

Design Criteria for Span Tables:

Values in the maximum allowable rail span tables provided herein are subject to the following general criteria and additional criteria shown on individual span tables sheets. Values in span tables are based on the same engineering methodology and calculation algorithms used for U-Builder and are provided here for reference.

Building Assumptions

- Building Risk Category: II
- Mean Roof Height: 30 ft
- Roof Pitch: 0°-45°
- Site Elevation: 0 ft

Wind Design Assumptions

- Wind loads used are based on ASCE 7-16 Sec 29.4.4 with Provisions from SEAOC PV2-2017
- Exposure Category B, C, or D
- Basic Wind Speed = 90 – 180 mph
- Level terrain. Topographic factor, $k_{zt} = 1.0$
- $\gamma_E = 1.0$ for 'Interior' spans, $\gamma_E = 1.5$ for 'Exposed' spans (ASCE 7-16, Fig. 29.4-7)

Snow Design Assumptions

- Ground Snow Load = 0-100 psf
- Exposure Factor coefficients of Partially Exposed condition
- Thermal Factor = 1.0
- Results based on uniform snow load

Seismic Design Assumptions

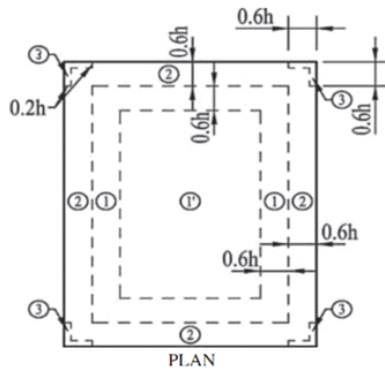
- 0.2-s Spectral Response Acceleration, $SS \leq 3$
- $S_s = 1.25$ and 3 per criteria shown on individual span tables sheets.
- $S_1 = 0.5$
- Seismic site class D

Array Assumptions

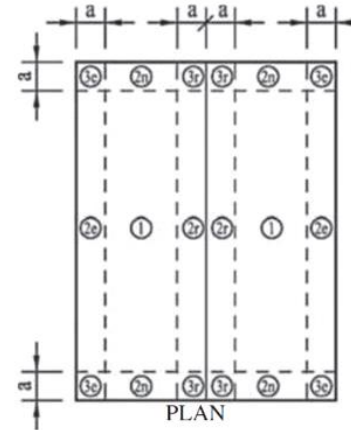
- Module orientation and Rail direction per criteria shown on individual span tables sheets.
- Maximum module dimensions of 40.1" x 67" (~19 sq.ft, 47.65 lbs) and 41" x 80" (~23 sq.ft, 58.6 lbs) per criteria shown on individual span tables sheets.
- Minimum distance between modules and roof edge is at least twice the module height above roof surface.
- Modules are parallel to roof surface and maximum height above roof surface is 5" to 10" depending on attachment type.
- Gaps between module rows and columns is 0.25" in to 1" depending on clamp type.
- The most restrictive of all roof zone spans shall be used when any part of the module is attributed to that span.
- 'Exposed' spans as defined in ASCE 7-16 sec. 29.4.4 shall be used when any part of an exposed module or panel as is attributed to that span.

Span Tables

Zone should be considered as per ASCE 7-16, Fig. 30.3-2A to 30.3-2D



Gable Roofs $\theta \leq 7^\circ$

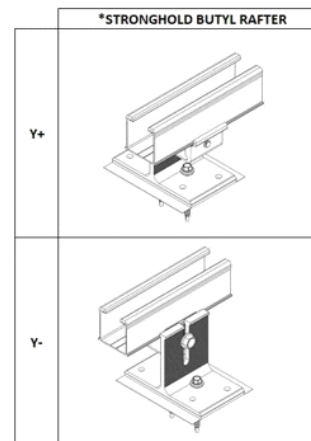


Gable Roofs $7^\circ < \theta \leq 45^\circ$

Grouping of ASCE 7-16 Roof Zones (Gable and Flat)

- **Roof Tilt 0° - 7°**
Roof Zone 1 = 1
Roof Zone 2 = 2
Roof Zone 3 = 3
- **Roof Tilt 7° - 27°**
Roof Zone 1 = 1, 2e
Roof Zone 2 = 2n, 2r, 3e
Roof Zone 3 = 3r
- **Roof Tilt 27° - 45°**
Roof Zone 1 = 1, 2e, 2r
Roof Zone 2 = 2n, 3r
Roof Zone 3 = 3e

Rails can be installed in these possible orientations.



Maximum Allowable Rail Spans for Rooftop Solar Panels Parallel to the Roof Surface (inches)

Ground Snow Load (psf)	Wind Exposure Category	Roof Tilt Angle (deg)	Panel Exposure	Basic Wind Speed (mph)																																							
				Roof Wind Zone																																							
				90			95			100			105			110			115			120			130			140			150			160			170			180			
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3				
0	B	0-7	Interior	86	86	86	86	86	86	86	86	86	83	86	86	79	86	86	76	86	83	73	86	80	71	85	75	66	80	71	54	76	67	43	72	58	37	68	49	33	65	41	29
			Exposed	86	86	76	86	82	73	86	79	70	86	76	67	83	73	61	80	53	77	68	46	72	59	38	68	47	32	61	40	28	50	35	25	42	31	22	37	27	29		
		7-20	Interior	86	86	86	86	86	84	86	86	80	86	83	77	86	80	74	86	77	71	83	74	69	78	69	59	73	62	45	69	48	38	66	40	33	57	35	29	49	31	26	
			Exposed	86	79	74	85	76	70	81	73	67	78	70	61	75	67	51	73	61	44	70	52	40	66	40	33	56	35	29	47	30	25	40	26	22	35	23	29	31	21	26	
		20-27	Interior	87	87	87	87	87	87	87	87	87	87	87	84	87	86	81	87	82	78	87	79	75	87	74	70	82	70	66	77	66	50	74	53	40	70	43	34	67	38	29	
			Exposed	87	85	81	87	81	77	87	78	74	87	75	71	84	72	68	81	69	64	79	67	54	74	53	41	70	42	33	66	36	28	57	32	23	49	28	20	42	25	17	
	27-45	Interior	87	87	87	87	87	87	87	87	87	87	87	87	87	87	84	87	87	81	87	86	78	86	80	73	81	75	69	76	71	64	72	68	52	68	61	42	63	50	37		
		Exposed	87	87	84	87	87	81	87	84	77	87	81	74	83	78	71	80	75	69	77	73	66	72	68	53	68	59	41	58	47	35	46	40	30	39	35	26	35	31	22		
	C	0-7	Interior	86	86	78	86	85	75	86	81	72	86	78	69	85	75	66	82	72	59	79	70	51	74	66	41	70	52	35	66	43	30	55	37	26	46	33	23	40	29	21	
			Exposed	85	75	66	81	72	57	78	69	48	75	66	42	72	59	38	70	51	34	67	45	31	56	38	27	45	32	23	38	28	30	33	24	26	29	21	23	26	29	20	
		7-20	Interior	86	82	76	86	78	72	84	75	69	80	72	66	77	69	58	75	66	49	72	59	42	68	44	36	61	37	31	51	32	27	43	28	23	38	25	21	34	22	28	
			Exposed	77	69	58	74	66	47	71	54	41	69	46	37	66	40	33	60	37	30	54	34	28	44	28	24	30	37	24	20	32	21	26	28	23	25	20	22	22	18		
20-27		Interior	87	87	83	87	84	79	87	80	76	87	77	73	87	74	70	84	71	67	81	69	62	76	60	45	72	46	36	68	39	30	62	34	25	53	30	22	46	27	19		
		Exposed	87	74	70	83	71	67	80	68	57	77	63	47	74	53	40	71	46	36	69	41	32	63	34	26	52	29	21	44	25	18	38	22	23	33	30	20	30	26	18		
27-45	Interior	87	87	87	87	87	83	87	87	79	87	83	76	86	80	73	83	77	71	80	75	68	74	70	59	70	66	46	66	53	38	52	43	32	42	38	28	37	33	24			
	Exposed	86	80	73	82	76	70	78	73	67	75	70	61	72	68	52	69	65	45	67	56	40	53	43	33	41	37	27	36	32	23	31	28	20	28	25	24	22	22				
D	0-7	Interior	86	83	73	86	79	70	86	76	67	83	73	60	79	70	52	77	68	45	74	65	40	69	51	34	64	41	29	52	36	25	43	31	22	38	27	29	33	24	26		
		Exposed	79	70	51	76	67	43	73	61	39	70	52	35	67	46	32	63	41	29	55	37	26	44	32	22	37	27	29	32	23	25	28	20	22	25	27	19	22	24	17		
	7-20	Interior	85	76	71	81	73	67	78	70	61	75	67	51	72	59	43	70	50	39	68	43	36	59	36	30	49	31	26	41	27	22	36	24	30	32	21	26	28	28	23		
		Exposed	72	59	43	69	48	38	67	41	34	61	37	31	54	34	28	48	31	25	43	28	23	36	24	30	31	20	26	27	22	24	23	19	21	17	22	18	15				
	20-27	Interior	87	82	77	87	78	74	87	75	71	84	72	68	81	69	63	78	66	53	76	59	45	71	45	35	67	38	29	59	33	24	50	29	20	43	25	17	38	22	23		
		Exposed	81	69	62	77	66	50	74	55	42	72	47	37	69	41	32	67	37	29	63	34	25	51	29	21	42	25	17	36	21	22	32	28	19	28	25	17	22	15			
27-45	Interior	87	87	81	87	84	77	87	81	74	83	78	71	80	75	68	77	72	66	74	70	58	69	64	45	63	50	37	48	41	31	40	36	26	35	32	23	31	28	20			
	Exposed	80	75	68	76	71	65	73	68	54	70	66	46	67	57	40	61	49	36	52	43	32	40	36	27	35	31	22	30	27	19	26	23	24	23	21	21	28	18				
10	B	0-7	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	71	72	72	66	72	71	54	72	67	43	72	58	37	68	49	33	65	41	29			
			Exposed	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	68	72	72	59	38	68	47	32	61	40	28	50	35	25	42	31	22	37	27
		7-20	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	71	72	72	69	72	69	59	72	62	45	69	48	38	66	40	33	57	35	29	49	31	26		
			Exposed	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	66	40	33	56	35	29	47	30	25	40	26	22	35	23	29	31	21	26	
		20-27	Interior	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	83	82	78	83	79	75	83	74	70	82	70	66	77	66	50	74	53	40	70	43	34	67	38	29
			Exposed	83	83	81	83	81	77	83	78	74	83	75	71	83	72	68	81	69	64	79	67	54	74	53	41	70	42	33	66	36	28	57	32	23	49	28	20	42	25	17	
	27-45	Interior	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	86	80	73	81	75	69	76	71	64	72	68	52	68	61	42	63	50	37			
		Exposed	86	86	84	86	86	81	86	84	77	86	81	74	83	78	71	80	75	69	77	73	66	72	68	53	68	59	41	58	47	35	46	40	30	39	35	26	35	31	22		
	C	0-7	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	71	72	72	66	72	71	54	72	67	43	72	58	37	68	49	33	65	41	29		
			Exposed	72	72	66	72	72	57	72	69	48	72	66	42	72	59	38	70	51	34	67	45	31	56	38	27	45	32	23	38	28	30	33	24	26	29	21	23	26	29	20	
		7-20	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	71	72	72	69	72	69	59	72	62	45	69	48	38	66	40	33	57	35	29	49	31	26		
			Exposed	72	69	58	72	66	47	71	54	41	69	46	37	66	40	33	60	37	30	54	34	28	44	28	24	30	37	24	20	32	21	26	28	23	25	20	22	22	18		
20-27		Interior	83	83	83	83	83	79	83	80	76	83	77	73	83	74	70	83	71	67	81	69	62	76	60	45	72	46	36	68	39	30	62	34	25	53	30	22	46	27	19		
		Exposed	83	74	70	83	71	67	80	68	57	77	63	47	74	53	40	71	46	36	69	41	32	63	34	26	52	29	21	44	25	18	38	22	23	33	30	20	30	26	18		
27-45	Interior	86	86	86	86	86	83	86	86	79	86	83	76	86	80	73	83	77	71	80	75	68	74	70	59	70	66	46	66	53	38	52	43	32	42	38	28	37	33	24			
	Exposed	86	80	73	82	76	70	78	73	67	75	70	61	72	68	52	69	65	45	67	56	40	53	43	33	41	37	27	36	32	23	31	28	20	28	25	24	22	22				
D	0-7	Interior	72																																								

Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

* Cells with an asterisk indicates that the L-root must be oriented in the Y- direction as indicated in the image.

* Cells with an asterisk indicates that the L-root must be oriented in the Y- direction as indicated in the image.

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

[illegible]

* Cells with an asterisk indicates that the L-root must be oriented in the Y- direction as indicated in the image.

10 Highlighted cell indicate 3-rail system span. Contact Unirac Engineering Services for support.

40 Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

[illegible]

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

* Cells with an astrisks indicates that the L-root must be oriented in the Y- direction as indicated in the image.

Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

10 Highlighted cell indicate 3-rail system span. Contact Unirac Engineering Services for support.

[illegible]

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.

Maximum Allowable Rail Spans for Rooftop Solar Panels Parallel to the Roof Surface (inches)

Ground Snow Load (psf)	Wind Exposure Category	Roof Tilt Angle (deg)	Panel Exposure	Basic Wind Speed (mph)																																								
				Roof Wind Zone																																								
				90			95			100			105			110			115			120			130			140			150			160			170			180				
				1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3					
0	B	0-7	Interior	86	86	86	86	86	86	86	86	86	83	86	86	79	86	86	76	86	83	73	86	80	71	85	75	66	80	71	54	76	67	43	72	58	37	68	49	33	65	41	29	
			Exposed	86	86	76	86	82	73	86	79	70	86	76	67	83	73	61	80	53	77	68	46	72	59	38	68	47	32	61	40	28	50	35	25	42	31	22	37	27	29			
		7-20	Interior	86	86	86	86	86	84	86	86	80	86	83	77	86	80	74	86	77	71	83	74	69	78	69	59	73	62	45	69	48	38	66	40	33	57	35	29	49	31	26		
			Exposed	86	79	74	85	76	70	81	73	67	78	70	61	75	67	51	73	61	44	70	52	40	66	40	33	56	35	29	47	30	25	40	26	22	35	23	29	31	21	26		
		20-27	Interior	87	87	87	87	87	87	87	87	87	87	87	84	87	86	81	87	82	78	87	79	75	87	74	70	82	70	66	77	66	50	74	53	40	70	43	34	67	38	29		
			Exposed	87	85	81	87	81	77	87	78	74	87	75	71	84	72	68	81	69	64	79	67	54	74	53	41	70	42	33	66	36	28	57	32	23	49	28	20	42	25	17		
	C	0-7	Interior	87	87	87	87	87	87	87	87	87	87	87	87	87	87	84	87	87	81	87	86	78	86	80	73	81	75	69	76	71	64	72	68	52	68	61	42	63	50	37		
			Exposed	87	87	84	87	87	81	87	84	77	87	81	74	83	78	71	80	75	69	77	73	66	72	68	53	68	59	41	58	47	35	46	40	30	39	35	26	35	31	22		
		7-20	Interior	86	86	78	86	85	75	86	81	72	86	78	69	85	75	66	82	72	59	79	70	51	74	66	41	70	52	35	66	43	30	55	37	26	46	33	23	40	29	21		
			Exposed	86	82	76	86	78	72	84	75	69	80	72	66	77	69	58	75	66	49	72	59	42	68	44	36	61	37	31	51	32	27	43	28	23	38	25	21	34	22	28		
		20-27	Interior	77	69	58	74	66	47	71	54	41	69	46	37	66	40	33	60	37	30	54	34	28	44	28	24	30	32	21	26	28	23	25	25	20	22	22	19					
			Exposed	87	87	83	87	84	79	87	80	76	87	77	73	87	74	70	84	71	67	81	69	62	76	60	45	72	46	36	68	39	30	62	34	25	53	30	22	46	27	19		
D	0-7	Interior	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87	87			
		Exposed	86	80	73	82	76	70	78	73	67	75	70	61	72	68	52	69	65	45	67	56	40	53	43	33	41	37	27	36	32	23	31	28	20	28	25	24	22	22				
	7-20	Interior	86	83	73	86	79	70	86	76	67	83	73	60	79	70	52	77	68	45	74	65	40	69	51	34	64	41	29	52	36	25	43	31	22	38	27	29	33	24	26			
		Exposed	79	70	51	76	67	43	73	61	39	70	52	35	67	46	32	63	41	29	55	37	26	44	32	22	37	27	29	32	23	25	28	20	22	25	27	19	22	17				
	20-27	Interior	85	76	71	81	73	67	78	70	61	75	67	51	72	59	43	70	50	39	68	43	36	59	36	30	49	31	26	41	27	22	36	24	30	32	21	26	28	28	23			
		Exposed	72	59	43	69	48	38	67	41	34	61	37	31	54	34	28	48	31	25	43	28	23	36	24	30	31	20	26	27	22	24	23	19	21	21	17	28	18	15				
10	B	0-7	Interior	87	82	77	87	78	74	87	75	71	84	72	68	81	69	63	78	66	53	76	59	45	71	45	35	67	38	29	59	33	24	50	29	20	43	25	17	38	22	23		
			Exposed	81	69	62	77	66	50	74	55	42	72	47	37	69	41	32	67	37	29	63	34	25	51	29	21	42	25	17	36	21	22	32	28	19	28	25	17	25	22	15		
		7-20	Interior	87	87	81	87	84	77	87	81	74	83	78	71	80	75	68	77	72	66	74	70	58	69	64	45	63	50	37	48	41	31	40	36	26	35	32	23	31	28	20		
			Exposed	80	75	68	76	71	65	73	68	54	70	66	46	67	57	40	61	49	36	52	43	32	40	36	27	35	31	22	30	27	19	26	23	24	23	21	21	21	28	18		
		20-27	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72		
			Exposed	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72		
	C	0-7	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72		
			Exposed	72	72	66	72	72	57	72	69	48	72	66	42	72	59	38	70	51	34	67	45	31	56	38	27	45	32	23	38	28	30	33	24	26	29	21	23	26	29	20		
		7-20	Interior	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72	72		
			Exposed	72	69	58	72	66	47	71	54	41	69	46	37	66	40	33	60	37	30	54	34	28	44	28	24	30	32	21	26	28	23	25	25	20	22	22	19					
		20-27	Interior	83	83	83	83	83	79	83	80	76	83	77	73	83	74	70	83	71	67	81	69	62	76	60	45	72	46	36	68	39	30	62	34	25	53	30	22	46	27	19		
			Exposed	83	74	70	83	71	67	80	68	57	77	63	47	74	53	40	71	46	36	69	41	32	63	34	26	52	29	21	44	25	18	38	22	23	33	30	20	30	26	18		
D	0-7	Interior	86	86	86	86	86	83	86	86	79	86	83	76	86	80	73	83	77	71	80	75	68	77	72	66	74	70	59	70	66	46	66	53	38	52	43	32	42	38	28	37	33	24
		Exposed	86	80	73	82	76	70	78	73	67	75	70	61	72	68	52	69	65	45	67	56	40	53	43	33	41	37	27	36	32	23	31	28	20	28	25	24	22	22				
	7-20	Interior	72	72	72	72	72	70	72	72	67	72	72	60	72	70	52	72	68	45	72	65	40	69	51	34	64	41	29	52	36	25	43	31	22	38	27	29	33	24	26			
		Exposed	72	70	51	72	67	43	72	61	39	70	52	35	67	46	32	63	41	29	55	37	26	44	32	22	37	27	29	32	23	25	28	20	22	25	27	19	22	17				
	20-27	Interior	72	72	71	72	72	67	72	70	61	72	67	51	72	59	43	70	50	39	68	43	36	59	36	30	49	31	26	41	27	22	36	24	30	32	21	26	28	28	23			
		Exposed	72	59	43	69	48	38	67	41	34	61	37	31	54	34	28	48	31	25	43	28	23	36	24	30	31	20	26	27	22	24	23	19	21	21	17	28	18	15				
20	B	0-7	Interior	84	82	77	84	78	74	84	75	71	84	72	68	81	69	63	78	66	53	76	59	45	71	45	35	67	38	29	59	33	24	50	29	20	43	25	17	38	22	23		
			Exposed	81	69	62	77	66	50	74	55	42	72	47	37	69	41	32	67	37	29	63	34	25	51	29	21	42	25	17	36	21	22	32	28	19	28	25	17	25	22	15		
		7-20	Interior	87	87	81	87	84	77	87	81	74	83	78	71	80	75	68	77	72	66	74	70	58	69	64	45	63	50	37	48	41	31	40	36	26	35	32	23	31	28	20		
			Exposed	80	75	68	76	71	65	73	68	54	70	66	46	67	57	40	61	49	36	52	43	32	40	36	27	35	31															

10 Highlighted cell indicate 3-rail system span. Contact Unirac Engineering Services for support.

[illegible]

10 Highlighted cell indicate 3-rail system span. Contact Unirac Engineering Services for support.

[illegible]

* Cells with an asterisk indicates that the L-foot must be oriented in the Y- direction as indicated in the image.



ASCE 7-16
Design Standard

II
Risk Category

30 ft
Roof Height

Ss = 3.00
Seismic

19 sq.ft
Module Area

LANDSCAPE
Orientation

CROSS-SLOPE
Rail Direction

NXT
Rail Type

NXT COMBO
Clamp

Stronghold BUTYL Rafter
Attachment

SPAN TABLES

Maximum Allowable Rail Spans for Rooftop Solar Panels Parallel to the Roof Surface (inches)

Ground Snow Load (psf)	Wind Exposure Category	Roof Tilt Angle (deg)	Panel Exposure	Basic Wind Speed (mph)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

10 Highlighted cell indicate 3-rail system span. Contact Unirac Engineering Services for support.

Maximum Allowable Rail Spans for Rooftop Solar Panels Parallel to the Roof Surface (inches)

[illegible]

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Highlighted cell with strikethrough indicate 3-rail system span and module clamp allowable capacity exceeds with 3-rails. 4-Rail system required. Contact Unirac Engineering Services for support.

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