



VSE Project Number: U5396.0007.241

January 17, 2025

Upliftic Energy
1327 SE Tacoma St PMB 321
Portland, OR 97202

REFERENCE: Maria Culbertson Residence: 6916 North Maryland Avenue, Portland, OR 97217
Solar Array Installation

To Whom It May Concern:

We have reviewed the existing structure at the above referenced site. The purpose of our review was to determine the adequacy of the existing structure to support the proposed installation of solar panels on the roof as shown on the panel layout plan.

Based upon our review, we conclude that the existing structure will require a retrofit per the attached detail in order to support the proposed solar panel installation. Retrofit to occur on all rafters supporting the array exceeding a horizontal span of 7.75 ft.

Design Parameters

Code: Oregon Structural Specialty Code, 2022 Edition (2021 IBC)
Risk Category: II
Design wind speed, Vult: 97 mph (3-sec gust)
Wind exposure category: B
Ground snow load, Pg: 10 psf
Minimum roof snow load, Pm: 20 psf (not reducible)
Seismic design category: D

Existing Roof Structure

Roof structure: 2x4 rafters @ 24" o.c.
Roofing material: asphalt (composite) shingles
Roof slope: 27°

Connection to Roof

Mounting connection: (1) 5/16" lag screw w/ min. 2.5" threaded embedment into framing at max. 48" o.c. along rails

- Install (2) rails per row of panels, evenly spaced from panel center
- Panel length perpendicular to the rails shall not exceed 69 in
- Rail cantilever shall not exceed the lesser of 50% of the connection spacing or max cantilever allowed by manufacturer
- Connections shall be staggered so as not to overload any existing structural member

Conclusions

Based upon our review, we conclude that the existing structure is adequate to support the proposed solar panel installation. See attached calculations.

Supplemental
1/21/2025



The solar array will be flush-mounted (no more than 10" above the roof surface) and parallel to the roof surface. Thus, we conclude that any additional wind loading on the structure related to the addition of the proposed solar array is negligible. The attached calculations verify the capacity of the connections of the solar array to the existing roof against wind (uplift), the governing load case. Regarding seismic loads, we conclude that any additional forces will be small. Conservatively neglecting the weight of existing wall materials, the installation of the solar panels represents an increase in the total weight (and resulting seismic load) of 6.8%. Increases in lateral forces less than 10% are considered acceptable. Thus the existing lateral force resisting system is permitted to remain unaltered.

Limitations

Installation of the solar panels must be performed in accordance with manufacturer recommendations. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. The contractor must notify Vector Structural Engineering, LLC should any damage, deterioration or discrepancies between the as-built condition of the structure and the condition described in this letter be found. The use of solar panel support span tables provided by others is allowed only where the building type, site conditions, site-specific design parameters, and solar panel configuration match the description of the span tables. The design of the solar panels, solar racking (mounts, rails, etc.) and electrical engineering is the responsibility of others. Waterproofing around the roof penetrations is the responsibility of others. Vector Structural Engineering assumes no responsibility for improper installation of the solar array. Vector Structural Engineering shall be notified of any changes from the approved layout prior to installation.

VECTOR STRUCTURAL ENGINEERING, LLC



01/17/2025

Wells Holmes, S.E.

Project Engineer

Enclosures

WLH/ssh



JOB NO.: U5396.0007.241
SUBJECT: SEISMIC LOADS

PROJECT: Maria Culbertson Residence

CHECK INCREASE IN OVERALL SEISMIC LOADS

Estimated Roof Dead Load	9.4	psf
Solar Dead Load	3.0	
% Roof Covered	21%	
Equiv. Total Dead Load	10.0	psf
Add'l Seismic Weight	6.8%	

Conservatively neglecting the weight of existing wall materials, the installation of the solar panels represents an increase in the total weight (and resulting seismic load) of 6.8%. Because the increase is less than 10%, this addition meets the requirements of the exception in Section 805.3 of the 2021 IEBC. Thus the existing structure is permitted to remain unaltered.



JOB NO.: U5396.0007.241
SUBJECT: WIND PRESSURE

PROJECT: Maria Culbertson Residence

Components and Cladding Wind Calculations

Label: Solar Panel Array

Note: Calculations per ASCE 7-16

SITE-SPECIFIC WIND PARAMETERS:

Basic Wind Speed [mph]: 97
Exposure Category: B
Risk Category: II

Notes:

ADDITIONAL INPUT & CALCULATIONS:

Height of Roof, h [ft]: 15 (Approximate)
Comp/Cladding Location: Hip Roofs $20^\circ < \theta \leq 27^\circ$
Enclosure Classification: Enclosed Buildings
Zone 1 GCp: 1.37 Figure 30.3-2G Zone 1 γ_a : 0.78 Fig.
Zone 2e, 2r, 3 GCp: 1.96 (negative coeff.) Zone 2e, 2r, 3 γ_a : 0.78 29.4-8

α : 7 Table 26.11-1
 z_g [ft]: 1200 Table 26.11-1
 K_h : 0.57 Table 26.10-1
 K_e : 0.99 Table 26.9-1
 K_{zt} : 1 Equation 26.8-1
 K_d : 0.85 Table 26.6-1
Velocity Pressure, q_h [psf]: 11.7 Equation 26.10-1
 γ_E : 1.50 Section 29.4.4

WIND PRESSURES: Equation 29.4-7 $p = q_h (GC_p)(\gamma_E)(\gamma_a)$

Zone 1, p [psf]: 18.6 psf (1.0 W)
Zone 2e, 2r, 3, p [psf]: 26.7 psf (1.0 W)

(a = 3 ft)



JOB NO.: U5396.0007.241
SUBJECT: CONNECTION

PROJECT: Maria Culbertson Residence

Calculate Uplift Forces on Connection

	Pressure (0.6 Dead -0.6 Wind) (psf)	Max Trib. Width ¹ (ft)	Max Trib. Area ² (ft ²)	Max Uplift Force (lbs)
Zone 1	9.4	4.0	11.4	107
Zone 2e, 2r, 3	14.2	4.0	11.4	162

Calculate Connection Capacity

Lag Screw Size [in]:	5/16	NDS Table 2.3.2
C _d :	1.6	
Embedment ³ [in]:	2.5	NDS Table 12.2A
Grade:	SPF (G = 0.42)	
Nominal Capacity [lbs/in]:	205	
Number of Screws:	1	
Prying Coefficient:	1.4	
Total Capacity [lbs]:	586	

Determine Result

Maximum Demand [lbs]:	162
Lag Screw Capacity [lbs]:	586

Result: **Capacity > Demand, Connection is adequate.**

Notes

1. 'Max Trib. Width' is the width along the rails tributary to the connection.
2. 'Max Trib Area' is the product of the 'Max. Trib Width' and 1/2 the panel width/height perpendicular to the rails. (2) rails per row of panels. Length of panels perpendicular to the rails shall not exceed 68".
3. Embedment is measured from the top of the framing member to the beginning of the tapered tip of the lag screw. Embedment in sheathing or other material is not effective. The length of the tapered tip is not part of the embedment length.



JOB NO.: U5396.0007.241
SUBJECT: GRAVITY LOADS

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GRAVITY LOADS

Roof Pitch: **6.1** :12

ROOF DEAD LOAD (D)	Design material weight [psf]	Increase due to pitch	Material weight [psf]
Asphalt (Composite) Shingles	2.2	1.12	2.0
1/2" Plywood	1.1	1.12	1.0
Framing*	0.0		0.0
Insulation	0.0		0.0
1/2" Gypsum Clg.	0.0	1.12	0.0
M, E & Misc	2.0		2.0
Total Existing Roof DL	5.4		
PV Array DL	3.4	1.12	3

*Self weight of framing members calculated on beam analysis page

ROOF LIVE LOAD (Lr)

Existing Design Roof Live Load [psf]	20	ASCE 7-16 Table 4.3-1
Roof Live Load With PV Array [psf]	0	2022 OSSC, Section 1607.14.4.1

SNOW LOAD (S):

Existing w/ Solar Array

Roof Slope [x:12]:	6.1	6.1	
Roof Slope [°]:	27	27	
Ground Snow Load, p_g [psf]:	10	10	ASCE 7-16, Section 7.2
Terrain Category:	B	B	ASCE 7-16, Table 7.3-1
Exposure of Roof:	Fully Exposed	Fully Exposed	ASCE 7-16, Table 7.3-1
Exposure Factor, C_e :	0.9	0.9	ASCE 7-16, Table 7.3-1
Thermal Factor, C_t :	1.1	1.1	ASCE 7-16, Table 7.3-2
Risk Category:	II	II	ASCE 7-16, Table 1.5-1
Importance Factor, I_s :	1.0	1.0	ASCE 7-16, Table 1.5-2
Flat Roof Snow Load, p_f [psf]:	7	7	ASCE 7-16, Equation 7.3-1
Minimum Roof Snow Load, p_m [psf]:	20	20	ASCE 7-16, Section 7.3.4
Unobstructed Slippery Surface?	No	Yes	ASCE 7-16, Section 7.4
Slope Factor Figure:	Figure 7-2b	Figure 7-2b	ASCE 7-16, Section 7.4
Roof Slope Factor, C_s :	1.00	0.72	ASCE 7-16, Figure 7.4-1
Sloped Roof Snow Load, p_s [psf]:	7	5	ASCE 7-16, Equation 7.4-1
Design Snow Load, S [psf]:	20	20	



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SUBJECT: BEAMS

DESIGN LOADS:	Load Types:	Snow	Live	Dead
	Roof	20	20	5
	Solar			3.4

CRITERIA (L)	D _{TL}	D _{LL}	D _{DL}
A _(BLANK)	120	180	

Abbrev	GRADES		F _{bxx} (psi)	F _{vxx} (psi)	E _{xx} (psi)	g (lb/ft ³)
DFL#1	DFL#1		1,000	180	1,700,000	32
DFL#2	DFL#2		900	180	1,600,000	32
DF1 (5X)	DFL#1 5X5 & LARGER		1,350	170	1,600,000	32
SPF#2	SPF#2		875	135	1,400,000	26.2
SP#2	SP#2		1,100	175	1,400,000	34.3
24F-V4	24F-V4		2,400	240	1,800,000	32
24F-V8	24F-V8		2,400	240	1,800,000	40
LVL (1.9)	LVL (1.9X106E)		2,600	285	1,900,000	40
LVL (2.0)	LVL (2.0X106E)		2,200	285	2,000,000	42
LSL	LSL (1.3X106E)		1,700	400	1,300,000	42
STL36	GRADE 36 STEEL		21,600	14,400	29,000,000	490
STL46	GRADE 46 STEEL		27,700	16,500	29,000,000	490
STL50	GRADE 50 STEEL		30,000	20,000	29,000,000	490

Label	Length 'L' (ft)	Roof Trib (ft)	Floor Trib (ft)	Wall Trib (ft)	Add'l Live Load (plf)	Add'l Solar Load (plf)	Point Load From	React (A/B)	Dist 'a' (ft)	Point Live Load 'P _{LL} ' (lb)	Point Dead Load 'P _{DL} ' (lb)	# PLIES	Grade	Size	"BM/HDR"	D CRITERIA	C _r	C _D	C _{F,V}	R _a (lb)	R _b (lb)	M _{max} (ft-lb)	M _{allow} (ft-lb)	V _{max} (lb)	V _{allow} (lb)	D _{TL} (in)	D _{TLallow} (in)	D _{LL} (in)	D _{LLallow} (in)	1.5DL GLB Camb	Check
Rafter	7.8	2.00				6.7						(1)	SPF#2	2x4			1.15	1.15	1.50	226	226	439	443	209	543	0.632	0.775	0.433	0.517		0.99 M