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

November 14, 2023

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

Subject: Certification Letter
Skinner Residence
12933 NC-27
Broadway, NC. 27505

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&3) consist of metal roofing on 1x decking 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 14'-6", with a slope of 23 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&3) 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 32" o.c. for landscape and 32" o.c. for portrait orientation, with a staggered pattern to ensure proper distribution of loads. Contractor to field verify the metal roofing has a minimum thickness of 26 ga.

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 Ss<.4g and Seismic Design Category (SDC) < B

Design Criteria:

- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE 7-10
- Roof Dead Load = 6 psf (MP1,2&3)
- 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: S-5! Proteabracket w/ (4) 6mmx25mm self-piercing screw directly into metal roofing, at spacing shown above.

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

Digitally signed by John A. Calvert
Date: 2023.11.14 10:14:42 -07'00'

Sincerely,

John Calvert, P.E.
Project Engineer

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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)
Cs = Slope Factor =	1	
p_s = Sloped Roof Snow Load =	10.5 psf	

PV Dead Load = 3 psf (Per Blue Raven Solar)	
DL Adjusted to 23 Degree Slope	3.26 psf
PV System Weight	
Weight of PV System (Per Blue Raven Solar)	3.0 psf
X Standoff Spacing =	2.67 ft
Y Standoff Spacing =	3.04 ft
Standoff Tributary Area =	8.11 sft
Point Loads of Standoffs	24 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&3)		
Metal Roofing	1.00	
1x Decking	3.00	
2x6 Rafters @ 16"o.c.	1.72	
Vaulted Ceiling	0.00	(Ceiling Not Vaulted)
Miscellaneous	0.28	
Total Roof DL (MP1,2&3)	6.0 psf	
DL Adjusted to 23 Degree Slope	6.5 psf	

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Wind Calculations

Per ASCE 7-10 Components and Cladding

Input Variables	
Wind Speed	115 mph
Exposure Category	C
Roof Shape	Hip/Gable
Roof Slope	23 degrees
Mean Roof Height	20 ft
Effective Wind Area	21.3 ft

Design Wind Pressure Calculations		
Wind Pressure P = qh*G*Cn		
qh = 0.00256 * Kz * Kzt * Kd * V^2		(Eq. 30.3-1)
Kz (Exposure Coefficient) =	0.9	(Table 30.3-1)
Kzt (topographic factor) =	1	(Fig. 26.8-1)
Kd (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	
GCp =	-0.85	-1.52	-2.42	0.43	(Fig. 30.4-1)
Uplift Pressure =	-13.20 psf	-23.67 psf	-37.59 psf	11.1 psf	
X Standoff Spacing =	2.67	2.67	1.78		
Y Standoff Spacing =	3.04	3.041666667	3.04166667		
Tributary Area =	8.11	8.11	5.41		
Dead Load on Attachment=	24.33	24.33	16.22		
Footing Uplift (0.6D+0.6W)=	-92 lb	-177 lb	-194 lb		

Standoff Uplift Calculations-Landscape					
	Zone 1	Zone 2	Zone 3	Positive	
GCp =	-0.85	-1.52	-2.42	0.43	(Fig. 30.4-1)
Uplift Pressure =	-13.20 psf	-23.67 psf	-37.59 psf	10.0 psf	(Minimum)
X Standoff Spacing =	2.67	2.67	1.78		
Y Standoff Spacing =	1.75	1.75	1.75		
Tributary Area =	4.67	4.67	3.11		
Dead Load on Attachment=	14.00	14.00	9.33		
Footing Uplift (0.6D+0.6W) =	-53 lb	-102 lb	-111 lb		

Standoff Uplift Check	
Maximum Design Uplift =	-194 lb
Standoff Uplift Capacity =	250 lb
250 lb capacity > 194 lb demand	Therefore, OK

Fastener Capacity Check	
Fastener =	4 - 6mmx25mm
Number of Fasteners =	4
Embedment Depth =	0
Pullout Capacity Per Inch =	lb
Fastener Capacity =	lb
w/ F.S. of 1.5 & DOL of 1.6=	lb
Error -	Footing Uplift Too High

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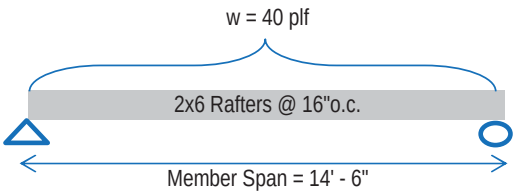
Framing Check

(MP1,2&3) PASS

Dead Load	6.5	psf
PV Load	3.3	psf
Live Load	20.0	psf

Governing Load Combo = DL + LL
Total Load 29.8 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
= 1043.444 ft#
= 12521.33 in#

Actual Bending Stress = (Maximum Moment) / S
= 1655.8 psi

Allowed > Actual -- 98.5% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = L/120 (E = 1600000 psi Per NDS)
= 1.45 in

Deflection Criteria Based on = Simple Span
Actual Deflection (Total Load) = (5*w*L^4) / (384*E*I)
= 1.187 in
= L/147 > L/120 Therefore OK

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

Actual Deflection (Live Load) = (5*w*L^4) / (384*E*I)
0.799 in
L/218 > 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 = 288 lb

Allowed > Actual -- 19.4% Stressed -- Therefore, OK