# La Luz Engineering, PLLC

February 18, 2022

**SolarTyme**
6710 Jefferson Davis Hwy
Richmond, VA 23237

**Re: Structural Review of Existing Roof for New Photovoltaic Panel Installation**
***Fenmore Residence – 22 Hallmark Dr, Spring Lake, NC 28390***

Per your request, we have reviewed the existing roof framing which will receive new solar panel arrays for this project. This review was performed in accordance with the provisions of the 2018 North Carolina Residential Code, 2018 North Carolina Existing Building Code and American Wood Council National Design Specification (NDS) for Wood Construction 2015 Edition. Moreover, the review evaluates the ability of the existing structure to handle gravitational loads and wind uplift loads from the addition of the proposed PV system. The calculations on the following pages detail the modifications to gravitational loading and wind uplift respectively.

The existing roof framing members are 2" x 4" wood trusses at 24" on center. The roofing material is composite shingle. There are twenty-two 365W photovoltaic modules which will be installed on the roof of this residence. Ironridge railing and attachments will be used for this project.

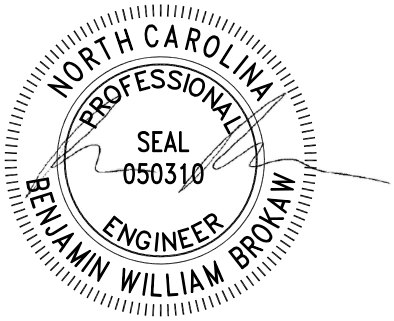
Per the ASD load calculations section of the calculations below, the PV system installation results in a decrease in loading to the existing roof structure. Based on this analysis the roof framing was found to adequately support the proposed PV system.

The proposed PV system roof attachments are 4.75" x 5/16" Diameter lag bolts at a 48" maximum attachment spacing. The calculations in the *Uplift Capacity* section of the calculations demonstrate the lag bolts will provide adequate resistance to uplift based on a 2.5-inch embedment depth. This analysis is based on the American Wood Council National Design Specification (NDS) for Wood Construction 2015 Edition.

Structural analysis of the entire structure was not completed, and we are not the original Engineer of Record for this residence. We did not inspect the residence and all roof framing dimensions are based on the contractor's site analysis and plan drawings. Our structural review was limited to analyzing the existing structural roof members for the addition of the photovoltaic panels, based on our understanding of the existing residence, as described above. The truss connections have not been reviewed and the type and quality of wood used for construction is unknown. We are also not the Engineer of Record for the solar hardware, connections or layout. La Luz Engineering does not assume responsibility for improper installation of any solar hardware.

Regards,
**La Luz Engineering, PLLC**

Ben Brokaw, P.E.
Principal




*2/18/2022*

***Site Information***

| | |
|---|---|
| *Wind* | 120 mph |
| *Exposure* | C |
| *Lumber* | Southern Pine |
| *Grade* | No. 2 |
| *Modulus of Elasticity* | 1,400,000 |

***Panel Information***

| | | | |
|---|---|---|---|
| *Panel Type* | Aptos365W | | |
| *Panel Length* | | 69.1 | in |
| *Panel Width* | | 40.9 | in |
| *Panel Weight* | | 45.2 | lbs |

| | | | | |
|---|---|---|---|---|
| *Roof Material* | Composite Shingle | | | |
| *Roof Dead Load* | | $Q_D$ = | 10 | psf |
| *PV System Dead Load* | | $Q_{PV}$ = | 3 | psf |
| *Framing Spacing* | | $s_{roof}$ = | 24 | in |
| *Linear Dead Load* | $w_D = (Q_D + Q_{PV})^* s_{roof}$ = | | 20 | plf |

***Gravitational Loading***

**R324.4.1*

| | | | | |
|---|---|---|---|---|
| *Existing Live Load* | $LL_E$ = | 20 | psf | Table 1607.1 |
| *Existing Snow Load* | $SL_E$ = | 10 | psf | |
| *Existing Roof Dead Load* | $DL_E$ = | 10 | psf | |
| *Installed PV System Live Load* | $LL_{pv}$ = | 0 | psf | |
| *Installed PV System Snow Load* | $SL_{pv}$ = | 8 | psf | |
| *Installed PV System Total Dead Load* | $DL_{pv}$ = | 13 | psf | |

| *ASD Load Combinations* | Existing | Installed PV |
|---|---|---|
| *DL* | 10 psf | 13 psf |
| *DL + LL* | 30 psf | 13 psf |
| *DL + SL* | 20 psf | 21 psf |
| *DL + .75LL + .75SL* | 32.5 psf | 19 psf |

Maximum Existing Load $M_{el}$ 32.5 psf

Maximum Installed PV System Load $M_{pv}$ 21 psf

**$M_{el}$ > $M_{pv}$ {OK}**

***Uplift Demand / Lag Screw Check***

| | | | |
|---|---|---|---|
| *Mean Roof Height* | < | 30 | |
| Exposure | | C | |
| *Height & Exposure Adjustment Coefficient* | | 1.00 | Table 27.6-2 |
| *Effective Wind Area* | | 10 | $ft^2$ |
| *Design Wind Pressure (*most conservative value)* | p = | -78.00 | Table 27.6-2 |
| *Trib. Depth for Each Rail* | $d_{pv}$ = L/2 = | 2.88 | ft |
| *Trib. Depth for Each Rail* | $b_{pv}$ = W/2 = | 1.70 | ft |
| *Screw Anchor Spacing* | $S_{pv}$ = | 4 | ft (max) |
| *Uplift Force on Each Screw, Portrait* | $U_L = (p + Q_{pv}) * d_{pv} * s_{pv}$ = | -863.75 | lbs (Upwards) |
| *Uplift Force on Each Screw, Landscape* | $U_w = (p + Q_{pv}) * b_{pv} * s_{pv}$ = | -511.25 | lbs (Upwards) |

**Design Uplift Force** **$P_{uplift} = 0.6*[Max ( U_L , U_W)]$ = -518.25 lbs (Upwards)**

***Uplift Capacity***

*NDS 2015 Adjustment Factors*

$C_D$ = 1.6

$C_M$ = 1

$C_t$ = 1

*SG* = 0.55

| | | | | |
|---|---|---|---|---|
| *Lumber Specific Gravity* | SG = | 0.55 | NDS Supplement Table 4a | |
| *Lag Screw Diameter* | D = | 5/16 | in | |
| *Withdraw Design /in* | $1800*SG^{3/2}*D^{3/4}$ = | 307 | lbs/in | NDS 2015 12.1-1 |
| *Embedment Depth* | $l_p$ = | 2.5 | in | |
| *Total Nominal Withdrawal Value* | $W = W * l_p$ = | 767 | lbs | |
| *Withdrawal Design Value* | $W' = W * C_D * C_M * C_t$ = | 1227 | lbs | NDS 2015 Table 11.3.1 |

**Demand-Capacity Ratio** **P uplift / W' = 0.42 < 1 {OK}**