Domus Structural Engineering, LLC
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530-864-7055
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September 23, 2022

To: Blue Raven Solar
1403 North Research Way, Building J
Orem, UT. 84097

Subject: Certification Letter
Darville Residence
1824 SW. Blackstone Pl.
Lee's Summit, MO. 64082

To Whom It May Concern,

A jobsite observation of the condition of the existing framing system was performed by an audit team of Blue Raven Solar as a request from Domus Structural Engineering. All review is based on these observations and the design criteria listed below and only deemed valid if provided information is true and accurate.

On the above referenced project, the roof structural framing has been reviewed for additional loading due to the installation of the solar PV addition to the roof. The structural review only applies to the section of the roof that is directly supporting the solar PV system and its supporting elements. The observed roof framing is described below. If field conditions differ, contractor to notify engineer prior to starting construction.

The roof structures of (MP1&2) consist of composition shingle on roof plywood that is supported by 2x6 rafters @ 16"o.c. with ceiling joists acting as rafter ties. The rafters have a max projected horizontal span of 13'-0", with a slope of 43 degrees. The rafters are connected at the ridge to a ridge board and are supported at the eave by a load bearing wall.

The existing roof framing systems of (MP1&2) are judged to be adequate to withstand the loading imposed by the installation of the solar panels. No reinforcement is necessary.

The spacing of the solar standoffs should be kept at 64" o.c. for landscape and 48" o.c. for portrait orientation, with a staggered pattern to ensure proper distribution of loads.

The scope of this report is strictly limited to an evaluation of the fastener attachment, underlying framing and supporting structure only. The attachment's to the existing structure are required to be in a staggered pattern to ensure proper distribution of loading. All panels, racking and hardware shall be installed per manufacturer specifications and within specified design limitations. All waterproofing shall be provided by the manufacturer. Domus Structural Engineering assumes no responsibility for misuse or improper installation of the solar PV panels or racking.

Note: Seismic check is not required since Ss<.4g and Seismic Design Category (SDC) < B

Design Criteria:

- Applicable Codes = 2018 IBC/IRC, ASCE 7-16
- Roof Dead Load = 8 psf (MP1&2)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph (Vult), Exposure C
- Ground Snow Load = 20 psf - Roof Snow Load = 14 psf
- Attachment: 1 - 5/16 dia. lag screw with 2.5 inch min. embedment depth, at spacing shown above.

Please contact me with any further questions or concerns regarding this project.

Sincerely,

Digitally signed by John A. Calvert
Date: 2022.09.23 16:30:40 -06'00'

John Calvert, P.E.
Project Engineer

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Gravity Loading

Roof Snow Load Calculations		
p_g = Ground Snow Load =	20 psf	
$p_f = 0.7\ C_e\ C_t\ I\ p_g$		(ASCE7 - Eq 7-1)
C_e = Exposure Factor =	1	(ASCE7 - Table 7-2)
C_t = Thermal Factor =	1	(ASCE7 - Table 7-3)
I = Importance Factor =	1	
p_f = Flat Roof Snow Load =	14.0 psf	
$p_s = C_s p_f$		(ASCE7 - Eq 7-2)
Cs = Slope Factor =	1	
p_s = Sloped Roof Snow Load =	14.0 psf	

PV Dead Load = 3 psf (Per Blue Raven Solar)	
DL Adjusted to 43 Degree Slope	4.10 psf

PV System Weight	
Weight of PV System (Per Blue Raven Solar)	3.0 psf
X Standoff Spacing =	4.00 ft
Y Standoff Spacing =	6.08 ft
Standoff Tributary Area =	24.33 sft
Point Loads of Standoffs	73 lb

Note: PV standoffs are staggered to ensure proper distribution of loading

Roof Live Load = 20 psf

Note: Roof live load is removed in area's covered by PV array.

Roof Dead Load (MP1&2)		
Composition Shingle	4.00	
Roof Plywood	2.00	
2x6 Rafters @ 16"o.c.	1.72	
Vaulted Ceiling	0.00	(Ceiling Not Vaulted)
Miscellaneous	0.28	
Total Roof DL (MP1&2)	8.0 psf	
DL Adjusted to 43 Degree Slope	10.9 psf	

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Wind Calculations
Per ASCE 7-16 Components and Cladding

Input Variables	
Wind Speed	115 mph
Exposure Category	C
Roof Shape	Gable Roof
Roof Slope	43 degrees
Mean Roof Height	20 ft
Effective Wind Area	21.3 ft
Ground Elevation	0 ft

Design Wind Pressure Calculations		
qh = 0.00256 * Kz * Kzt * Kd * Ke * V^2		(Eq. 26.10-1)
Kz (Exposure Coefficient) =	0.90	(Table 30.3-1)
Kzt (topographic factor) =	1.00	(Fig. 26.8-1)
Kd (Wind Directionality Factor) =	0.85	(Table 26.6-1)
Ke (Ground Elevation Factor) =	1.00	
V (Design Wind Speed) =	115 mph	(Fig. 26.5-1A)
Risk Category =	II	(Table 1.5-1)
qh =	25.95	

Standoff Uplift Calculations-Portrait	Zone 1	Zone 2	Zone 3	Positive	
y_a =	0.67	0.77	0.80	0.67	
GCp =	-1.41	-1.93	-2.59	0.75	(Fig. 30.3)
Uplift Pressure =	-24.6 psf	-38.7 psf	-53.7 psf	13.0 psf	(Eq. 29.4-7)
ASD Uplift Pressure =	-14.8 psf	-23.2 psf	-32.2 psf	9.6 psf	
X Standoff Spacing =	4.00	4.00	2.67		
Y Standoff Spacing =	6.08	3.04166667	3.04166667		
Tributary Area =	24.33	12.17	8.11		
Dead Load on attachment =	73 lb	37 lb	24 lb		
Footing Uplift (0.6D+0.6W) =	-315 lb	-261 lb	-247 lb		

Standoff Uplift Calculations-Landscape	Zone 1	Zone 2	Zone 3	Positive	
y_a =	0.71	0.80	0.80	0.71	
GCp =	-1.53	-2.00	-2.70	0.79	(Fig. 30.3)
Uplift Pressure =	-28.1 psf	-41.5 psf	-56.1 psf	14.6 psf	(Eq. 29.4-7)
ASD Uplift Pressure (0.6W)=	-16.9 psf	-24.9 psf	-33.7 psf	9.6 psf	
X Standoff Spacing =	5.33	5.33	3.56		
Y Standoff Spacing =	3.50	1.75	1.75		
Tributary Area =	18.67	9.33	6.22		
Dead Load on attachment =	56.00	28.00	18.67		
Footing Uplift (0.6D+0.6W) =	-281 lb	-216 lb	-198 lb		

Standoff Uplift Check	
Maximum Design Uplift =	-315 lb
Standoff Uplift Capacity =	450 lb
450 lb capacity > 315 lb demand	Therefore, OK

Fastener Capacity Check	
Fastener =	1 - 5/16" dia. lag
Number of Fasteners =	1
Embedment Depth =	2.5
Pullout Capacity Per Inch =	250 lb
Fastener Capacity =	625 lb
w/ F.S. of 1.5 & DOL of 1.6=	667 lb
667.2 lb capacity > 315 lb demand	Therefore, OK

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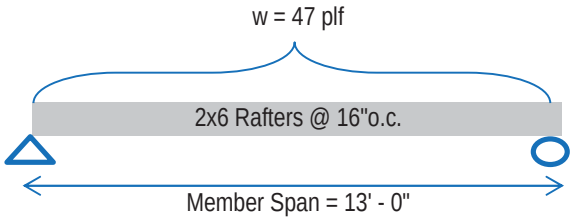
Framing Check

(MP1&2) PASS

Dead Load	10.9 psf
PV Load	4.1 psf
Snow Load	14.0 psf

Governing Load Combo = DL + LL
Total Load 35.0 psf



Member Properties

Member Size	S (in^3)	I (in^4)	Lumber Sp/Gr	Member Spacing
2x6	7.56	20.80	DF#2	@ 16"o.c.

Check Bending Stress

Fb (psi) =	f'b	x	Cd	x	Cf	x	Cr	(NDS Table 4.3.1)
	900	x	1.25	x	1.3	x	1.15	

Allowed Bending Stress = 1681.8 psi

Maximum Moment = (wL^2) / 8
= 986.977 ft#
= 11843.72 in#

Actual Bending Stress = (Maximum Moment) / S
= 1566.2 psi

Allowed > Actual -- 93.2% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = L/120 (E = 1600000 psi Per NDS)
= 1.3 in

Deflection Criteria Based on = Simple Span
Actual Deflection (Total Load) = (5*w*L^4) / (384*E*I)
= 0.903 in
= L/173 > L/120 Therefore OK

Allowed Deflection (Live Load) = L/180
0.866 in

Actual Deflection (Live Load) = (5*w*L^4) / (384*E*I)
0.516 in
L/303 > L/180 Therefore OK

Check Shear

Member Area = 8.3 in^2 Fv (psi) = 180 psi (NDS Table 4A)

Allowed Shear = Fv * A = 1485 lb Max Shear (V) = w * L / 2 = 304 lb

Allowed > Actual -- 20.5% Stressed -- Therefore, OK