	15.4	15.1	16.3	16.9	17.4	17.7
		No. 2	16.2	16.2	14.9	14.9	14.9	14.8	14.5	14.2	15.4	16	16.4	16.7
	Douglas Fir Larch	No. 1	18.5	18.5	17	17	17	16.9	16.6	16.3	17.6	18.3	18.8	19.2
		No. 2	17.6	17.5	16.2	16.2	16.2	16	15.7	15.5	16.7	17.3	17.8	18.2
2x12	Southern Pine	No.1	24.3	24.3	22.2	22.2	22.2	22	21.7	21.3	23	23.9	24.7	25.2
		No. 2	21.4	21.3	19.9	19.9	19.9	19.7	19.4	19	20.5	21.3	22	22.5
	Spruce Pine Fir	No.1	20.1	20	18.6	18.6	18.6	18.4	18.1	17.8	19.1	19.9	20.5	21
		No. 2	18.9	18.8	17.6	17.6	17.6	17.3	17.1	16.8	18.1	18.8	19.4	19.8
	Douglas Fir Larch	No.1	21.6	21.6	20.1	20.1	20.1	19.8	19.5	19.2	20.7	21.5	22.2	22.7
		No. 2	20.5	20.4	19.1	19.1	19	18.8	18.5	18.2	19.6	20.4	21	21.5

*** Member is not long enough to accommodate two rows of PV panels. (Member length = span/cos(α) where α is the angle of the roof slope.) (The PV panel length used is 5'-6" with a 1" space between the rows.)

TABLE 5: WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH SINGLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 48" o.c. — **DEAD LOAD: 14 PSF**

	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	12.4	12.4	11	11	11	10.9	10.6	10.4	11.3	11.6	11.7	11.7
		No. 2	10.7	10.7	9.8	9.8	9.8	9.6	9.4	9.2	10	10.2	10.4	10.4
	Spruce Pine Fir	No. 1	10.2	10.1	9.2	9.2	9.2	9	8.8	8.6	9.4	9.6	9.7	9.8
		No. 2	9.5	9.5	8.7	8.7	8.7	8.5	8.3	8.1	8.9	9.1	9.2	9.2
	Douglas Fir Larch	No. 1	10.9	10.9	9.9	9.9	9.9	9.7	9.5	9.3	10.1	10.4	10.5	10.5
		No. 2	10.3	10.3	9.4	9.4	9.4	9.2	9	8.8	9.6	9.8	9.9	10
2x8	Southern Pine	No. 1	15.8	15.7	14.2	14.2	14.2	14	13.7	13.4	14.5	14.9	15.1	15.2
		No. 2	14	14	12.9	12.9	12.8	12.6	12.4	12.1	13.1	13.5	13.7	13.8
	Spruce Pine Fir	No. 1	13	13	11.9	11.9	11.8	11.7	11.4	11.2	12.1	12.4	12.6	12.7
		No. 2	12.2	12.2	11.2	11.2	11.2	11	10.8	10.5	11.4	11.7	11.9	12
	Douglas Fir Larch	No. 1	14	14	12.8	12.8	12.8	12.6	12.3	12	13.1	13.4	13.6	13.7
		No. 2	13.3	13.2	12.2	12.2	12.1	11.9	11.7	11.4	12.4	12.7	12.9	13
2X10	Southern Pine	No. 1	18.9	18.9	17.3	17.3	17.2	16.9	16.6	16.2	17.6	18.1	18.4	18.5
		No. 2	16.9	16.9	15.7	15.7	15.6	15.4	15.1	14.7	16	16.4	16.7	16.8
	Spruce Pine Fir	No. 1	16.1	16	14.8	14.8	14.7	14.5	14.2	13.9	15.1	15.5	15.7	15.8
		No. 2	15.1	15.1	14	14	13.9	13.7	13.4	13.1	14.2	14.6	14.8	14.9
	Douglas Fir Larch	No. 1	17.3	17.3	16	16	15.9	15.6	15.3	15	16.3	16.7	17	17.1
		No. 2	16.4	16.3	15.1	15.1	15.1	14.8	14.5	14.2	15.4	15.8	16.1	16.2
2x12	Southern Pine	No.1	22.7	22.6	20.8	20.8	20.7	20.4	20	19.6	21.3	21.9	22.2	22.4
		No. 2	20	19.9	18.7	18.7	18.5	18.2	17.9	17.5	19	19.5	19.8	20
	Spruce Pine Fir	No.1	18.7	18.7	17.4	17.4	17.3	17	16.7	16.3	17.7	18.2	18.5	18.7
		No. 2	17.6	17.6	16.4	16.4	16.3	16.1	15.8	15.4	16.7	17.2	17.5	17.6
	Douglas Fir Larch	No.1	20.2	20.2	18.8	18.8	18.7	18.4	18	17.6	19.1	19.7	20	20.2
		No. 2	19.1	19.1	17.8	17.8	17.7	17.4	17.1	16.7	18.1	18.6	19	19.1

TABLE 6:	WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH DOUBLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 48" o.c.	DEAD LOAD: 14 PSF

	LIVE LOAD		25 PSF							VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)										
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	12	12	10.6	10.6	10.6	10.4	10.2	9.9	10.8	11	11.1	11.1
		No. 2	***	***	***	***	9.4	9.2	9	8.8	9.6	9.8	9.8	9.8
	Spruce Pine Fir	No. 1	***	***	***	***	***	8.7	8.5	8.3	***	9.2	9.2	9.2
		No. 2	***	***	***	***	***	***	8	7.8	***	8.7	8.7	8.7
	Douglas Fir Larch	No. 1	***	***	***	***	9.5	9.3	9.1	8.9	9.7	9.9	9.9	9.9
		No. 2	***	***	***	***	***	8.9	8.7	8.4	9.3	9.4	9.4	9.4
2x8	Southern Pine	No. 1	15.2	15.1	13.6	13.6	13.6	13.4	13.1	12.8	13.9	14.2	14.3	14.3
		No. 2	13.5	13.5	12.4	12.4	12.3	12.1	11.8	11.5	12.6	12.8	12.9	13
	Spruce Pine Fir	No. 1	12.6	12.5	11.4	11.4	11.4	11.2	10.9	10.7	11.6	11.8	11.9	11.9
		No. 2	11.8	11.8	10.8	10.8	10.7	10.5	10.3	10	11	11.2	11.3	11.3
	Douglas Fir Larch	No. 1	13.5	13.5	12.3	12.3	12.3	12	11.8	11.5	12.5	12.8	12.9	12.9
		No. 2	12.8	12.8	11.7	11.7	11.6	11.4	11.2	10.9	11.9	12.1	12.2	12.2
2X10	Southern Pine	No. 1	18.2	18.1	16.6	16.6	16.5	16.2	15.9	15.5	16.9	17.3	17.5	17.6
		No. 2	16.2	16.2	15.1	15.1	14.9	14.7	14.4	14.1	15.3	15.6	15.8	15.9
	Spruce Pine Fir	No. 1	15.4	15.4	14.2	14.2	14.1	13.9	13.6	13.3	14.4	14.7	14.9	15
		No. 2	14.5	14.5	13.4	13.4	13.3	13.1	12.8	12.5	13.6	13.9	14	14.1
	Douglas Fir Larch	No. 1	16.6	16.6	15.3	15.3	15.2	15	14.7	14.3	15.6	15.9	16.1	16.2
		No. 2	15.7	15.7	14.6	14.6	14.4	14.2	13.9	13.6	14.8	15.1	15.3	15.3
2x12	Southern Pine	No.1	21.8	21.8	20.1	20.1	20	19.6	19.2	18.8	20.4	20.9	21.2	21.3
		No. 2	19.2	19.1	17.9	17.9	17.8	17.5	17.1	16.8	18.2	18.6	18.9	19
	Spruce Pine Fir	No.1	18	18	16.7	16.7	16.6	16.3	16	15.6	17	17.4	17.6	17.7
		No. 2	16.9	16.9	15.8	15.8	15.6	15.4	15.1	14.7	16	16.4	16.6	16.7
	Douglas Fir Larch	No.1	19.4	19.4	18.1	18.1	17.9	17.6	17.3	16.9	18.3	18.8	19	19.1
		No. 2	18.4	18.3	17.1	17.1	17	16.7	16.4	16	17.4	17.8	18	18.1

*** Member is not long enough to accommodate two rows of PV panels. (Member length = span/cos(α) where α is the angle of the roof slope.) (The PV panel length used is 5'-6" with a 1" space between the rows.)

Tables 7 & 8 are similar to Tables 5 & 6, respectively, except that the dead load of the existing roof structure is reduced to include only the roofing, roof sheathing and joists or rafters.

TABLE 7: WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH SINGLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 48" o.c. — **DEAD LOAD: 8 PSF**

	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	13.4	13.3	11.8	11.8	11.8	11.8	11.6	11.4	12.3	12.7	13.1	13.3
		No. 2	11.5	11.5	10.5	10.5	10.5	10.4	10.3	10.1	10.9	11.3	11.6	11.8
	Spruce Pine Fir	No. 1	10.9	10.9	9.8	9.8	9.8	9.8	9.6	9.4	10.2	10.6	10.8	11
		No. 2	10.3	10.2	9.3	9.3	9.3	9.2	9.1	8.9	9.6	10	10.2	10.4
	Douglas Fir Larch	No. 1	11.8	11.7	10.6	10.6	10.6	10.6	10.4	10.2	11	11.4	11.7	11.9
		No. 2	11.1	11.1	10.1	10.1	10.1	10	9.9	9.7	10.4	10.8	11.1	11.3
2x8	Southern Pine	No. 1	17	17	15.2	15.2	15.2	15.2	15	14.7	15.8	16.5	16.9	17.3
		No. 2	15.1	15.1	13.8	13.8	13.8	13.7	13.5	13.3	14.3	14.9	15.3	15.7
	Spruce Pine Fir	No. 1	14	14	12.8	12.8	12.8	12.7	12.5	12.3	13.2	13.7	14.1	14.4
		No. 2	13.2	13.1	12.1	12.1	12.1	12	11.8	11.6	12.5	12.9	13.3	13.6
	Douglas Fir Larch	No. 1	15.1	15.1	13.8	13.8	13.8	13.7	13.5	13.2	14.3	14.8	15.3	15.6
		No. 2	14.3	14.3	13.1	13.1	13.1	13	12.8	12.5	13.5	14.1	14.5	14.8
2X10	Southern Pine	No. 1	20.4	20.4	18.6	18.6	18.6	18.5	18.2	17.9	19.3	20.1	20.7	21.1
		No. 2	18.2	18.2	16.9	16.9	16.9	16.8	16.5	16.2	17.5	18.2	18.8	19.2
	Spruce Pine Fir	No. 1	17.3	17.3	15.9	15.9	15.9	15.8	15.6	15.3	16.5	17.1	17.7	18.1
		No. 2	16.3	16.3	15	15	15	14.9	14.7	14.4	15.5	16.2	16.7	17
	Douglas Fir Larch	No. 1	18.7	18.7	17.2	17.2	17.2	17	16.8	16.5	17.8	18.5	19.1	19.5
		No. 2	17.7	17.6	16.3	16.3	16.3	16.2	15.9	15.6	16.8	17.5	18.1	18.5
2x12	Southern Pine	No.1	24.5	24.5	22.5	22.5	22.5	22.3	22	21.6	23.3	24.3	25	25.6
		No. 2	21.6	21.5	20.1	20.1	20.1	19.9	19.6	19.3	20.8	21.6	22.4	22.9
	Spruce Pine Fir	No.1	20.2	20.2	18.8	18.8	18.8	18.6	18.3	18	19.4	20.2	20.9	21.3
		No. 2	19	19	17.7	17.7	17.7	17.5	17.3	17	18.3	19.1	19.7	20.2
	Douglas Fir Larch	No.1	21.8	21.8	20.3	20.3	20.3	20.1	19.8	19.4	20.9	21.8	22.5	23.1
		No. 2	20.7	20.6	19.2	19.2	19.2	19	18.7	18.4	19.8	20.7	21.4	21.9

TYPICAL UNIFORM LOAD OF ROOFING MATERIALS	
ROOF MEMBRANE	**UNIFORM LOAD OR WEIGHT**
Asphalt Shingles	**3 psf / layer**
Modified Bitumen	**2 psf / layer**
Built-Up Roof	**6 psf / layer**
EPDM, PVC or TPO	**1 psf / layer**
SLATE	**10 psf**
Clay tile	**9 – 14 psf**
Standing Seam Metal	**1 psf**

TABLE 8:	WOOD JOIST/RAFTER MAXIMUM SPANS (for 16" o.c. spacing) WITH DOUBLE ROW OF PV PANELS AT MIDSPAN (ft.) AND PANEL SUPPORT AT 48" o.c.												DEAD LOAD: 8 PSF
	LIVE LOAD		25 PSF								VARIES WITH SLOPE			
Joist/Rafter Size	Species	Grade	Roof Slope (inches vertical per horizontal ft.)											
			0	2	4	6	8	10	12	14	8	10	12	14
2x6	Southern Pine	No. 1	12.8	12.8	11.3	11.3	11.3	11.2	11	10.7	11.7	12	12.2	12.3
		No. 2	11.1	11.1	***	10.2	10.1	9.9	9.7	9.5	10.3	10.6	10.8	10.9
	Spruce Pine Fir	No. 1	***	***	***	***	9.5	9.3	9.1	8.9	9.7	10	10.1	10.2
		No. 2	***	***	***	***	***	8.8	8.6	8.4	***	9.4	9.6	9.6
	Douglas Fir Larch	No. 1	11.4	11.3	***	10.3	10.2	10.1	9.9	9.6	10.5	10.8	10.9	11
		No. 2	***	***	***	***	9.7	9.5	9.4	9.1	9.9	10.2	10.4	10.5
2x8	Southern Pine	No. 1	16.3	16.2	14.6	14.6	14.6	14.5	14.2	13.9	15	15.5	15.9	16.1
		No. 2	14.5	14.4	13.2	13.2	13.2	13	12.8	12.6	13.6	14	14.3	14.5
	Spruce Pine Fir	No. 1	13.4	13.4	12.2	12.2	12.2	12	11.8	11.6	12.5	12.9	13.2	13.4
		No. 2	12.6	12.6	11.6	11.6	11.5	11.4	11.2	10.9	11.8	12.2	12.4	12.6
	Douglas Fir Larch	No. 1	14.5	14.4	13.2	13.2	13.2	13	12.8	12.5	13.5	14	14.3	14.5
		No. 2	13.7	13.7	12.5	12.5	12.5	12.3	12.1	11.9	12.8	13.2	13.5	13.7
2X10	Southern Pine	No. 1	19.5	19.5	17.8	17.8	17.8	17.6	17.3	17	18.3	19	19.5	19.8
		No. 2	17.4	17.4	16.2	16.2	16.1	15.9	15.7	15.4	16.6	17.2	17.6	17.9
	Spruce Pine Fir	No. 1	16.6	16.5	15.2	15.2	15.2	15	14.8	14.5	15.6	16.2	16.6	16.8
		No. 2	15.6	15.5	14.4	14.4	14.3	14.1	13.9	13.7	14.7	15.2	15.6	15.9
	Douglas Fir Larch	No. 1	17.8	17.8	16.4	16.4	16.4	16.2	16	15.7	16.9	17.5	17.9	18.2
		No. 2	16.9	16.8	15.6	15.6	15.6	15.4	15.1	14.8	16	16.5	17	17.3
2x12	Southern Pine	No.1	23.5	23.5	21.5	21.5	21.5	21.3	21	20.6	22.2	23.1	23.7	24.2
		No. 2	20.6	20.6	19.3	19.3	19.2	19	18.7	18.4	19.8	20.5	21.1	21.5
	Spruce Pine Fir	No.1	19.3	19.3	17.9	17.9	17.9	17.7	17.4	17.1	18.4	19.1	19.6	20
		No. 2	18.2	18.1	16.9	16.9	16.9	16.7	16.4	16.1	17.4	18	18.5	18.8
	Douglas Fir Larch	No.1	20.9	20.8	19.4	19.4	19.4	19.1	18.8	18.5	19.9	20.7	21.3	21.7
		No. 2	19.7	19.7	18.4	18.4	18.3	18.1	17.8	17.5	18.9	19.6	20.1	20.5

*** Member is not long enough to accommodate two rows of PV panels. (Member length = span/cos(α) where α is the angle of the roof slope.) (The PV panel length used is 5'-6" with a 1" space between the rows.)

TYPICAL UNIFORM LOAD OF BUILDING MATERIALS	
MATERIAL	**UNIFORM LOAD OR WEIGHT**
2x6 @ 16" o.c.	**2 psf**
2x8 @ 16" o.c.	**2.5 psf**
2x10 @ 16" o.c.	**3 psf**
2x12 @ 16" o.c.	**3.5 psf**
¾" Plywood	**2.5 psf**
Batt Insulation	**1 psf**
5/8" Gypsum Board	**2.5 psf**

In these examples, two sample PV panel installations are shown; the first includes a sloped roof and the second a flat roof.

For this first example, each of the tables/forms is completed for a sloped roof with a mechanically attached system.

BUILDING INFORMATION:		
BUILDING ADDRESS	**Anywhere Chicago but not within 600 feet of the Lake**	
BUILDING HEIGHT	**35 ft.**	**Not to exceed 55 feet to be considered within the expedited permit process.**
BUILDING MAXIMUM LENGTH	**60 ft.**	**The maximum plan dimension of the building.**
BUILDING WIDTH	**20 ft.**	**The minimum plan dimension of the building.**
ROOF SLOPE	**12:12**	**The slope must be 1.5:12 (7 degrees) or less to be considered flat. (0 degrees = flat.)**

We, as the Property Owner and General Contractor, certify that the information provided herein and the statements made are true, and understand that the Department of Buildings has the right to revocation and penalties (as listed in the Easy Permit Application certification statements) in the event that the statements made regarding this criteria information have been falsified or is determined to be inaccurate.

Single Family Residence Owner

_____	_____	_____
Property Owner's Name	Property Owner's Signature	Date

PV Installer Construction

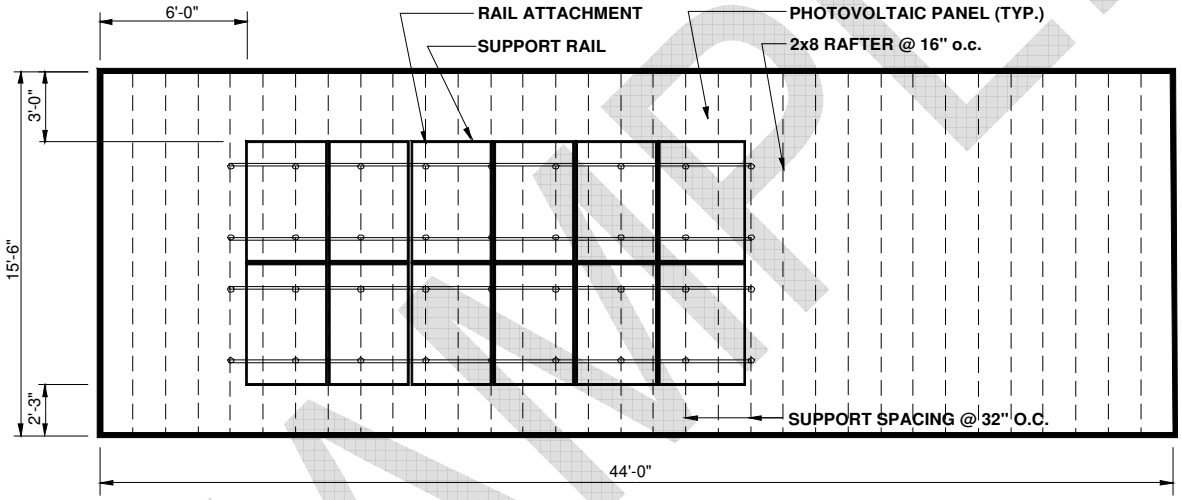
_____	_____	_____
General Contractor's Name	General Contractor Signature	Date

ZONING INFORMATION:		
CATEGORY	**DATA**	**ZONING REQUIRMENTS**
LANDMARK	☐ Yes ☒ No	Is the building that the PV panel system to be mounted on a national or state landmark? (If yes, then the expedited process cannot be used.)
	☐ Yes ☒ No	Is the building that the PV panel system to be mounted on a city designated landmark? (If yes, then the expedited process cannot be used.)
	☐ Yes ☒ No	Is the building that the PV panel system to be mounted on located in a code orange or red landmark district? (If yes, then the expedited process cannot be used.)
LOCATION ON BUILDING	**South facing surface of gable roof.**	Define specifically, where on the building the PV panels are to be located. (PV panels must be installed on a defined, permitted rooftop. If in the residential zoning district, the PV panels must be located on the property's principal structure.)
PANEL HEIGHT ABOVE FLAT ROOF	**N/A**	State the dimension that the top edge of the PV panel extends above the roof surface. (If installed on a flat rooftop, no part of the PV panel system may exceed 9 feet in overall height, or extend 5 feet above the building parapet, whichever is less.)
TOP PANEL SURFACE ABOVE SLOPED ROOF DECK	**8" to top surface of panel**	State the dimension between the top of the roof surface and the top of the PV panel. (If installed on an inclined or sloped roof, the PV panels must be attached to and mounted parallel with the roof. The top surface of the PV panels shall not be more than 12 inches from the roof deck at any point. No portion of the PV panels shall extend above the ridgeline of the roof at any point.)
POLICY COMPLIANCE	☒ Yes ☐ No	Does the PV panel system adhere to all of the guidelines of the City of Chicago's Solar Zoning Policy?

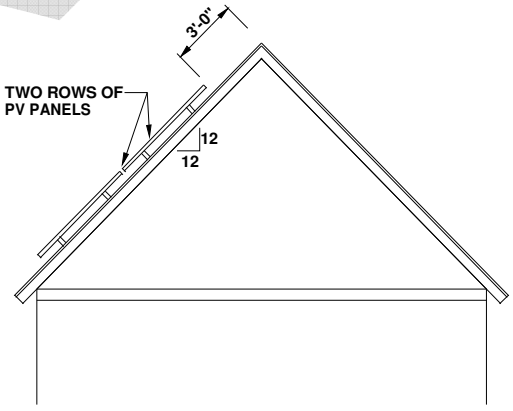
BUILDING ADDRESS:			
OWNER:	DOB Example		
DRAWN BY:		**DATE:**	

Required Information:

- Roof Plane with Overall Dimensions
- Location of Roof Plane on Building
- PV Panels (Show Individual Panels and Rows)
- Edge Distance Between PV Panels and Roof Edge
- End Distance Between PV Panels and Roof Edge
- Distance Between Rows of PV Panels
- Distance Between Adjacent PV Panels
- Side or End Elevation of Building Showing Roof Slope and PV Panel Locations
- North Arrow



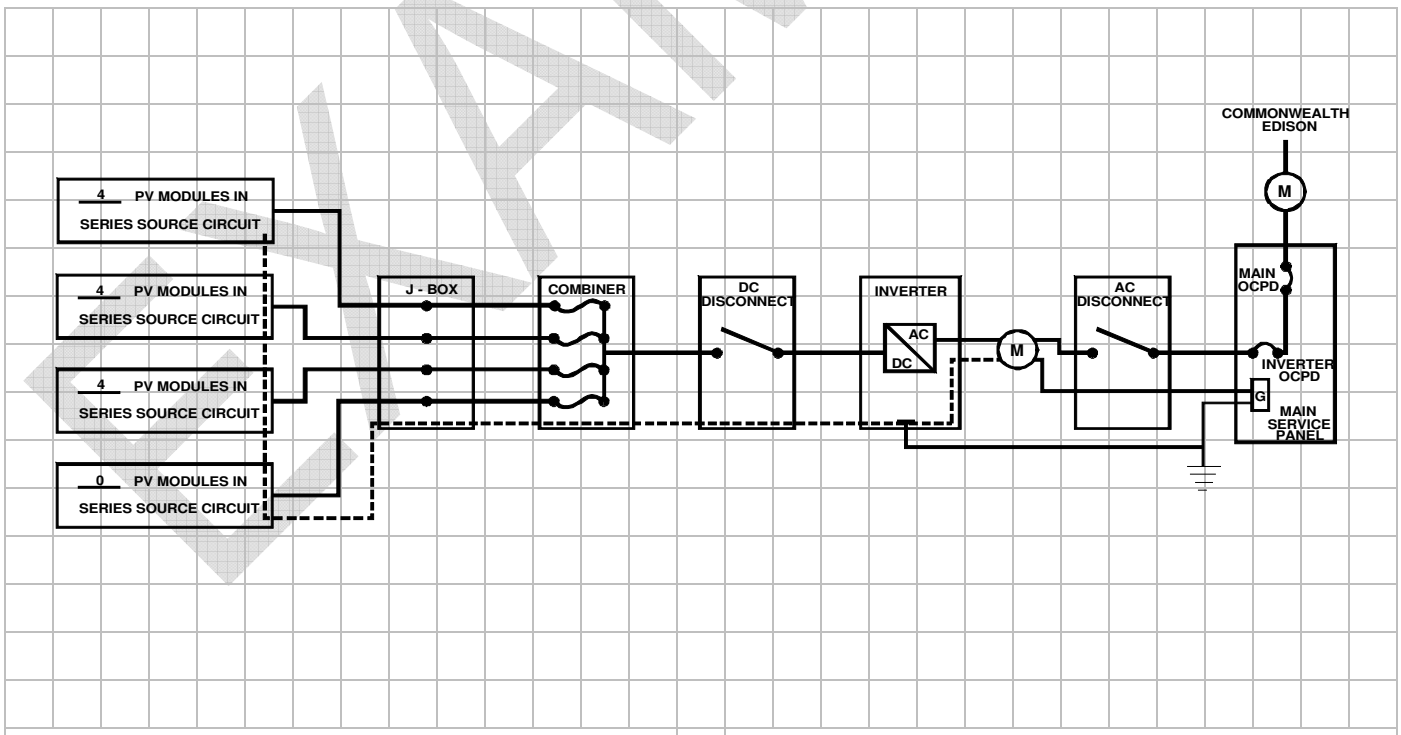
SOUTH FACING ROOF SURFACE



PARTIAL ELEVATION

ELECTRICAL INFORMATION:		
REQUIRED INFORMATION	**DATA**	**REQUIREMENTS**
INVERTER TYPE	**Fronius IG 4000W Grid Tied Inverter IG 4000**	**Manufacturer and model number**
INVERTER OUTPUT	**4 kW**	**System's inverter output is 13.44 kW or less (maximum size for 70-amp breaker)**
PV PANEL TYPE	**SunPower SPR-327NE-WHT-D**	**Manufacturer and model number**
PV PANEL OUTPUT	**327 W**	**Maximum watt output per panel**
NUMBER OF PANELS	**12**	**Total number of panels in installation**
TOTAL PV PANEL OUTPUT	**(327 W)(12) = 3924 W**	**Multiply the number of panels times the output per panel**
ELECTRICAL CONTRACTOR	***PV Installer Electrical Contractor***	**Must be a licensed electrician in good standing with the City of Chicago and has certified PV panel system installation.**
COMPONENT COMPLIANCE	**☑ Yes ☐ No**	**Do all electrical components comply with the Chicago Electrical Code (18-27, Article 690)? Yes/No.**
	☑ Yes ☐ No	**Are all electrical components (or equipment), including panels and inverters, listed and labeled by a Nationally Recognized Testing Laboratory (as per 18-27-110.2) and have all components been installed as per the manufacturer's instructions? Yes/No.**

Provide below, or on a separate sheet, a one line electrical diagram of PV panel electrical system.



Address: Anywhere Chicago…

Permit No.: From EPP Desk

PV PANEL & SUPPORT FRAME:				
PV PANEL	**DATA**			**REMARKS**
MANUFACTURER	SunPower SPR-327NE-WHT-D			Manufacturer and product number
PANEL WATTAGE	327 W			Maximum watt output per panel
NUMBER OF PANELS	Number of Rows	Number per Row		Number of panels per group or roof surface
	2	6		
PANEL DIMENSIONS	Length	Width	Area	Length & width (in.) and area (sq. ft.)
	61.4 in.	41.2 in.	17.6 sq. ft.	
PANEL WEIGHT	41 lbs.			Weight of individual panel (lbs)
PANEL SPACING	Sides	Top	Bottom	The side spacing is the space between adjacent panels in a row. The top and bottom spacing is the distance between rows of panels. If there is no row above or below, state not applicable (N/A).
	0.5 in.	12 in.	0 in.	
TYPE OF SUPPORT RAILS	SolarMount Beam, Clamps & Clips			Manufacturer and part or model number
ANCHOR BOLTS OR FASTENERS	3/8 in. x 4 in Lag Screw			Size and/or manufacturer's part number
SUPPORT RAIL ATTACHMENT SPACING	32 in. on center			Equal to multiple of joist, rafter or truss spacing
ANGLE OF PANEL TO ROOF SURFACE	0 deg.			Provide angle in degrees from the roof surface.
BALLAST TYPE & WEIGHT	0 lbs.			If PV panels & frames are to be ballasted, then provide total load per panel. If mechanically attached state 0 lbs.
PANEL AND RAIL UNIFORM LOAD	3.5 psf			Uniform dead load of panel and panel support system, as determined by dividing the weight of the panel and support rails by the panel area, in pounds per square foot (psf)

WIND LOADS:

BUILDING CODE SECTION	CODE PROVISION		WIND PRESSURE	
For PV panels mounted flat to the roof surface, the provisions of CBC Section 13-52-310(b) may be used for the determination of the wind load on the panels even though reference is made to "roof framing." The wind load provisions of ASCE 7 for Components and Cladding provide more appropriate loads for PV panels mounted flat to the roof surface and should be used.				For PV panels mounted parallel to a flat or sloped roof.
CBC Table 13-52-310	Table 13-52-310 Column A: For buildings of 200 feet or less the design wind pressure is 20 psf			
CBC Section 13-52-310(b)	(b) Roof Structures Over Enclosed Building Or Other Structures. All main roof framing structures shall be designed and constructed for the following pressures:	1. Flat roofs: an outward pressure acting normal to the surface equal to 75 percent of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof and applied to the entire roof area.		
		2. Sloped roof, slope equal to or less than 30 degrees: an outward pressure acting normal to the surface equal to 100 percent on the windward side and 75 percent on the leeward side of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof.		
		3. Sloped roofs, slope greater than 30 degrees: an inward pressure acting normal to the surface equal to 100 percent on the windward side and an outward pressure acting normal to the surface equal to 75 percent on the leeward side of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof.	+20 psf windward -15 psf leeward	
		5. Roofing sheathing and membranes: an outward pressure acting normal to the surface equal to the pressures set forth in Section 13-52-310b.1, b.2 and b.3 except within an area at the edge of the roof equal to ten percent of the width of the structure parallel to the wind direction being considered, outward pressure equal to 200 percent of those established in Table 13-52-310, Column (A) as set out in this section, for the corresponding mean height of the roof.		
ASCE 7-05 Section Figure 6-11B	Roof edge zone is 10% of the least horizontal dimension or 0.4h, whichever is smaller but not less than either 4% of least horizontal dimension or 3 ft. where h is the mean height of the building		3 ft.	
ASCE 7-05 Section 6.5.6	Wind Exposure B for majority of the City except Exposure D within 600 feet (or 20 times the building height) of Lake Michigan			
ASCE 7-05 Section 6.5.10	The wind velocity pressure is based upon the expression $q_h = 0.00256K_zK_{zt}K_dV^2I$, where:			
	Basic Wind Speed:	From Figure 6-1, V =	90 mph	
	Structure Classification:	From Table 1-1, the structure is classified as Category:	II	
	Importance Factor:	From Table 6-1, I =	1.0	
	Wind Directionality Factor:	From Table 6-4, K_d =	0.85	
	Exposure Category:	From Section 6.5.6, the exposure category is:	B	

	Topographical Effect:	From Section 6.5.7, K_{zt} =			1.0	
	Velocity Pressure Coefficient:	From Section 6.5.6.4 and Table 6-3 for a height of 35 ft. and exposure B, K_z =			0.73	
	Wind Velocity Pressure	$q_h = 0.00256K_zK_{zt}K_dV^2I$ =			12.87 psf	
ASCE 7-05 Section 6.5.12.4	The design wind pressure on components and cladding is based upon the expression $p = q_h [(GC_p) - (GC_{pi})]$, where:					For PV panels mounted parallel to a flat or sloped roof.
	Internal Pressure Coefficient:	From Figure 6-5 GC_{pi} =			+/-0.18	
	Gust Effect Factor:	The gust effect factor for components and cladding GC_p is determined from Figures 6-11B through 6-17 for the applicable roof type and slope (where θ is the angle of the roof from the horizontal.)				
	For a Gable Roof	From Figure 6-11B for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $\theta < 7^o$ and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of a gable roof surface where $\theta < 7^o$ and a tributary area of ____ ft^2, GC_p =			
		From Figure 6-11C for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $7^o < \theta < 27^o$ and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of a gable roof surface where $7^o < \theta < 27^o$ and a tributary area of ____ ft^2, GC_p =			
		From Figure 6-11D for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $27^o < \theta < 45^o$ and a tributary area of 20 ft^2, GC_p =		-0.9	-13.9 psf at center
			For PV panels located within the edge of a gable roof surface where $27^o < \theta < 45^o$ and a tributary area of 20 ft^2, GC_p =		-1.1	-16.47 psf at edge but not corner
	For Other Roof Configuration	From Figure _____	For PV panels located away from the edge of roof surface and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of roof surface and a tributary area of ____ ft^2, GC_p =			

For PV panels mounted at an angle to a flat roof, the Wind Velocity Pressure must be determined from Section 6.5.10 of ASCE 7 and the appropriate factors and coefficients must be obtained from SEAOC PV2-2012, as listed below, to obtain the Design Wind Pressure.

SEAOC PV2-2012	The width of the edge zone is defined as $2a_{pv}$. a_{pv} is defined as $0.5(hW_L)^{0.5}$ but need not exceed h. Where, h = the mean roof height of the building and W_L = longest plan dimension of the building.			For PV panels mounted at an angle to a flat roof.
	From Figure 29.9-1, the net pressure normal to the surface of the PV panel is based upon the expression $p = q_h(\gamma_p\gamma_c(GC_m)_{nom})E$, where:			
	Velocity Pressure:	From ASCE 7-05 Section 6-5-10, q_h =		
	Angle of Panel to Roof Surface	As illustrated in Figure 29.9-1, the angle of the panel to the roof surface is:		
	Parapet Height Factor:	From Figure 29.9-1 for a parapet height of ____, γ_p =		
	Panel Chord Length Factor:	From Figure 29.9-1 for a panel angle of ____, γ_c =		
	Array Edge Factor	From Figure 29.9-1, for the location of the panel within the array, E =		
	Roof Zone:	From Figure 29.9-1, the roof zone for the panels is:		
	Effective Wind Area:	From Figure 29.9-1, the effective wind area for the structural element _____ being designed is:		
	Normalized Wind Area:	From Figure 29.9-1, the normalized wind area A_n =		
	Nominal Pressure Coefficient:	From Figure 29.9-1, the nominal net pressure coefficient $(GC_m)_{nom}$ =		
	Design Wind Pressure:	$p = q_h(\gamma_p\gamma_c(GC_m)_{nom})E$ =		

PV PANEL ATTACHMENT:

REQUIRED INFORMATION	DATA	REMARKS
TRIBUTARY AREA PER ATTACHMENT BOLT (ft^2/bolt)	(6)(17.6 sq. ft.)/18 = 5.9 sq. ft.	Number of panels in a row x panel area / number of bolts
UPLIFT FORCE PER BOLT (lbs)	(5.9 sq. ft.)(16.47 psf) = 96.6 lb.	Tributary area per bolt x wind uplift pressure
BOLT PULLOUT CAPACITY (lbs)	>200 lbs	Pullout strength is based upon the National Design Specification manufacturer's literature and species of wood joist, rafter or truss top chord. (An increase in allowable stress or capacity of 1.33 for transient wind loads is not allowed.) Anchorage capacity must include a factor of safety of 1.5 as discussed below.

BOLT PULLOUT CAPACITY GREATER THAN WIND UPLIFT	☒ Yes ☐ No	**Yes or no. If no, revise bolt size and or spacing.**

EXISTING CONCRETE ROOF CONSTRUCTION:			
ROOF FRAMING TYPE	N/A		Flat slab, slab and beam or joists
SLAB THICKNESS OR JOIST DEPTH			
JOIST/BEAM WIDTH			
JOIST/BEAM SPACING (in.)			
SPAN (ft.)			For two-way slab, list span in both directions

EXISTING STRUCTURAL STEEL ROOF CONSTRUCTION:			
ROOF FLAT OR SLOPED	N/A		Provide roof slope (in./12 in.) and degrees or 0 if none or flat α = tan(rise/run) and is the angle of the roof plane from the horizontal
FRAMING TYPE			Joists, trusses or beams
DECK TYPE			Concrete and/or metal deck
JOIST, TRUSS OR BEAM SPACING (in.)			
SPAN (ft.)			Joist, rafter or truss span. (Horizontal projection)

EXISTING WOOD ROOF CONSTRUCTION:					
ROOF FLAT OR SLOPED		12:12 α = 45 degrees			Provide roof slope (in./12 in.) and degrees or 0 if none or flat α = atan(rise/run) and is the angle of the roof plane from the horizontal
FRAMING TYPE		Rafter			Joists/rafters or trusses
WOOD SPECIES AND GRADE		Douglas Fir Larch No. 1			If unknown, use SPF No. 2
JOIST/RAFTER OR TRUSS SPACING		16 in. o.c.			Units = inches (in.)
SPAN (ft.)		10 ft.			Joist, rafter or truss span. (Horizontal projection)
				WEIGHT (psf)	
JOIST/RAFTER OR TOP CHORD SIZE.		2x8		2	Size of lumber
SHEATHING TYPE		Spaced sheathing		2.5	Plywood or lumber
ROOFING	TYPE	Asphalt shingles		3	Total roofing load
	NUMBER OF LAYERS	1			
CEILING		Gypsum board		2.5	
INSULATION		Fiberglass batt		1	
OTHER		Wood furring & electrical		3	Other materials including mechanical and electrical equipment
BALLAST				0	Ballast to resist wind loads on PV panel system, if used
		DEAD LOAD SUBTOTAL		14	Dead load per square foot of roof surface
SNOW				25	Minimum snow load of 25 psf required by the CBC, plus drifting as defined in ASCE 7-05 (See Note 1.)
		TOTAL DEAD & LIVE LOAD		39	Total dead and live load to be supported by existing structure along length of member
LIVE LOAD TIMES MEMBER SPACING		25 psf x 1.33 ft.	33.33	Live or snow load per lineal foot of member (plf)	
HORIZONTAL PROJECTION OF DEAD LOAD TIMES MEMBER SPACING		14 psf x 1.33 ft / cos(α)	26.4		
HORIZONTAL PROJECTION OF PV PANEL DEAD LOAD TIMES SUPPORT SPACING		3.5 psf x 1.33 x 2 / cos(α)	13.2	Uniform load of PV panel times support spacing and divided by the cosine of the roof angle (The PV panel load is assumed over full length of member.) (plf)	
TOTAL PROJECTED DEAD, PV PANEL & LIVE LOAD SUPPORTED BY MEMBER			73	Sum of dead, PV panel and live loads (plf)	
STRUCTURAL LOAD CAPACITY			N/A	Maximum load capacity of the wood roof rafters, joists or trusses calculated separately (plf)	

ALTERNATE – USE TABLES TO DETERMINE MAXIMUM SPAN	☒ Yes ☐ No	**12.5 ft.**	**State whether tables are being used and provide the maximum span listed in tables. (ft.)**
IS THE EXISTING WOOD STRUCTURE ADEQUATE TO SUPPORT THE ADDITIONAL LOAD DUE TO THE NEW PV PANEL SYSTEM?	☒ Yes ☐ No		**If the structure is not adequate to support the additional load, then provide drawings and calculations to show how the structure is to be reinforced.**

1. A reduction in snow load, as per CBC Section 13-52-280(b), was not considered for this example with a sloped roof.

2.

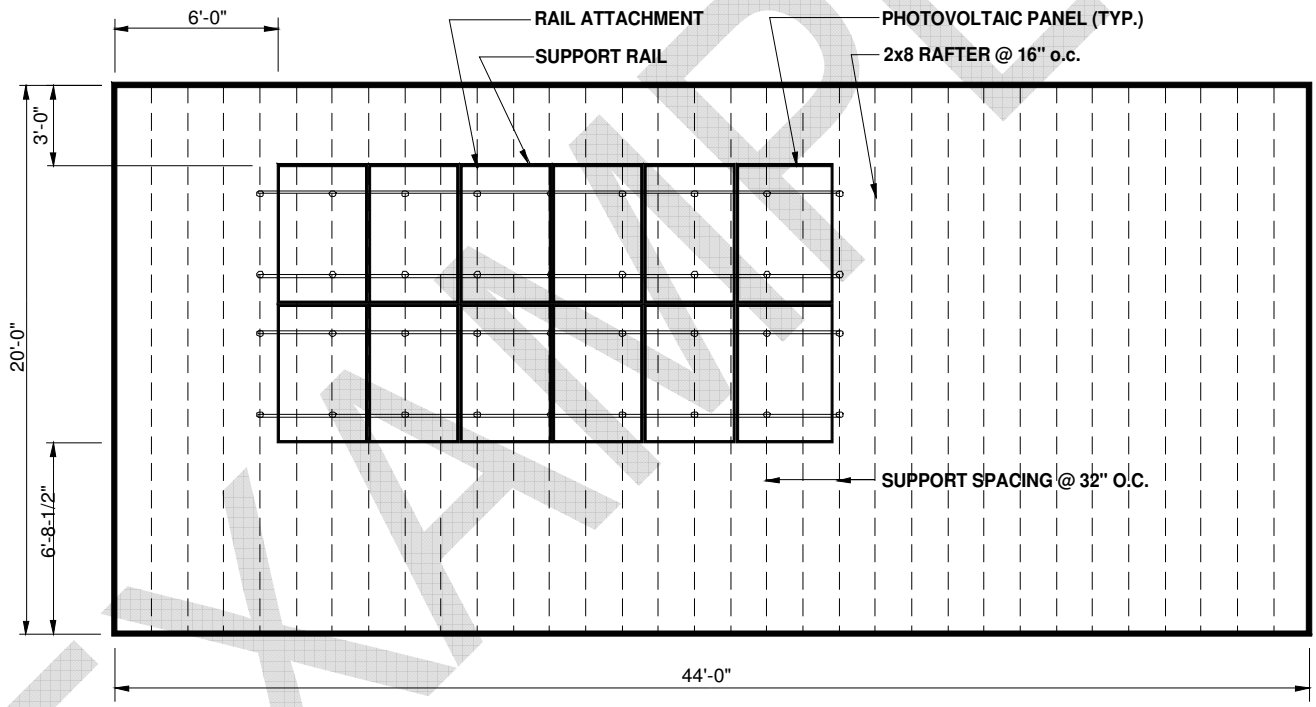
The following is the second example and is provided to illustrate the differences in calculating the wind load on a bolt, given a flat roof. The General, Zoning, and Electrical information are the same as that listed above except that the roof slope is 0:12. The PV panels are mounted at an angle of 5 degrees from the roof surface.

PV PANEL & SUPPORT FRAME:				
PV PANEL	**DATA**			**REMARKS**
MANUFACTURER	SunPower SPR-327NE-WHT-D			Manufacturer and product number
PANEL WATTAGE	327 W			Maximum watt output per panel
NUMBER OF PANELS	Number of Rows	Number per Row		Number of panels per group or roof surface
	2	6		
PANEL DIMENSIONS	Length	Width	Area	Length & width (in.) and area (sq. ft.)
	61.4 in.	41.2 in.	17.6 sq. ft.	
PANEL WEIGHT	41 lbs.			Weight of individual panel (lbs)
PANEL SPACING	Sides	Top	Bottom	The side spacing is the space between adjacent panels in a row. The top and bottom spacing is the distance between rows of panels. If there is no row above or below, state not applicable (N/A).
	0.5 in.	12 in.	0 in.	
TYPE OF SUPPORT RAILS	SolarMount Beam, Clamps & Clips			Manufacturer and part or model number
ANCHOR BOLTS OR FASTENERS	3/8 in. x 4 in Lag Screw			Size and/or manufacturer's part number
SUPPORT RAIL ATTACHMENT SPACING	32 in. on center			Equal to multiple of joist, rafter or truss spacing
ANGLE OF PANEL TO ROOF SURFACE	5 deg.			Provide angle in degrees from the roof surface.
BALLAST TYPE & WEIGHT	0 lbs.			If PV panels & frames are to be ballasted, then provide total load per panel. If mechanically attached state 0 lbs.
PANEL AND RAIL UNIFORM LOAD	3.5 psf			Uniform dead load of panel and panel support system, as determined by dividing the weight of the panel and support rails by the panel area, in pounds per square foot (psf)

BUILDING ADDRESS:			
OWNER:	DOB Example		
DRAWN BY:		**DATE:**	

Required Information:

- Roof Plane with Overall Dimensions
- Location of Roof Plane on Building
- PV Panels (Show Individual Panels and Rows)
- Edge Distance Between PV Panels and Roof Edge
- End Distance Between PV Panels and Roof Edge
- Distance Between Rows of PV Panels
- Distance Between Adjacent PV Panels
- Side or End Elevation of Building Showing Roof Slope and PV Panel Locations
- North Arrow



ROOF PLAN

WIND LOADS:

BUILDING CODE SECTION	CODE PROVISION		WIND PRESSURE	
For PV panels mounted flat to the roof surface, the provisions of CBC Section 13-52-310(b) may be used for the determination of the wind load on the panels even though reference is made to "roof framing." The wind load provisions of ASCE 7 for Components and Cladding provide more appropriate loads for PV panels mounted flat to the roof surface and should be used.				For PV panels mounted parallel to a flat or sloped roof.
CBC Table 13-52-310	Table 13-52-310 Column A: For buildings of 200 feet or less the design wind pressure is 20 psf			
CBC Section 13-52-310(b)	(b) Roof Structures Over Enclosed Building Or Other Structures. All main roof framing structures shall be designed and constructed for the following pressures:	1. Flat roofs: an outward pressure acting normal to the surface equal to 75 percent of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof and applied to the entire roof area.		
		2. Sloped roof, slope equal to or less than 30 degrees: an outward pressure acting normal to the surface equal to 100 percent on the windward side and 75 percent on the leeward side of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof.		
		3. Sloped roofs, slope greater than 30 degrees: an inward pressure acting normal to the surface equal to 100 percent on the windward side and an outward pressure acting normal to the surface equal to 75 percent on the leeward side of those established in Table 13-52-310, Column (A) for the corresponding mean height of the roof.		
		5. Roofing sheathing and membranes: an outward pressure acting normal to the surface equal to the pressures set forth in Section 13-52-310b.1, b.2 and b.3 except within an area at the edge of the roof equal to ten percent of the width of the structure parallel to the wind direction being considered, outward pressure equal to 200 percent of those established in Table 13-52-310, Column (A) as set out in this section, for the corresponding mean height of the roof.		
ASCE 7-05 Section Figure 6-11B	Roof edge zone is 10% of the least horizontal dimension or 0.4h, whichever is smaller but not less than either 4% of least horizontal dimension or 3 ft. where h is the mean height of the building		3 ft.	
ASCE 7-05 Section 6.5.6	Wind Exposure B for majority of the City except Exposure D within 600 feet (or 20 times the building height) of Lake Michigan			
ASCE 7-05 Section 6.5.10	The wind velocity pressure is based upon the expression $q_h = 0.00256K_zK_{zt}K_dV^2I$, where:			
	Basic Wind Speed:	From Figure 6-1, V =	90 mph	
	Structure Classification:	From Table 1-1, the structure is classified as Category:	II	
	Importance Factor:	From Table 6-1, I =	1.0	
	Wind Directionality Factor:	From Table 6-4, K_d =	0.85	
	Exposure Category:	From Section 6.5.6, the exposure category is:	B	

	Topographical Effect:	From Section 6.5.7, K_{zt} =			1.0	
	Velocity Pressure Coefficient:	From Section 6.5.6.4 and Table 6-3 for a height of 35 ft. and exposure B, K_z =			0.73	
	Wind Velocity Pressure	$q_h = 0.00256K_zK_{zt}K_dV^2I$ =			12.87 psf	
ASCE 7-05 Section 6.5.12.4	The design wind pressure on components and cladding is based upon the expression $p = q_h [(GC_p) - (GC_{pi})]$, where:					For PV panels mounted parallel to a flat or sloped roof.
	Internal Pressure Coefficient:	From Figure 6-5 GC_{pi} =			+/-0.18	
	Gust Effect Factor:	The gust effect factor for components and cladding GC_p is determined from Figures 6-11B through 6-17 for the applicable roof type and slope (where θ is the angle of the roof from the horizontal.)				
	For a Gable Roof	From Figure 6-11B for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $\theta < 7^o$ and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of a gable roof surface where $\theta < 7^o$ and a tributary area of ____ ft^2, GC_p =			
		From Figure 6-11C for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $7^o < \theta < 27^o$ and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of a gable roof surface where $7^o < \theta < 27^o$ and a tributary area of ____ ft^2, GC_p =			
		From Figure 6-11D for a building less than 60 ft. high	For PV panels located away from the edge of a gable roof surface where $27^o < \theta < 45^o$ and a tributary area of 20 ft^2, GC_p =			
			For PV panels located within the edge of a gable roof surface where $27^o < \theta < 45^o$ and a tributary area of 20 ft^2, GC_p =			
	For Other Roof Configuration	From Figure _____	For PV panels located away from the edge of roof surface and a tributary area of ____ ft^2, GC_p =			
			For PV panels located within the edge of roof surface and a tributary area of ____ ft^2, GC_p =			

For PV panels mounted at an angle to a flat roof, the Wind Velocity Pressure must be determined from Section 6.5.10 of ASCE 7 and the appropriate factors and coefficients must be obtained from SEAOC PV2-2012, as listed below, to obtain the Design Wind Pressure.

SEAOC PV2-2012	The width of the edge zone is defined as $2a_{pv}$. a_{pv} is defined as $0.5(hW_L)^{0.5}$ but need not exceed h. Where, h = the mean roof height of the building and W_L = longest plan dimension of the building.		35 ft.	For PV panels mounted at an angle to a flat roof.
	From Figure 29.9-1, the net pressure normal to the surface of the PV panel is based upon the expression $p = q_h(\gamma_p\gamma_c(GC_m)_{nom})E$, where:			
	Velocity Pressure:	From ASCE 7-05 Section 6-5-10, q_h =	12.87 psf	
	Angle of Panel to Roof Surface	As illustrated in Figure 29.9-1, the angle of the panel to the roof surface is:	5 degrees	
	Parapet Height Factor:	From Figure 29.9-1 for a parapet height of 2 ft. , γ_p =	1.0	
	Panel Chord Length Factor:	From Figure 29.9-1 for a panel angle of 5 deg. , γ_c =	1.0	
	Array Edge Factor	From Figure 29.9-1, for the location of the panel within the array, E =	1.0	
	Roof Zone:	From Figure 29.9-1, the roof zone for the panels is:	2	
	Effective Wind Area:	From Figure 29.9-1, the effective wind area for the structural element bolt being designed is:	5.9 ft.^{2}	
	Normalized Wind Area:	From Figure 29.9-1, the normalized wind area A_n =	19.1 ft.^{2}	
	Nominal Pressure Coefficient:	From Figure 29.9-1, the nominal net pressure coefficient $(GC_m)_{nom}$ =	1.32	
	Design Wind Pressure:	$p = q_h(\gamma_p\gamma_c(GC_m)_{nom})E$ =	15.73 psf	
			15.73 psf	
			15.73 psf	
				15.73 psf

PV PANEL ATTACHMENT:

REQUIRED INFORMATION	DATA	REMARKS
TRIBUTARY AREA PER ATTACHMENT BOLT (ft^2/bolt)	(6)(17.6 sq. ft.)/18 = 5.9 sq. ft.	Number of panels in a row x panel area / number of bolts
UPLIFT FORCE PER BOLT (lbs)	(5.9 sq. ft.)(15.73 psf) = 92.9 lb.	Tributary area per bolt x wind uplift pressure
BOLT PULLOUT CAPACITY (lbs)	>200 lbs	Pullout strength based upon manufacturer's literature and species of wood joist, rafter or truss top chord

BOLT PULLOUT CAPACITY GREATER THAN WIND UPLIFT	☒ Yes ☐ No	**Yes or no. If no, revise bolt size and or spacing.**

EXISTING WOOD ROOF CONSTRUCTION:					
ROOF FLAT OR SLOPED		0:12 α = 0 degrees			Provide roof slope (in./12 in.) and degrees or 0 if none or flat α = atan(rise/run) and is the angle of the roof plane from the horizontal
FRAMING TYPE		Joist			Joists/rafters or trusses
WOOD SPECIES AND GRADE		Douglas Fir Larch No. 1			If unknown, use SPF No. 2
JOIST/RAFTER OR TRUSS SPACING		16 in. o.c.			Units = inches (in.)
SPAN (ft.)		20 ft.			Joist, rafter or truss span. (Horizontal projection)
				WEIGHT (psf)	
JOIST/RAFTER OR TOP CHORD SIZE.		2x12		3.5	Size of lumber
SHEATHING TYPE		Spaced sheathing		2.5	Plywood or lumber
ROOFING	TYPE	Asphalt shingles		3	Total roofing load
	NUMBER OF LAYERS	1			
CEILING		Gypsum board		2.5	
INSULATION		Fiberglass batt		1	
OTHER		Wood furring & electrical		1.5	Other materials including mechanical and electrical equipment
BALLAST				0	Ballast to resist wind loads on PV panel system, if used
		DEAD LOAD SUBTOTAL		14	Dead load per square foot of roof surface
SNOW				25	Minimum snow load of 25 psf required by the CBC, plus drifting as defined in ASCE 7-05
		TOTAL DEAD & LIVE LOAD		39	Total dead and live load to be supported by existing structure along length of member
LIVE LOAD TIMES MEMBER SPACING		25 psf x 1.33 ft.	33.33	Live or snow load per lineal foot of member (plf)	
HORIZONTAL PROJECTION OF DEAD LOAD TIMES MEMBER SPACING		14 psf x 1.33 ft / cos(α)	18.62		
HORIZONTAL PROJECTION OF PV PANEL DEAD LOAD TIMES SUPPORT SPACING		3.5 psf x 1.33 x 2 / cos(α)	9.31	Uniform load of PV panel times support spacing and divided by the cosine of the roof angle (The PV panel load is assumed over full length of member.) (plf)	
TOTAL PROJECTED DEAD, PV PANEL & LIVE LOAD SUPPORTED BY MEMBER			61	Sum of dead, PV panel and live loads (plf)	
STRUCTURAL LOAD CAPACITY			N/A	Maximum load capacity of the wood roof rafters, joists or trusses calculated separately (plf)	

ALTERNATE – USE TABLES TO DETERMINE MAXIMUM SPAN	☒ Yes ☐ No	**20.1 ft.**	**State whether tables are being used and provide the maximum span listed in tables. (ft.)**
IS THE EXISTING WOOD STRUCTURE ADEQUATE TO SUPPORT THE ADDITIONAL LOAD DUE TO THE NEW PV PANEL SYSTEM?	☒ Yes ☐ No		**If the structure is not adequate to support the additional load, then provide drawings and calculations to show how the structure is to be reinforced.**