VSE Project Number: U2305.0958.211

June 9, 2021

G3 Solar
ATTENTION: Brandon Peterson
272 W 200 N Suite 200
Lindon, UT 84042

**REFERENCE: Jennifer Ead Residence: 67 Senter Farm Court, Fuquay-Varina, NC 27526**
**Solar Array Installation**

To Whom It May Concern:

Per your request, Cameron Alworth, a representative of Vector Structural Engineering, LLC performed a site visit at the address above on June 8, 2021. The purpose of the visit was to observe the existing framing and determine the adequacy of the existing structure to support the proposed installation of solar panels on the roof.

Based upon our review, we conclude that the existing structure is adequate to support the proposed solar panel installation.

**Design Parameters**

Code: North Carolina Building Code, 2018 Edition (2015 IBC)
Risk Category: II
Design wind speed, Vult: 116 mph (3-sec gust) per ASCE 7-10
Wind exposure category: C
Ground snow load, Pg: 15 psf

**Existing Roof Structure**

Roof structure: 2x6 rafters @ 16" o.c.
Roofing material: composite shingles
Roof slope: 30°

**Connection to Roof**

Mounting connection: (1) 5/16" lag screw w/ min. 2.5" threaded embedment into framing at max. 48" o.c. along rails
(2) rails per row of panels, evenly spaced; panel length perpendicular to the rails not to exceed 67 in. Rail cantilever shall not exceed 50% of connection spacing.

**Conclusions**

Based upon our review, we conclude that the existing structure is adequate to support the proposed solar panel installation. In the area of the solar array, other live loads will not be present or will be greatly reduced (2018 NCBC, Section 1607.12.5). The gravity loads, and thus the stresses of the structural elements, in the area of the solar array are either decreased or increased by no more than 5%. Therefore, the requirements of Section 807.4 of the 2018 NCEBC (2015 IEBC) are met and the structure is permitted to remain unaltered.

The solar array will be flush-mounted (no more than 10" above the roof surface) and parallel to the roof surface. Thus, we conclude that any additional wind loading on the structure related to the addition of the proposed solar array is negligible. The attached calculations verify the capacity of the connections of the solar array to the existing roof against wind (uplift), the governing load case. Because the increase in lateral forces is less than 10%, this addition meets the requirements of the exception in Section 807.5 of the 2018 NCEBC (2015 IEBC). Thus the existing lateral force resisting system is permitted to remain unaltered.

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**Limitations**

Installation of the solar panels must be performed in accordance with manufacturer recommendations. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. The contractor must notify Vector Structural Engineering, LLC should any damage, deterioration or discrepancies between the as-built condition of the structure and the condition described in this letter be found. Connections to existing roof framing must be staggered, except at array ends, so as not to overload any existing structural member. The use of solar panel support span tables provided by others is allowed only where the building type, site conditions, site-specific design parameters, and solar panel configuration match the description of the span tables. The design of the solar panel racking (mounts, rails, etc.) and electrical engineering is the responsibility of others. Waterproofing around the roof penetrations is the responsibility of others. Vector Structural Engineering assumes no responsibility for improper installation of the solar array.

VECTOR STRUCTURAL ENGINEERING, LLC
NC Firm License: COA #P-0742


06/09/2021

Russell Emery, P.E.
NC License: 049874 - Expires: 12/31/2021
Project Engineer

Enclosures

RNE/ard

**JOB NO.:** U2305.0958.211
**SUBJECT:** WIND PRESSURE

**PROJECT:** Jennifer Ead Residence

**Components and Cladding Wind Calculations**

Label: Solar Panel Array

Note: Calculations per ASCE 7-10

## SITE-SPECIFIC WIND PARAMETERS:

| | |
|---|---|
| Basic Wind Speed [mph]: | 116 |
| Exposure Category: | C |
| Risk Category: | II |

Notes:

## ADDITIONAL INPUT & CALCULATIONS:

| | | |
|---|---|---|
| Height of Roof, h [ft]: | 15 | (Approximate) |
| Comp/Cladding Location: | Gable Roofs 27° < θ ≤ 45° | |
| Enclosure Classification: | Enclosed Buildings | |
| Zone 1 $GC_p$: | 1.0 | Figure 30.4-2C (enter negative pressure coefficients) |
| Zone 2 $GC_p$: | 1.2 | |
| Zone 3 $GC_p$: | 1.2 | |
| α: | 9.5 | Table 26.9-1 |
| $z_g$ [ft]: | 900 | Table 26.9-1 |
| $K_h$: | 0.85 | Table 30.3-1 |
| $K_{zt}$: | 1 | Equation 26.8-1 |
| $K_d$: | 0.85 | Table 26.6-1 |
| Velocity Pressure, $q_h$ [psf]: | 24.9 | Equation 30.3-1 |
| $GC_{pi}$: | 0 | Table 26.11-1 |

## PRESSURES:

$$p = q_h\left[(GC_p)-(GC_{pi})\right]$$ Equation 30.9-1

| | | |
|---|---|---|
| Zone 1, p [psf]: | 24.6 | psf (1.0 W, Interior Zones, beyond 'a' from roof edge) |
| Zone 2, p [psf]: | 29.6 | psf (1.0 W, End Zones, within 'a' from roof edge) |
| Zone 3, p [psf]: | 29.6 | psf (1.0 W, Corner Zones, within 'a' from roof corner) (a= 3 ft) |

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**SUBJECT:** CONNECTION

**PROJECT:** Jennifer Ead Residence

## Calculate Uplift Forces on Connection

| | Pressure (0.6 Dead -0.6 Wind) (psf) | Max Trib. Width[1] (ft) | Max Trib. Area[2] ($ft^2$) | Max Uplift Force (lbs) |
|---|---|---|---|---|
| Zone 1 | 13.0 | 4.0 | 11.2 | 145 |
| Zone 2 | 15.9 | 4.0 | 11.2 | 178 |
| Zone 3 | 15.9 | 4.0 | 11.2 | 178 |

## Calculate Connection Capacity

| | | |
|---|---|---|
| Lag Screw Size [in]: | 5/16 | |
| $C_d$: | 1.6 | NDS Table 2.3.2 |
| Embedment[3] [in]: | 2.5 | |
| Grade: | SPF (G = 0.42) | |
| Nominal Capacity [lbs/in]: | 205 | NDS Table 12.2A |
| Number of Screws: | 1 | |
| Prying Coefficient: | 1.4 | |
| Total Capacity [lbs]: | 586 | |

## Determine Result

| | |
|---|---|
| Maximum Demand [lbs]: | 178 |
| Lag Screw Capacity [lbs]: | 586 |

Result: **Capacity > Demand, Connection is adequate.**

## Notes

1. 'Max Trib. Width' is the width along the rails tributary to the connection.
2. 'Max Trib Area' is the product of the 'Max. Trib Width' and 1/2 the panel width/height perpendicular to the rails. (2) rails per row of panels. Length of panels perpendicular to the rails shall not exceed 67".
3. Embedment is measured from the top of the framing member to the beginning of the tapered tip of the lag screw. Embedment in sheathing or other material is not effective. The length of the tapered tip is not part of the embedment length.

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**SUBJECT:** GRAVITY LOADS

**PROJECT:** Jennifer Ead Residence

## GRAVITY LOADS

Roof Pitch: 6.9 :12

| ROOF DEAD LOAD (D) | Design material weight [psf] | Increase due to pitch | Material weight [psf] |
|---|---|---|---|
| Composite Shingles | 2.3 | 1.15 | 2.0 |
| 1/2" Plywood | 1.2 | 1.15 | 1.0 |
| Framing | 3.0 | | 3.0 |
| Insulation | 0.0 | | 0.0 |
| 1/2" Gypsum Clg. | 0.0 | 1.15 | 0.0 |
| M, E & Misc | 0.0 | | 0.0 |
| Total Existing Roof DL | 6.5 | | |
| PV Array DL | 3.5 | 1.15 | 3 |

## ROOF LIVE LOAD (Lr)

| | | |
|---|---|---|
| Existing Design Roof Live Load [psf] | 20 | ASCE 7-10 Table 4-1 |
| Roof Live Load With PV Array [psf] | 0 | 2018 NCBC, Section 1607.12.5 |

| SNOW LOAD (S): | Existing | w/ Solar Array | |
|---|---|---|---|
| Roof Slope [x:12]: | 6.9 | 6.9 | |
| Roof Slope [°]: | 30 | 30 | |
| Ground Snow Load, $p_g$ [psf]: | 15 | 15 | ASCE 7-10, Section 7.2 |
| Terrain Category: | C | C | ASCE 7-10, Table 7-2 |
| Exposure of Roof: | Fully Exposed | Fully Exposed | ASCE 7-10, Table 7-2 |
| Exposure Factor, $C_e$: | 0.9 | 0.9 | ASCE 7-10, Table 7-2 |
| Thermal Factor, $C_t$: | 1.1 | 1.1 | ASCE 7-10, Table 7-3 |
| Risk Category: | II | II | ASCE 7-10, Table 1.5-1 |
| Importance Factor, $I_s$: | 1.0 | 1.0 | ASCE 7-10, Table 1.5-2 |
| Flat Roof Snow Load, $p_f$ [psf]: | 10 | 10 | ASCE 7-10, Equation 7.3-1 |
| Minimum Roof Snow Load, $p_m$ [psf]: | 0 | 0 | ASCE 7-10, Section 7.3.4 |
| Unobstructed Slippery Surface? | No | No | ASCE 7-10, Section 7.4 |
| Slope Factor Figure: | Figure 7-2b | Figure 7-2b | ASCE 7-10, Section 7.4 |
| Roof Slope Factor, $C_s$: | 1.00 | 1.00 | ASCE 7-10, Figure 7-2 |
| Sloped Roof Snow Load, $p_s$ [psf]: | 10 | 10 | ASCE 7-10, Equation 7.4-1 |
| Design Snow Load, S [psf]: | 10 | 10 | |

**JOB NO.:** U2305.0958.211
**SUBJECT:** LOAD COMPARISON

**PROJECT:** Jennifer Ead Residence

Summary of Loads

| | Existing | With PV Array |
|---|---|---|
| D [psf] | 6 | 10 |
| Lr [psf] | 20 | 0 |
| S [psf] | 10 | 10 |

Maximum Gravity Loads:

| | Existing | With PV Array | |
|---|---|---|---|
| (D + Lr) / Cd [psf] | 21 | 11 | ASCE 7-10, Section 2.4.1 |
| (D + S) / Cd [psf] | 15 | 18 | ASCE 7-10, Section 2.4.1 |

(Cd = Load Duration Factor = 0.9 for D, 1.15 for S, and 1.25 for Lr)

| | | |
|---|---|---|
| Maximum Gravity Load [psf]: | 21 | 18 |

Ratio Proposed Loading to Current Loading: **83%** **OK**

**The gravity loads, and thus the stresses of the structural elements, in the area of the solar array are either decreased or increased by no more than 5%. Therefore, the requirements of Section 807.4 of the 2018 NCEBC (2015 IEBC) are met and the structure is permitted to remain unaltered.**