May 2, 2021

To: Blue Raven Solar
        1220 S. 630 E. Ste. 430
        American Fork, UT. 84003

Subject: Certification Letter
           Jones Residence
           5088 Christian Light Rd
           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 attached structural calculations are based on these observations and the design criteria listed below.

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, including the plans and calculations only apply 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.

The roof structure of (MP1) consists of composition shingle on 1x decking that is supported by 2x5 rafters @ 16"o.c. with ceiling joists acting as rafter ties. The rafters have a max projected horizontal span of 13'-5", with a slope of 16 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 system of (MP1) 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.

Design Criteria:
- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE7-10, and NDS-12
- Roof Dead Load = 8 psf (MP1)
- Roof Live Load = 20 psf
- Wind Speed = 115 mph, Exposure C
- Ground Snow Load = 15 psf - Roof Snow Load = 10.5 psf
- Attachments: (1) 5/16" dia lag screw with 2.5" 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
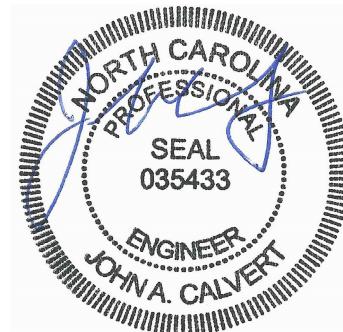
NORTH CAROLINA
PROFESSIONAL
SEAL
035433
ENGINEER
JOHN A. CALVERT

Wind Calculations

Per ASCE7-10 Components and Cladding

Input Variables	
Wind Speed	115 mph
Exposure Category	C
Roof Shape	Gable/Hip
Roof Slope	16 degrees
Mean Roof Height	20 ft
Effective Wind Area	19.3 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	-1.55	-2.44	0.38	(Fig. 30.4-1)
Uplift Pressure =	-13.25 psf	-24.04 psf	-37.98 psf	10.0 psf	(Minimum)
X Standoff Spacing =	4.00	4.00	2.67		
Y Standoff Spacing =	5.50	2.75	2.75		
Tributary Area =	22.00	11.00	7.33		
Dead Load on Attachment=	66.00	33.00	22.00		
Footing Uplift (0.6D+0.6W) =	**-252 lb**	**-245 lb**	**-265 lb**		

Standoff Uplift Calculations-Landscape					
	Zone 1	Zone 2	Zone 3	Positive	
GCp =	-0.85	-1.55	-2.44	0.38	(Fig. 30.4-1)
Uplift Pressure =	-13.25 psf	-24.04 psf	-37.98 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)=	**-214 lb**	**-208 lb**	**-225 lb**		

Standoff Uplift Check
Maximum Design Uplift = -265 lb
Standoff Uplift Capacity = 450 lb
450 lb capacity > 265 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 > 265 lb demand **Therefore, OK**

Gravity Loading

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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)

PV System Weight	
Weight of PV System (Per Blue Raven Solar)	3.0 psf
X Standoff Spacing =	4.00 ft
Y Standoff Spacing =	5.50 ft
Standoff Tributary Area =	22.00 sft
Point Loads of Standoffs	**66 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)		
Composition Shingle	3.00	
1x Decking	3.00	
2x5 Rafters @ 16"o.c.	1.41	
Vaulted Ceiling	0.00	(Ceiling Not Vaulted)
Miscellaneous	0.59	
Total Roof DL (MP1)	**8.0 psf**	
DL Adjusted to 16 Degree Slope	8.3 psf	

Framing Check

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| **(MP1)** | **PASS** |

w = 29 plf

Dead Load	8.3 psf
PV Load	3.0 psf
Snow Load	10.5 psf

2x5 Rafters @ 16"o.c.

Governing Load Combo = DL + SL

Total Load   **21.8 psf**
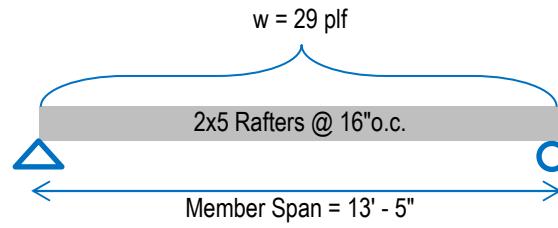
Member Span = 13' - 5"

Member Properties				
Member Size	S (in^3)	I (in^4)	Lumber Sp/Gr	Member Spacing
2x5	5.06	11.39	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	1.15	x	1.3	x	1.15	

Allowed Bending Stress = 1551.9419 psi

Maximum   Moment   = (wL^2) / 8

= 654.6971 ft#

= 7856.365 in#

Actual Bending Stress = (Maximum Moment) / S

= 1551.9 psi

Allowed > Actual -- 100% Stressed -- Therefore, OK

Check Deflection

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

= 1.341 in

Deflection Criteria Based on   =   Simple Span

Actual Deflection (Total Load)   =   (5*w*L^4) / (384*E*I)

= 1.164 in

= L/139   >   L/120   **Therefore OK**

Allowed Deflection (Live Load) =   L/180

0.894 in

Actual Deflection (Live Load)   =   (5*w*L^4) / (384*E*I)

0.561 in

L/287   >   L/180   **Therefore OK**

Check Shear

Member Area = 6.8 in^2	Fv (psi) = 180 psi	(NDS Table 4A)
Allowed Shear = Fv * A = 1215 lb	Max Shear (V) = w * L / 2 = 195 lb	

Allowed > Actual -- 16.1% Stressed -- Therefore, OK