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

June 8, 2022

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

Subject: Certification Letter
Moreton Residence
86 Gwendolyn Way
Fuquay Varina, NC. 27526

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 2x8 rafters @ 16"o.c.. The rafters support a vaulted ceiling and have a max projected horizontal span of 16'-0", with a slope of 23 degrees. The rafters are supported at the ridge by a ridge beam and at the eave by a load bearing wall.

The roof structure of (MP3) consists of composition shingle on roof plywood that is supported by nominal 2x8 rafters @ 16"o.c. with ceiling joists acting as rafter ties. The rafters have a max projected horizontal span of 17'-0", with a slope of 39 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 existing roof framing system of (MP3) is 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 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 = 13 psf (MP1&2) -- 9 psf (MP3)
- Roof Live Load = 20 psf
- Wind Speed = 117 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,

Digitally signed by John A. Calvert
Date: 2022.06.09 08:41:02 -06'00'

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 =	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 areas covered by PV array.

Roof Dead Load (MP1&2)	
Composition Shingle	4.00
Roof Plywood	2.00
2x8 Rafters @ 16"o.c.	2.27
Vaulted Ceiling	4.00
Miscellaneous	0.73
Total Roof DL (MP1&2)	**13.0 psf**
DL Adjusted to 23 Degree Slope	14.1 psf

Roof Dead Load (MP3)		
Composition Shingle	4.00	
Roof Plywood	2.00	
2x8 Rafters @ 16"o.c.	2.27	
Vaulted Ceiling	0.00	(Ceiling Not Vaulted)
Miscellaneous	0.73	
Total Roof DL (MP3)	**9.0 psf**	
DL Adjusted to 39 Degree Slope	11.58	

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Wind Calculations

Per ASCE 7-10 Components and Cladding

Input Variables	
Wind Speed	117 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) =	117 mph	(Fig. 26.5-1A)
Risk Category =	II	(Table 1.5-1)
qh =	26.81	
0.6 * qh =	16.09	

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 =	-13.66 psf	-24.50 psf	-38.91 psf	11.5 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)=	**-289 lb**	**-276 lb**	**-301 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 =	-13.66 psf	-24.50 psf	-38.91 psf	10.0 psf	(Minimum)
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) =	**-221 lb**	**-212 lb**	**-231 lb**		

Standoff Uplift Check	
Maximum Design Uplift =	-301 lb
Standoff Uplift Capacity =	450 lb
450 lb capacity > 301 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 > 301 lb demand	**Therefore, OK**

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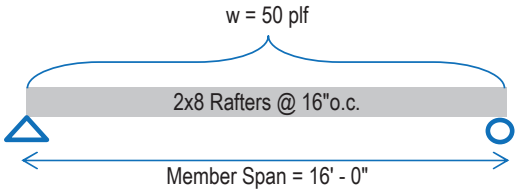
Framing Check

(MP1&2) **PASS**

Dead Load	14.1 psf
PV Load	3.3 psf
Live Load	20.0 psf

Governing Load Combo = DL + LL
Total Load **37.4 psf**



Member Properties

Member Size	S (in^3)	I (in^4)	Lumber Sp/Gr	Member Spacing
2x8	13.14	47.63	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	1.2	x	1.15	

Allowed Bending Stress = 1552.5 psi

Maximum Moment = (wL^2) / 8
= 1594.955 ft#
= 19139.46 in#

Actual Bending Stress = (Maximum Moment) / S
= 1456.6 psi

Allowed > Actual -- 93.9% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = L/180 (E = 1600000 psi Per NDS)
= 1.066 in

Deflection Criteria Based on = Simple Span

Actual Deflection (Total Load) = (5*w*L^4) / (384*E*I)
= 0.965 in
= L/199 > L/180 **Therefore OK**

Allowed Deflection (Live Load) = L/240
0.8 in

Actual Deflection (Live Load) = (5*w*L^4) / (384*E*I)
0.517 in
L/372 > L/240 **Therefore OK**

Check Shear

Member Area = 10.9 in^2 Fv (psi) = 180 psi (NDS Table 4A)

Allowed Shear = Fv * A = 1958 lb Max Shear (V) = w * L / 2 = 399 lb

Allowed > Actual -- 20.4% Stressed -- Therefore, OK

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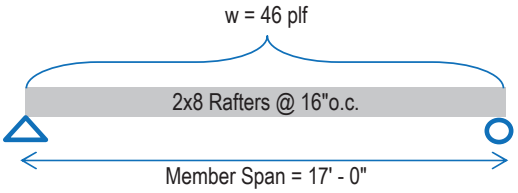
Framing Check

(MP3) **PASS**

Dead Load	11.6	psf
PV Load	3.3	psf
Live Load	20.0	psf

Governing Load Combo = DL + LL
Total Load **34.8 psf**



Member Properties

Member Size	S (in^3)	I (in^4)	Lumber Sp/Gr	Member Spacing
2x8	13.14	47.63	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	1.2	x	1.15	

Allowed Bending Stress = 1552.5 psi

Maximum Moment = (wL^2) / 8
= 1678.123 ft#
= 20137.47 in#

Actual Bending Stress = (Maximum Moment) / S
= 1532.5 psi

Allowed > Actual - 98.8% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = L/180 (E = 1600000 psi Per NDS)
= 1.133 in

Deflection Criteria Based on = Continuous Span

Actual Deflection (Total Load) = (w*L^4) / (185*E*I)
= 0.476 in
= L/429 > L/180 **Therefore OK**

Allowed Deflection (Live Load) = L/240
0.85 in

Actual Deflection (Live Load) = (w*L^4) / (185*E*I)
0.274 in
L/745 > L/240 **Therefore OK**

Check Shear

Member Area = 10.9 in^2 Fv (psi) = 180 psi (NDS Table 4A)

Allowed Shear = Fv * A = 1958 lb Max Shear (V) = w * L / 2 = 395 lb

Allowed > Actual -- 20.2% Stressed -- Therefore, OK