



BLUE RAVEN SOLAR, LLC.
Firm License No. D-0369
1403 North Research Way , Bldg. J
Orem, UT 84097

April 2, 2021

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

Subject: Certification Letter
Weaver Residence
145 Allwood Dr
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&2) consists 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 35 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'-0".

The existing roof framing system 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 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.

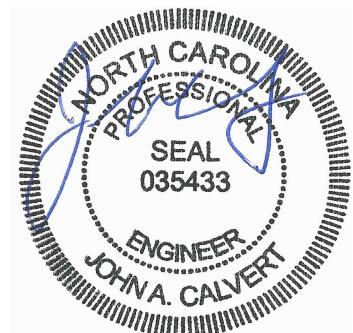
Design Criteria:

- Applicable Codes = 2018 North Carolina State Building Code (NCSBC), ASCE7-10, and NDS-12
- Roof Dead Load = 7 psf (MP1&2)
- 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





Wind Calculations

Per ASCE7-10 Components and Cladding

| Input Variables | |
|---------------------|------------|
| Wind Speed | 115 mph |
| Exposure Category | C |
| Roof Shape | Gable/Hip |
| Roof Slope | 35 degrees |
| Mean Roof Height | 20 ft |
| Effective Wind Area | 19.3 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 |
| $G C_p =$ | -0.88 | -1.08 | -1.08 | 0.84 |
| Uplift Pressure = | -13.61 psf | -16.72 psf | -16.72 psf | 21.7 psf |
| 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 | |
| Footing Uplift = | -299 lb | -184 lb | -123 lb | |

| Standoff Uplift Calculations-Landscape | | | | |
|--|----------------|----------------|----------------|----------|
| | Zone 1 | Zone 2 | Zone 3 | Positive |
| $G C_p =$ | -0.88 | -1.08 | -1.08 | 0.84 |
| Uplift Pressure = | -13.61 psf | -16.72 psf | -16.72 psf | 10.0 psf |
| 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 | |
| Footing Uplift = | -286 lb | -176 lb | -117 lb | |

| Standoff Uplift Check | |
|---------------------------------|----------------------|
| Maximum Design Uplift = | -299 lb |
| Standoff Uplift Capacity = | 450 lb |
| 450 lb capacity > 299 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 > 299 lb demand | Therefore, OK |



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) | |
|---|--------------|
| 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&2) | | |
|----------------------------------|----------------|-----------------------|
| 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 | |
| Total Roof DL (MP1&2) | 7.0 psf | |
| DL Adjusted to 35 Degree Slope | 8.5 psf | |

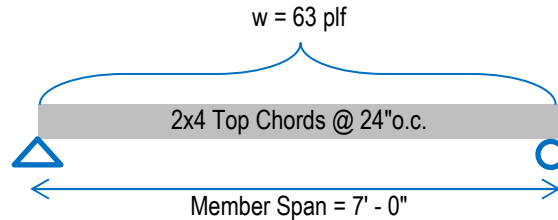


Framing Check

(MP1&2)

PASS

Dead Load 8.5 psf
 PV Load 3.0 psf
 Live Load 20.0 psf



Governing Load Combo = DL + LL
Total Load 31.5 psf

Member Properties

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

Check Bending Stress

$$F_b \text{ (psi)} = f_b \times C_d \times C_f \times C_r \quad \text{(NDS Table 4.3.1)}$$

$$900 \times 1.25 \times 1.5 \times 1.15$$

Allowed Bending Stress = 1940.6 psi

Maximum Moment = $(wL^2) / 8$
 = 386.4314 ft#
 = 4637.177 in#

Actual Bending Stress = (Maximum Moment) / S
 = 1514.2 psi

Allowed > Actual -- 78.1% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = $L/180$ (E = 1600000 psi Per NDS)
 = 0.466 in

Deflection Criteria Based on = Continuous Span
 Actual Deflection (Total Load) = $(wL^4) / (185 \times E \times I)$
 = 0.166 in
 $L/507 > L/180$ **Therefore OK**

Allowed Deflection (Live Load) = $L/240$
 0.35 in
 Actual Deflection (Live Load) = $(wL^4) / (185 \times E \times I)$
 0.105 in
 $L/800 > L/240$ **Therefore OK**

Check Shear

Member Area = 5.3 in² F_v (psi) = 180 psi (NDS Table 4A)
 Allowed Shear = F_v * A = 945 lb Max Shear (V) = w * L / 2 = 221 lb

Allowed > Actual -- 23.4% Stressed -- Therefore, OK