



BLUE RAVEN SOLAR, LLC.
Firm License No. D-0449
1403 North Research Way , Bldg. J
Orem, UT 84097

September 21, 2023

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

Subject: Certification Letter
Hendrickson Residence
16 Shelby St
Spring Lake, NC. 28390

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. 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.. The rafters support a vaulted ceiling and have a max projected horizontal span of 12'-6", with a slope of 39 degrees. The rafters are supported at the ridge by a ridge board and 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.

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

Design Criteria:

- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE 7-10
- Roof Dead Load = 12 psf (MP1&2)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph (Vult), Exposure C, Risk Category II
- Ground Snow Load = 15 psf - Roof Snow Load = 10.5 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,

John Calvert, P.E.
Project Engineer



Digitally signed by John A. Calvert
Date: 2023.09.21 11:37:54
-06'00'

Hendrickson Spring Lake NC 1



Gravity Loading

Roof Snow Load Calculations		
p_g = Ground Snow Load =	15 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 =	10.5 psf	
$p_s = C_s p_f$		(ASCE7 - Eq 7-2)
C_s = Slope Factor =	1	
p_s = Sloped Roof Snow Load =	10.5 psf	

PV Dead Load = 3 psf (Per Blue Raven Solar)	
DL Adjusted to 39 Degree Slope	3.86 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	4.00
Miscellaneous	0.28
Total Roof DL (MP1&2)	12.0 psf
DL Adjusted to 39 Degree Slope	15.4 psf



Wind Calculations

Per ASCE 7-10 Components and Cladding

Input Variables	
Wind Speed	115 mph
Exposure Category	C
Roof Shape	Hip/Gable
Roof Slope	39 degrees
Mean Roof Height	20 ft
Effective Wind Area	21.3 ft

Design Wind Pressure Calculations	
Wind Pressure $P = qh * G * C_n$	
$qh = 0.00256 * K_z * K_{zt} * K_d * V^2$	(Eq. 30.3-1)
K_z (Exposure Coefficient) = 0.9	(Table 30.3-1)
K_{zt} (topographic factor) = 1	(Fig. 26.8-1)
K_d (Wind Directionality Factor) = 0.85	(Table 26.6-1)
V (Design Wind Speed) = 115 mph	(Fig. 26.5-1A)
Risk Category = II	(Table 1.5-1)
$qh = 25.90$	
$0.6 * qh = 15.54$	

Standoff Uplift Calculations-Portrait				
	Zone 1	Zone 2	Zone 3	Positive
G_{Cp} =	-0.94	-1.15	-1.15	0.86
Uplift Pressure =	-14.55 psf	-17.80 psf	-17.80 psf	22.4 psf
X Standoff Spacing =	4.00	4.00	2.67	
Y Standoff Spacing =	6.08	3.041666667	3.041666667	
Tributary Area =	24.33	12.17	8.11	
Dead Load on Attachment =	73.00	36.50	24.33	
Footing Uplift (0.6D+0.6W) =	-310 lb	-195 lb	-130 lb	

Standoff Uplift Calculations-Landscape				
	Zone 1	Zone 2	Zone 3	Positive
G_{Cp} =	-0.94	-1.15	-1.15	0.86
Uplift Pressure =	-14.55 psf	-17.80 psf	-17.80 psf	10.5 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) =	-238 lb	-149 lb	-100 lb	

Standoff Uplift Check
Maximum Design Uplift = -310 lb
Standoff Uplift Capacity = 450 lb
450 lb capacity > 310 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 > 310 lb demand Therefore, OK



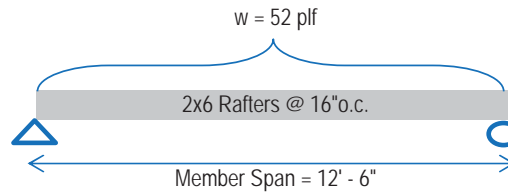
Framing Check

(MP1&2)

PASS

Dead Load 15.4 psf
 PV Load 3.9 psf
 Live Load 20.0 psf

Governing Load Combo = DL + LL
Total Load 39.3 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	C _d	x	C _f	x	C _r	(NDS Table 4.3.1)
	900	x	1.25	x	1.3	x	1.15	
Allowed Bending Stress = 1681.8 psi								

Maximum Moment = $(wL^2) / 8$
 = 1023.474 ft#
 = 12281.69 in#

Actual Bending Stress = (Maximum Moment) / S
 = 1624.1 psi

Allowed > Actual -- 96.6% Stressed -- Therefore, OK

Check Deflection		
Allowed Deflection (Total Load) =	$L/180$	(E = 1600000 psi Per NDS)
	= 0.833 in	
Deflection Criteria Based on =	Continuous Span	
Actual Deflection (Total Load) =	$(wL^4) / (185E*I)$	
	= 0.360 in	
	$L/417 > L/180$	Therefore OK
Allowed Deflection (Live Load) =	$L/240$	
	0.625 in	
Actual Deflection (Live Load) =	$(wL^4) / (185E*I)$	
	0.183 in	
	$L/820 > L/240$	Therefore OK

Check Shear		
Member Area = 8.3 in ²	F _v (psi) = 180 psi	(NDS Table 4A)
Allowed Shear = F _v * A = 1485 lb	Max Shear (V) = w * L / 2 =	328 lb

Allowed > Actual -- 22.1% Stressed -- Therefore, OK