



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

May 1, 2023

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

Subject: Certification Letter  
Morgan Residence  
226 Josey Williams Rd  
Erwin, NC. 28339

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 composition shingle on roof plywood that is supported by pre-manufactured trusses that are spaced at @ 24"o.c.. The top chords, sloped at 27 degrees, are 2x4 sections, the bottom chords are 2x4 sections and the web members are 2x4 sections. The truss members are connected by steel gusset plates. The max unsupported projected horizontal top chord span is approximately 7'-3".

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 72" 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 = 7 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: 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: 2023.05.01  
11:38:03 -06'00'



**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               |                     |
| <b><math>p_s</math> = Sloped Roof Snow Load =</b> | <b>10.5 psf</b> |                     |

| PV Dead Load = 3 psf (Per Blue Raven Solar)                               |              |
|---|--------------|
| DL Adjusted to 27 Degree Slope  | 3.37 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    |
| <b>Point Loads of Standoffs</b>   | <b>73 lb</b> |
| 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)           |                |                       |
|------------------------------------|----------------|-----------------------|
| Composition Shingle                | 4.00           |                       |
| Roof Plywood                       | 2.00           |                       |
| 2x4 Top Chords @ 24"o.c.           | 0.73           |                       |
| Vaulted Ceiling                    | 0.00           | (Ceiling Not Vaulted) |
| Miscellaneous                      | 0.27           |                       |
| <b>Total Roof DL (MP1,2&amp;3)</b> | <b>7.0 psf</b> |                       |
| DL Adjusted to 27 Degree Slope     | 7.9 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          | 27 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 =                  | 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)=           | -277 lb    | -266 lb     | -290 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 =                   | 6.00       | 6.00       | 4.00       |          |               |
| Y Standoff Spacing =                   | 3.50       | 1.75       | 1.75       |          |               |
| Tributary Area =                       | 21.00      | 10.50      | 7.00       |          |               |
| Dead Load on Attachment=               | 63.00      | 31.50      | 21.00      |          |               |
| Footing Uplift (0.6D+0.6W) =           | -239 lb    | -230 lb    | -251 lb    |          |               |

| Standoff Uplift Check                                |         |
|--|---------|
| Maximum Design Uplift =                              | -290 lb |
| Standoff Uplift Capacity =                           | 450 lb  |
| 450 lb capacity > 290 lb demand <b>Therefore, OK</b> |         |

| 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 > 290 lb demand <b>Therefore, OK</b> |        |



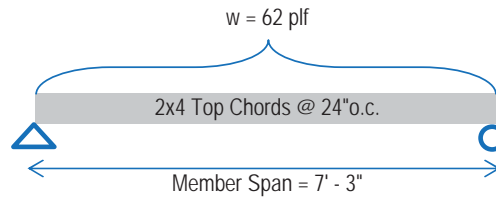
**Framing Check**

(MP1,2&3)

PASS

Dead Load 7.9 psf  
 PV Load 3.4 psf  
 Live Load 20.0 psf

Governing Load Combo = DL + LL  
**Total Load 31.2 psf**



| Member Properties |                      |                      |              |                |
|-------------------|----------------------|----------------------|--------------|----------------|
| Member Size       | S (in <sup>3</sup> ) | I (in <sup>4</sup> ) | Lumber Sp/Gr | Member Spacing |
| 2x4               | 3.06                 | 5.36                 | DF#2         | @ 24"o.c.      |

| Check Bending Stress |                |   |                |   |                |   |                |
|----------------------|----------------|---|----------------|---|----------------|---|----------------|
| Fb (psi) =           | f <sub>b</sub> | x | C <sub>d</sub> | x | C <sub>f</sub> | x | C <sub>r</sub> |
|                      | 900            | x | 1.25           | x | 1.5            | x | 1.15           |

(NDS Table 4.3.1)

Allowed Bending Stress = 1940.6 psi

Maximum Moment = (wL<sup>2</sup>) / 8  
 = 410.2932 ft#  
 = 4923.518 in#

Actual Bending Stress = (Maximum Moment) / S  
 = 1607.7 psi

Allowed > Actual -- 82.9% Stressed -- Therefore, OK

**Check Deflection**

Allowed Deflection (Total Load) = L/180 (E = 1600000 psi Per NDS)  
 = 0.483 in

Deflection Criteria Based on = Continuous Span  
 Actual Deflection (Total Load) = (w\*L<sup>4</sup>) / (185\*E\*I)  
 = 0.188 in  
 = L/463 > L/180 **Therefore OK**

Allowed Deflection (Live Load) = L/240  
 = 0.362 in  
 Actual Deflection (Live Load) = (w\*L<sup>4</sup>) / (185\*E\*I)  
 = 0.121 in  
 = L/720 > L/240 **Therefore OK**

**Check Shear**

Member Area = 5.3 in<sup>2</sup> F<sub>v</sub> (psi) = 180 psi (NDS Table 4A)  
 Allowed Shear = F<sub>v</sub> \* A = 945 lb Max Shear (V) = w \* L / 2 = 226 lb

Allowed > Actual -- 24% Stressed -- Therefore, OK