

April 2021

Harnett County

Property Owner: Dwarka Ramphal

Property Address: 107 Carriage Court, Dunn, NC 28334

RE: Photovoltaic System Roof Installations

I have reviewed the existing structure referenced above to determine the adequacy of the existing structure support the proposed installation of an array of solar panels on the roof.

Based on my review, the existing structure is adequate to support the proposed solar panel installation. This assessment is based on recent on-site inspection by SunPro Solar inspectors and photographs of the existing structure. The photovoltaic system is designed to withstand uplift and downward forces; our assessment is regarding the structure's support of the array. Stresses induced by the introduction of individual mount loads on the rafters are within acceptable limits as shown on the attached calculations. The structural considerations used in our review and assessment include the following:

Evaluation Criteria:

Applied Codes: ASCE 7-10 "PEBC 2018 NETC 2018 "PGE 2017

Risk Category: II

Design Wind Speed (3-second gust): 120MPH

Wind Exposure Category: C

Ground Snow Load: 10 PSF

Seismic Design Category: D

Existing Structure:

Roof Material: Metal

Roofing Structure: 2x6 rafters @ 24" O.C.

Roof Slope: 2/12

Connection of Array to Structure:

Manufacturer: S-5!

Mount: Protea Bracket

Mounting Connection: S-5! ProteaBracket(SS) L vert. to min. 26 ga steel w/(4) 6mm self-piercing screws at max. 36" o.c. along rails

Zone 1: 2 rails 4'-0" o.c. mounts

Zone 2: 2 rails 4'-0" o.c. mounts

Zone 3: 2 rails 2'-0" o.c. mounts



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Effect of the Solar Array on Structure Loading:

Gravity Loads:

Per IBC Section 1607.12.5.1, the areas of the roof where solar panels are located are considered inaccessible, and therefore not subject to roof live loading. Live load in these areas is replaced by the dead load of the solar array, 3 psf. The total gravity load on the structure is therefore reduced and the structure may remain unaltered. Connections of the mounts to the underlying structure are to be installed in a staggered pattern, except at the array ends, to distribute the loading evenly to the roof structure. The stresses within the rafters due to the introduction of discrete mount loads are within acceptable limits, as shown on the attached calculations.

Wind Load:

The solar panel array will be flush mounted (no more than 6" above the surrounding roof surface, and parallel to the roof surface. Any additional wind loading on the structure due to the presence of the array is negligible. The array structure is designed by the manufacturer to withstand uplift and downward forces resulting from wind and snow loads. The attached calculations verify the capacity of the connection of the solar array to the roof to resist uplift due to wind loads, the governing load case.

Snow Load:

The reduced friction of the glass surface of the solar panels allows for the lower slope factor (C_s) per Section 7.4 of ASCE 7-10 resulting in a reduced design snow load for the structure. This analysis conservatively considered the snow load to be unchanged.

Seismic Load:

Analysis shows that additional seismic loads due to the array installation will be small. Even conservatively neglecting the wall materials, the solar panel installation represents an increase in the total weight of the roof and corresponding seismic load of less than 10%. This magnitude of additional forces meets the requirements of the exception in Section 11B.4 of ASCE 7-10. The existing lateral force resisting system of the structure is therefore allowed to remain unaltered.

Conclusion:

To the best of my professional knowledge and belief, the subject construction and photovoltaic system installation will be in compliance with all state and local building codes and guidelines in effect at the time of our review.

Limitations:

Engineer's assessment of the existing structure is based on recent field reports and current photographs of the elements of the structure that were readily accessible at the time of inspection. The design of the solar panel racking (mounts, rails, connectors, etc.), connections between the racking and panels, and electrical engineering related to the installation are the responsibility of others. The photovoltaic system installation must be by competent personnel in accordance with manufacturer recommendations and specifications and should meet or exceed industry standards for quality. The contractor is responsible for ensuring that the solar array is installed according to the approved plans and must notify the engineer of any undocumented damage or deterioration of the structure, or of discrepancies between the conditions depicted in the approved plans and those discovered on site so that the project may be reevaluated and altered as required. Engineer does not assume any responsibility for improper installation of the proposed photovoltaic system.

Uplift and Wind Downforce Calculation Summary (ASCE 7-10, 30.5 Part 2)

Mount, Rack, & Panel Proportioning

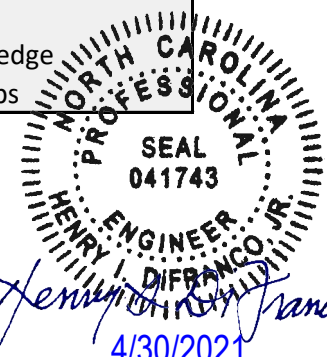
Property Owner:	Dwarka Ramphal	Max. Individual Panel Dimensions		
Project Address:	107 Carriage Lane	Length (in)	Width (in)	Area (sf)
City, State:	Dunn, NC 28334	77	39	20.85

Building Characteristics, Design Input, and Adjustment Factors				
3-Sec Gust Wind Speed:	120	From ASCE 7-10, Fig. 26.5-1A		
Exposure Category:	C	Para 26.7.3		
Risk Category:	II			
Effective Wind Area (sf):	10	(Area per individual fastener)		
Roof Dimensions:	Length: 34	Least Dimension: 33		
	Width: 33			
Roof Height (h):	25	Must be less than 60		
Pitch: 2 on 12 =	9.5	degrees; must be less than 45		
Ht. & Exposure Adjustment (λ)	1.35	Fig. 30.5-1		
Importance Factor (I)	1			
Topographic Adj. (K_{zt})	1	Fig. 26.8-1		

Roof Zone Strip (a), in ft, Fig. 30.5-1, Note 5	
1 - Least Roof Horizontal Dimension (L or W) x 0.10	3.3
2 - Roof Height x 0.4	10
3 - Least Roof Horizontal Dimension (L or W) x 0.04	1.32
4 - Least of (1) and (2)	3.3
5 - Greater of (3) and (4)	3.3
6 - Greater of (5) and 3 feet	a= 3.3

Net Design Pressures, Components & Cladding					
Allowable Stress Design, Use 0.6W (2.4.1)					
	Uplift (-psf)		Down (psf)		
	P_{30net}	$ K_{zt}P_{30net} $	P_{30net}	$ K_{zt}P_{30net} $	
Zone 1	21.1	28.5	13.3	17.9	Interior Roof Area Strip of (a) ft wide at roof edge Corner intersection of strips
Zone 2	37.1	50.0	13.3	17.9	
Zone 3	54.8	73.9	13.3	17.9	

	Uplift (-psf)		Down (psf)		
	$W_{asd} = 0.6P_{30}$		$W_{asd} = 0.6P_{30}$		
Zone 1	17.1		10.7		Interior Roof Area Strip of (a) ft wide at roof edge Corner intersection of strips
Zone 2	30.0		10.7		
Zone 3	44.3		10.7		



Henry I. DiFranco, Jr.

4/30/2021

Protea Bracket Mount & Rail Selection (FS=3.0) (Rolled Metal)

Manufacturer:	Generic 26 Ga. Steel	<u>Perpendicular Panel Orientation</u>	
Model:	ProteaBracket	<u>Allowable Scheme by Uplift Pressure</u>	
Ultimate Uplift (lb):	1092	< 30 psf	2 rails, 4'-0" OC mounts
<u>Parallel : Mounts per Individual Panel</u>		31-45 psf	2 rails, 3'-0" OC mounts
# Mounts/ Panel for FS=3.0		46-59 psf	2 rails, 2'-0" OC mounts
Zone 1	1.6	60-90 psf	3 rails, 2'-0" OC; 2 rails, 1'-4" OC
Zone 2	2.9	90-125 psf	3 rails, 1'-6" OC mounts
Zone 3	4.2	125-150 psf	3 rails, 1'-0" OC
Verify Metal roofing is 26 gauge min.			
Set minimum 2 ea. #14 roofing screws into purlin or plywood deck adjacent each bracket.			
Set min. 8 ea. #14 roofing screws into OSB deck adj. each bracket. Lag bolt deck to rafter.			



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