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iROOFA®

Instant Roof Framing Analysis

www.iroofa.solar

tel: 540.313.5317 - email: info@iRooFA.solar

STRUCTURAL ANALYSIS

for the

ROOFTOP PV SOLAR INSTALLATION

Project: Tom Fritz Residence, 929N 33Rd St, Milwaukee, WI 53208

Prepared for:

WOLF RIVER ELECTRIC

101 Isanti Parkway Ne - Suite G Isanti, MN 55040

Calculation Report Index

Project No: 147.185, Rev. 0

Report Date: 11/14/2025

Report Prepared by:

WISCONSIN Richard Pantel E-44528 Round Hill VA PROFESSIONAL ENGINEER

Richard Pantel, P.E.

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Loading Summary

Exposure and Occupancy Categories		
C		*Exposure Category (ASCE 7-10 Table 26.7.3, Page 274)*
II		*Building Use Occupancy / Risk Category (ASCE 7-10 Table 1.5-1, Page 5)*

Wind Loading:			
v	109	*mph*	*Value overridden from ASCE Hazards default*
qz	24.59	*psf*	*Velocity qz, calculated at height z [ASD]*

Snow Loading			
pg	30.00	*psf*	*Ground Snow Load pg (Value overridden from ASCE Hazards default)*
Total Snow Load			
ps	20.00	*psf*	*Effective snow load on roof and modules*

Module Data			
SunPower: SPR-M415-BLK-H-AC 240VAC			
Dimensions	*mm*	*ft*	*in*
Length	1,872	6.14	73.70
Width	1,032	3.39	40.63
Area (m^2, ft^2)	1.9	20.79	
Weight	kg	lb	psf load
Module	21.80	48.06	2.31

Roof Panel (Cladding) Loading Summary		Module Loading Summary			
Support Point Loads		*Upward*	*Upward*	*Upward*	*Downward*
Roof Zones		1	2	3	All
Net load per module	*lb*	-54	-78	-78	137

Positive values indicate net downward force

Primary Stanchion: Pegasus Solar Comp Mount PSCR-UBB0

StanchionFastener Pull-out and Spacing Calculations				
Framing spacing		*ft*	2.00	
Rails / Module		*ea*	2	
Max proposed stanchion span		*ft*	4.00	
# fasteners per stanchion			1	
Bolt thread embedment depth		*in*	2.50	
Safety Factor			1.10	
Pull-out for 5/16 threaded fasteners		*lb/in*	220	*lb per inch of embedment*
Factored max fastener uplift capacity		*lb*	499	
Fastener details	*Material* Stainless	*Size*	5/16	*Predrill hole 0.16" dia or use self tapping*
Max stanchion uplift capacity		*lb*	618	
Max support point uplift capacity		*lb*	499	

Roof Zones		*1*	*2*	*3*
Net lift per module	*lb*	54	78	78
Min tot bolt thread embedment depth rq'd	*in*	0.27	0.39	0.39
Net uplift pressure 7. 0.6D - 0.6W	*psf*	-3.96	-5.75	-5.75
Allowable lift area / support point	*sf*	126.10	86.77	86.77
Max rail span per support spacing	*ft*	4.00	4.00	4.00
Landscape Modules				
Length along rafter	*ft*	3.39		
Lift calc'ed max stanchion EW spacing	*ft*	> 6	> 6	> 6
Max stanchion EW spacing	*ft*	4.00	4.00	4.00
Maximum module area / support point	*sf*	6.77	6.77	6.77
Factored lift per support point	*lb*	-27	-39	-39
Portrait Modules				

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Length along rafter	*ft*	6.14		
Lift calc'ed max stanchion EW spacing	*ft*	> 6	> 6	> 6
Max stanchion EW spacing	*ft*	4.00	4.00	4.00
Maximum module area / support point	*sf*	12.28	12.28	12.28
Factored lift per support point	*lb*	-49	-71	-71

Stanchion support threaded fastener sizes are indicated in the Module Loading Summary table above. Lift forces were determined from GCp and other coefficients contained in the ASCE nomographs

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Conclusions

We were asked to review the roof of Tom Fritz Residence, located at 929N 33Rd St, Milwaukee, WI, by WOLF RIVER ELECTRIC, to determine its suitability to support a PV solar system installation.

The referenced building's roof structure was field measured by WOLF RIVER ELECTRIC on 11/14/2025. The attached framing analyses reflect the results of those field measurements combined with the PV solar module locations shown on the PV solar roof layout design prepared by WOLF RIVER ELECTRIC. Loads are calculated to combine the existing building and environmental loads with the proposed new PV array loads.

The SunPower InvisiMount 6000 series racking and Pegasus Solar Comp Mount PSCR-UBB0 stanchions were selected for this project by WOLF RIVER ELECTRIC. The racking and support stanchions shall be placed as shown on their plans, dated 11/14/2025, and shall be fastened to the roof framing using fastener sizes indicated in this report. Rack support spacing shall be no more than that shown above. Note that support points for alternating rows shall share the same rafter. Intermediate rows shall move the support points laterally to the next rafter.

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Google Location Map

Framing Summary

	Ex. Framing	Total Ex DL
MP 1: 1.50" x 3.50" member x 18.00' span with a 45° slope @ 24" OC w/ ex. supports @ 8.00'	0.50 psf	4.90 psf

** Wood species used in these calculations assumes spruce, pine or fir, #2 grade.*

Based upon the attached calculations, the existing roof's framing system is capable of supporting the additional loading for the proposed PV solar system along with the existing building and environmental loads. No supplemental roof framing structural supports are required. No further structural alterations or modifications are needed to support the system. Minimum required anchorage fastening is described above.

Wood fastener notes: 1) Fastener threads must be embedded in the side grain of a roof support structural member or other structural member integrated into the building's structure. 2) Fastener must be located in the middle third of the structural member. 3) Install fasteners with head and where required, washer, flush to material surface (no gap). Do not over-torque.

References and Codes:

1) *ASCE 7-10 Minimum Design Loads for Buildings and Other Structures*
2) *2015 IBC*
3) *2015 IRC*
4) *American Wood Council, NDS 2018,Table 12.2A, 12.3.3A.*
5) *American Wood Council, Wood Structural Design, 1992, Figure 6.*

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Roof Structural Calculations for PV Solar Installation **Array AR-1**
Location: MP 1 ***Roof shape: Gable / Hip***
Member: Rafter - Total Length 18 ft, Unsupported 3.97 ft

Geometric Data			
Θ	*deg.*	49.0	*Angle of roof plane from horizontal, in degrees*
ω	*deg.*	0.0	*Angle the solar panel makes with the roof surface*
L	*ft.*	19.00	*Length of roof plane, in feet (meters)*
W	*ft.*	12.31	*Plan view width of roof plane, in feet (meters)*
h	*ft.*	26.37	*Average height of roof above grade, in feet (meters)*

Roof Wind Zone Width			
	use, a =	3.00	*ft*

Wind Velocity Pressure, q_z evaluated at the height z						
q_z=	24.59	*psf*	*Vasd* q_z=	14.95	*psf*	Basic wind pressure
V=	109	mph				

Framing Data		
Wood type	US Spruce	
Wood source, moisture content	White 0.12%	
# Framing Members / Support		1
Rafter / Truss OC	*in*	24.00
Member Total Length	*ft*	18.00

2	# Rafters / Rack Support Width
4.00	Rack Support Spacing (ft)
48.00	Max. Rack Support Spacing (in)
3	Max # of mod's / Rafter

Member Properties		**Member**
Name		(1)1.5x3.5
Repetitive Member Factor (Cr)		1.15
Max Shear perp. to grain	*psi*	530
Max Shear parallel to grain	*psi*	1,100

** Mem properties based upon field measurements*

Rafter

24.00	Collar tie OC spacing, in.

Module Data			
Weight	kg	lb	psf load
Module	21.80	48.06	2.31
4 Stanchions	1.81	4.0	0.19

Existing Dead Loads	*Units*	*Value*	*Description*
Framing Member	*psf*	0.50	
Roof Deck & Surface Material*	*psf*	4.40	*0.50 in. Plywood w/ Standard Asphalt Shingles*

** Roof surface: Standard Asphalt Shingles*

Rack Support Spacing and Loading				
Across rafters	*ft*	4.0		
Along rafter slope	*ft*	3.4		
Area / support point	*sf*	6.8		
Uphill gap between modules	*in*	1.0	0.08	*ft*

Member Total Length	*ft*	18.00	
Maximum member free span	*ft*	3.97	Rafter btwn CT & KW
Rafter segment to calc	*ft*	3.97	Free span
Deflection Ratio		180	Use max delta 1/x for deflection

** Collar Tie & Knee wall height @ 8.00' AFF max height. Adjust to match lowest adjoining roof's collar*

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Eave Overhang Length past Rafter Plate	0.50	*ft*
Uphill Distance from Eave to Lowest Support	3.25	*ft*

Zones	1	2	3
GCp	-0.94	-1.14	-1.14

Downward, Zones 1, 2 & 3
GCp 0.87

ASCE 7-10 Chapter 2 Combinations of Loads, Table 2.4, Page 8 (in psf)				
Zones	1	2	3	1, 2 & 3
2.2 SYMBOLS AND NOTATION	*Module Upward*	*Module Upward*	*Module Upward*	*Downward*
D = dead load of PV Module + Stanchion	2.50	2.50	2.50	2.50
S = snow load	20.00	20.00	20.00	20.00
W = Vasd Windload	-14.00	-16.99	-16.99	12.98

2.4 Combining Nominal Loads Using Allowable Stress Design (in psf)				
2.4.1 Basic Combinations. Loads listed herein shall be considered to act in the following combinations; whichever produces the most unfavorable effect in the building, foundation, or structural member being considered. Effects of one or more loads not acting shall be considered.				
Combination Formulae	*Upward*	*Upward*	*Upward*	*Downward*
Use this loading combination for DOWNWARD for Proposed PV Dead Load				
6. D + 0.75L - 0.75(0 or 0.7)eE + 0.75S	22.50	22.50	22.50	23.34
Module Support point load (lb)	152	152	152	158
Cr Factored Module Support point load (lb)	133	133	133	137

Use this loading combination for UPWARD for Proposed PV Dead Load				
7. 0.6D - 0.6W	-3.96	-5.75	-5.75	4.44
Module Support point load (lb)	-27	-39	-39	30

DOWNWARD

Presume loading directly over member.

Combined Dead and Wind Pressure Downward Loading					
	Rafter btwn CT & KW				
PV Module Row	Point load loc's from Left support		Module Support Point Load	Comment	Module Orientation
	ft from left		*lb*		
1	2.75			Support outside of max stressed section	Portrait
1	8.89		137		Portrait
2	8.98		137		Landscape
2	12.36			Support outside of max stressed section	Landscape
3	12.44			Support outside of max stressed section	Landscape
3	15.83			Support outside of max stressed section	Landscape

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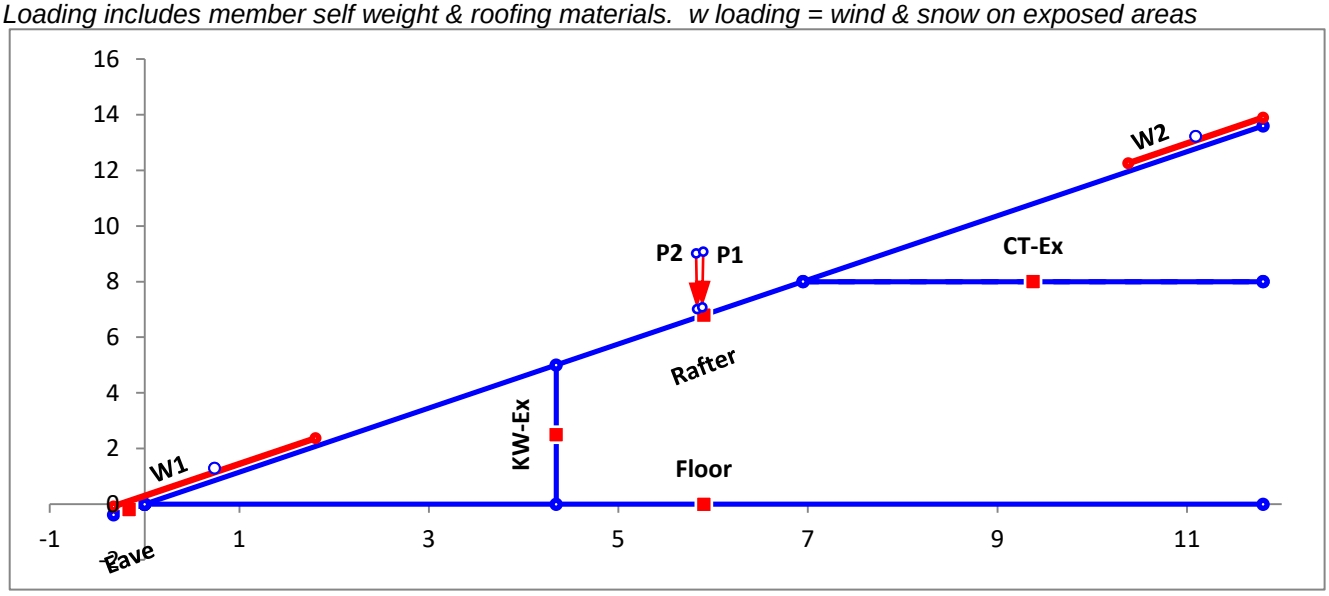
Analysis for PV impacted areas

5. Simple Beam - Exposed Roof Snow Load - Above and Below PV				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Deflection @ mid span	*in*	0.03	0.26	***OK***
M at mid span	*lb-ft*	221	1,667	***OK***

Sum Downward Loading Conditions: PV; Beam DL; Exposed Roof Environmental Load				
Parameter	*Units*	*Total*	*Allowed*	*Check*
Deflection	*in*	0.11	0.26	***OK***
Percent Max Deflection	*%*	42%	100%	***OK***
Moment	*lb-ft*	459	1,667	***OK***
fs	*psi*	1,797	6,533	***OK***

** Loading includes member self weight & roofing materials. w loading = wind & snow on exposed areas*



Framing section with max stress: Rafter btwn CT & KW

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Snow Loading Analysis

where:

		Fully Exposed	Exposure category
Ce	=	0.9	Exposure Factor, Ce (ASCE 7-10 Table 7.3-1, Page 61)
Ct	=	1.0	Thermal Factor, Ct (ASCE 7-10 Table 7.3-2, Page 61)
Is	=	1.0	Snow Importance Factor, Is (ASCE 7-10 Table 1.5-2, Page 5)
p_g	=	30.00	Ground Snow Load pg (Value overridden from ASCE Hazards default)
p_f	=	**0.7CeCtIsPg**	Flat Roof Snow Load, pf (ASCE 7-10 Table 7.3-1, Page 61)
p_f	=	**18.90**	psf
			but where Pf is not less than the following:
			Minimum Snow Load pm (ASCE 7-10 Table 7.3.4, Page 62)
p_m	=	**20**	psf. When Pg > 20 psf, then use Pf = 20 psf x Is
p_f	=	**20.00**	psf. Resultant Snow pressure to be used with Roof slope factor below
p_s	=	$C_s p_f$	Sloped Roof Snow Load ps (ASCE 7-10 Table 7.4, Page 61)
			Roof Type Warm Roofs

Roof slope factor Cs for Warm Roofs, where Ct = 1.0

Roof surface condition = Slippery Roof

C_s	=	1.00	Roof Slope Factor, Cs (ASCE 7-10 Table 7.4-1a, Page 62)

Total Snow Load

p_s	=	**20.00**	**psf**	Roof snow load

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