VSE Project Number: U2179-0710-191

February 6, 2019

Sigora Solar
1222 Harris Street
Charlottesville, VA 22903

REFERENCE: Schafer Residence: 432 Lakeside Lane, Sanford, NC 27332
Solar Array Installation

To Whom It May Concern:

Per your request, a representative of Vector Structural Engineering, LLC performed a site visit on January 31, 2019. The purpose of our 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.

Design Parameters

Code: North Carolina Building Code, 2018 Edition (2015 IBC)
Risk Category: II
Design wind speed: 115 mph (3-sec gust) per ASCE 7-10
Wind exposure category: D
Ground snow load: 15 psf

Existing Roof Structure

Roof structure: 2x4 manufactured trusses @ 24" O.C.
Roofing material: asphalt shingles
Roof pitch: 8:12
Roof pitch: 14:12

Connection to Roof

Mounting connection: (1) 5/16" lag screw w/ min. 2.5" embedment into framing at max. 48" O.C. along rails
(2) rails per row of panels, evenly spaced; panel height not to exceed 5'-6”

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 in the area of the solar array are decreased; thus, the stresses of the structural elements are decreased. Therefore, the requirements of Section 807.4 of the 2015 NCEBC (2012 IEBC) are met and the structure is permitted to remain unaltered.

The solar array will be flush-mounted (no more than 6" 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 2015 NCEBC (2012 IEBC). Thus the existing lateral force resisting system is permitted to remain unaltered.

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 shall 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

02/06/2019

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Roger Alworth, P.E.
NC License: 34504 - Expires: 12/31/2019
Principal

Enclosures

RTA/jsl

JOB NO.: U2179-0710-191
SUBJECT: WIND PRESSURE

PROJECT: Schafer Residence

Components and Cladding Wind Calculations

Label: Solar Panel Array

Note: Calculations per ASCE 7-10

SITE-SPECIFIC WIND PARAMETERS:

Basic Wind Speed [mph]:	115
Exposure Category:	D
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 largest abs. value)
Zone 2 GC_p:	1.2		(enter largest abs. value)
Zone 3 GC_p:	1.2		(enter largest abs. value)
α:	11.5	Table 26.9-1	
z_g [ft]:	700	Table 26.9-1	
K_h:	1.03	Table 30.3-1	
K_{zt}:	1	Equation 26.8-1	
K_d:	0.85	Table 26.6-1	
Velocity Pressure, q_h [psf]:	29.6	Equation 30.3-1	
GC_{pi}:	0	Table 26.11-1	(largest abs. value)

OUTPUT:

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

Zone 1 Pressure, p [psf]:	29.6	psf (1.0 W, Interior Zones*)
Zone 2 Pressure, p [psf]:	35.6	psf (1.0 W, End Zones*)
Zone 3 Pressure, p [psf]:	35.6	psf (1.0 W, Corner Zones* within a) (a= 3 ft)

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SUBJECT: CONNECTION

PROJECT: Schafer Residence

Lag Screw Connection

Capacity:

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

Demand:

Zone	Pressure (0.6 Wind) (psf)	Max Tributary Width (ft)	Max. Trib. Area[2] (ft^2)	Max. Uplift Force (lbs)
1	17.8	4.0	11.0	196
2	21.3	4.0	11.0	235
3	21.3	4.0	11.0	235

Demand< Capacity: **CONNECTION OKAY**

1. 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.
2. 'Max. Trib Area' is the product of the 'Max. Tributary Width' (along the rails) and 1/2 the panel width/height (perpendicular to the rails).

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SUBJECT: GRAVITY LOADS

PROJECT: Schafer Residence

CALCULATE ESTIMATED GRAVITY LOADS

ROOF DEAD LOAD (D)			Increase due to pitch	Original loading
Roof Pitch/12		8.0		
Asphalt Shingles		2.4	1.20	2.0 psf
1/2" Plywood		1.2	1.20	1.0 psf
Framing		3.0 psf		
Insulation		0.5 psf		
1/2" Gypsum Clg.		2.0 psf		
M, E & Misc		1.5 psf		
	DL	11 psf		
	PV Array DL	3 psf		

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 Panel Array	
Roof Slope [x:12]:	8.0	8.0	
Roof Slope [°]:	34	34	
Snow Ground Load, p_g [psf]:	15	15	ASCE 7-10, Section 7.2
Terrain Category:	D	D	ASCE 7-10, Table 7-2
Exposure of Roof:	Fully Exposed	Fully Exposed	ASCE 7-10, Table 7-2
Exposure Factor, C_e:	0.8	0.8	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]:	9	9	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]:	9	9	ASCE 7-10, Equation 7.4-1
Design Snow Load, S [psf]:	9	9	

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SUBJECT: LOAD COMPARISON

PROJECT: Schafer Residence

Summary of Loads

	Existing	With PV Array
D [psf]	11	14
Lr [psf]	20	0
S [psf]	9	9

Maximum Gravity Loads:

	Existing	With PV Array	
D + L_r [psf]	31	14	ASCE 7-10, Section 2.4.1
D + S [psf]	20	23	ASCE 7-10, Section 2.4.1
Maximum Gravity Load [psf]:	31	23	

Ratio Proposed Loading to Current Loading: **75%** **OK**

The gravity loads in the area of the solar array are decreased; thus, the stresses of the structural elements are decreased. Therefore, the requirements of Section 807.4 of the 2015 NCEBC (2012 IEBC) are met and the structure is permitted to remain unaltered.

JOB NO.: U2179-0710-191
SUBJECT: SOLAR LAYOUT

PROJECT: Schafer Residence