



**June 17, 2021**

BES Project Number: 1070 Randy Dieterle

Power Home Solar, LLC  
919 N Main St.  
Mooresville, NC 28115

**Project Location: Randy Dieterle: 204 Lamplighter Way, Spring Lake, NC 28390  
Solar Array Installation**

To Whom It May Concern:

Per your request, BES has reviewed the existing structure at the above referenced location. The purpose of this review was to determine the adequacy of the existing structure to support the proposed installation of solar panels on the roof as shown on the attached panel layout plan.

Based upon our review, we certify that existing roof structure will adequately support with the following: Racking and attachment 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 length perpendicular to the rails not to exceed 67 in. Solar module mounting hardware design is by the manufacturer.

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 BES 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 to not overload any existing structural member. The design of the solar panel racking (mounts, rails, etc.) is the responsibility of the manufacturer. Waterproofing around the roof penetrations is the responsibility of others. BES assumes no responsibility for improper installation of the solar array. Existing structure meets or exceeds standard building practices with current building code with assumed single layer asphalt shingles.

Sincerely,



**Jermey Bowers M.E., P.E.**  
*Principal Engineer*

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BOWERS ENGINEERING SERVICES  
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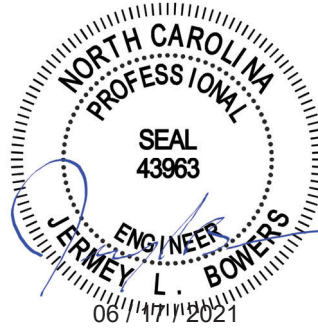
# Structural Analysis

## Location

204 Lamplighter Way  
Spring Lake, NC 28390

## Roof Mount Solar

6/17/2021



Project: 1070

Rev: -

BES <b>121 South Main ST</b> Auburn, IN		Date: 6/17/2021	Connections
Cust. Name:	Bowers Engineering Services	Subject:	Roof Mount
Job Number:	1070	Originator:	0
<b><u>STRUCTURAL SUMMARY</u></b>			
<b><u>CODE SPEC</u></b>			
WIND			
IBC 2015		Speed:	119 MPH
ASCE 7-10		Exp.:	C
Risk Cat:	II		

**Wind Load - uplift**

		Max lb
Zone 1	-27.08 psf	-181.98 lb
Zone 2	-32.55 psf	-218.71 lb
Zone 3	-32.55 psf	-218.71 lb
Max trib	11.20 ft2	

**Max loading at connection**

Negative -218.71 lb/fastener

**Connection (Pull Out)**

Lag screw	5/16 in		
Cd	1.60 Table 2.3.2		
embedment	2.5 in		
Nominal CapacityPrying	205.00 lbs G=0.42		
Max capacity (lbs)	<b>533.00</b>	>	<b>218.71</b> <b>OK</b>

Note:

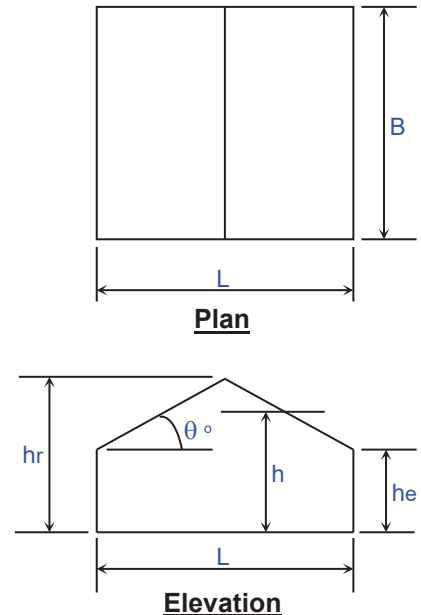
\* Lag screws to be diameter 5/16x2.5inches long.

\* All fasteners need to be placed at roof rafters.

BES 121 South Main ST Auburn, IN		WIND LOADING Per ASCE 7-10	
Cust Name:	Bowers Engineering Services	Subject:	Roof Mount
Job Number:	1070	Originator:	0
		Checker:	

**Input Data:**

Wind Speed, V =	119	mph (Wind Map, Figure 26.5-1A-C)
Bldg. Classification =	II	(Table 1-1 Occupancy Category)
Exposure Category =	C	(Sect. 26.7)
Ridge Height, hr =	26.94	ft. (hr >= he)
Eave Height, he =	10.00	ft. (he <= hr)
Building Width =	45.00	ft. (Normal to Building Ridge)
Building Length =	66.00	ft. (Parallel to Building Ridge)
Roof Type =	Gable	(Gable or Monoslope)
Topo. Factor, Kzt =	1.00	(Sect. 26.8 & Figure 26.8-1)
Direct. Factor, Kd =	0.85	(Table 26.6)
Enclosed? (Y/N)	Y	(Sect. 28.6-1 & Figure 26.11-1)
Hurricane Region?	N	
Component Name =	Decking	(Purlin, Joist, Decking, or Fastener)
Effective Area, Ae =	11.1	ft.^2 (Area Tributary to C&C)
Overhangs? (Y/N)	N	(if used, overhangs on all sides)



**Resulting Parameters and Coefficients:**

Roof Angle, $\theta$ =	36.97	deg.
Mean Roof Ht., h =	18.47	ft. (h = (hr+he)/2, for roof angle >10 deg.)

Roof External Pressure Coefficients, GCp:

GCp Zone 1-3 Pos. =	0.90	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 1 Neg. =	-0.99	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 2 Neg. =	-1.19	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 3 Neg. =	-1.19	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)

Positive & Negative Internal Pressure Coefficients, GCpi (Figure 26.11-1):

+GCpi Coef. =	0.00	(positive internal pressure)
-GCpi Coef. =	0.00	(negative internal pressure)

If  $z \leq 15$  then:  $Kz = 2.01 \cdot (15/zg)^{2/\alpha}$ , If  $z > 15$  then:  $Kz = 2.01 \cdot (z/zg)^{2/\alpha}$  (Table 30.3-1)

$\alpha$ =	9.50	(Table 26.9-1)
zg =	900	(Table 26.9-1)
Kh =	0.89	(Kh = Kz evaluated at z = h)

Velocity Pressure:  $qz = 0.00256 \cdot Kz \cdot Kzt \cdot Kd \cdot V^2$  (Sect. 30.3.2, Eq. 30.3-1)

qh =	27.33	psf	qh = 0.00256 * Kh * Kzt * Kd * V^2 (qz evaluated at z = h)
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Design Net External Wind Pressures (Sect. 30.4 & 30.6):

For  $h \leq 60$  ft.:  $p = qh \cdot ((GCp) - (+/-GCpi))$  (psf)

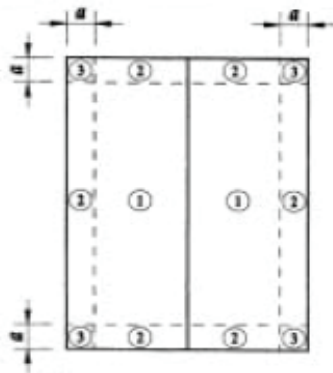
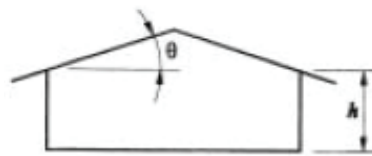
For  $h > 60$  ft.:  $p = q \cdot ((GCp) - qi \cdot (+/-GCpi))$  (psf)

where: q = qh for roof

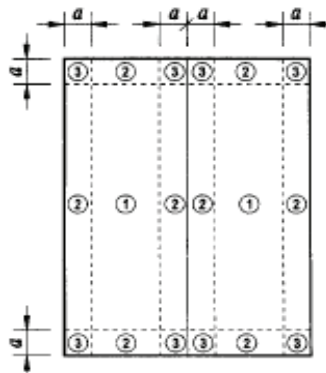
qi = qh for roof (conservatively assumed per Sect. 30.6)



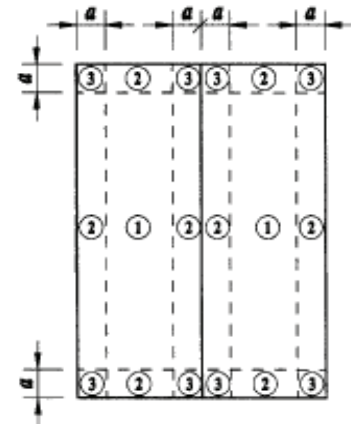
**Roof Components and Cladding:**



$\theta \leq 7$  deg.

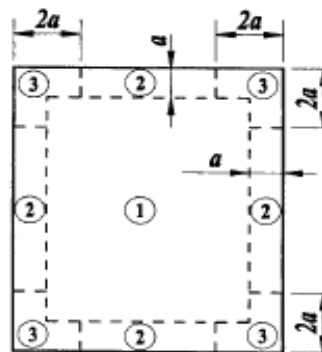


$7 \text{ deg.} < \theta \leq 27$  deg.



$27 \text{ deg.} < \theta \leq 45$  deg.

**Roof Zones for Buildings with  $h \leq 60$  ft.**  
 (for Gable Roofs  $\leq 45^\circ$  and Monoslope Roofs  $\leq 3^\circ$ )



**ROOF PLAN**

**Roof Zones for Buildings with  $h > 60$  ft.**  
 (for Gable Roofs  $\leq 10^\circ$  and Monoslope Roofs  $\leq 3^\circ$ )

Frame Design		General Info	
Cust. Name:	Bowers Engineering Services	Subject:	Roof Mount
Job Number:	1070	Originator:	Checker:
Date:	44364	Rev:	-
Address:	204 Lamplighter Way		
City, State:	Spring Lake, NC 28390		

**Roof Rafter**

Rafter Size= 2x6 **SPF**  
 Trib. Area= 1.33 ft  
 Rafter length= 12 ft

w= 37.91 plf  
 M= 682.29 lb-ft

$$fb = \frac{M * 12}{Sx}$$

$$F'b = Fb * Cd * Cr * Cf$$

$$\frac{5wl^4}{384EI}$$

$\Delta L = 0.43$  in  
 $\Delta S = 0.21$  in  
 $\Delta D+L = 0.55$  in

$\Delta_{allow in} = 0.55 <$   
 $\Delta_{allow in} = 0.43 <$

**Roof Loads**

Dead Load= 6 psf  
 Live Load= 20 psf  
 Snow Load= 10 psf

**Load Combination**

D+0.75L+0.75S 28.5 psf

EI= ##### ib-in  
 Sx = 7.5625  
 C<sub>M</sub>= 1.0  
 C<sub>r</sub>= 1.2  
 C<sub>D</sub>= 1.15  
 C<sub>F</sub>= 1.3  
 F<sub>b</sub>= 875 psi

1082.64 psi  
 1504.34 psi **OK**

2x6	@	1.33 o/c	<b>OK</b>
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OK

BES <b>121 South Main ST</b> Auburn, IN		Date: 6/17/2021	Connections
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<b><u>CODE SPEC</u></b>			
WIND			
IBC 2015		Speed:	119 MPH
ASCE 7-10		Exp.:	C
Risk Cat:	II		

**Wind Load - uplift**

		Max lb
Zone 1	-25.59 psf	-171.93 lb
Zone 2	-47.92 psf	-322.05 lb
Zone 3	-73.51 psf	-493.98 lb
Max trib	11.20 ft2	

**Max loading at connection**

Negative -493.98 lb/fastener

**Connection (Pull Out)**

Lag screw	5/16 in		
Cd	1.60 Table 2.3.2		
embedment	2.5 in		
Nominal CapacityPrying	205.00 lbs G=0.42		
Max capacity (lbs)	<b>533.00</b>	>	<b>493.98</b> <b>OK</b>

Note:

\* Lag screws to be diameter 5/16x2.5inches long.

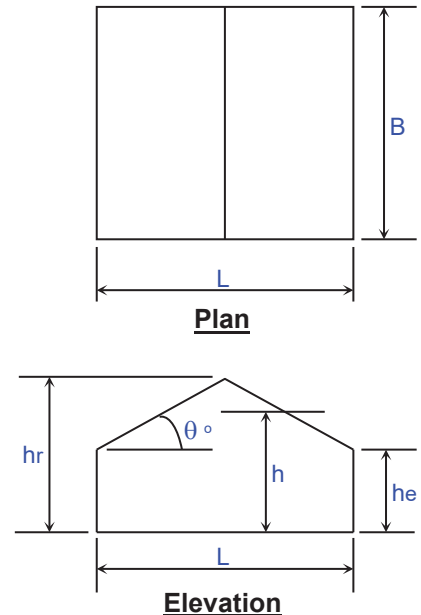
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Exposure Category =	C	(Sect. 26.7)
Ridge Height, hr =	25.63	ft. (hr >= he)
Eave Height, he =	20.00	ft. (he <= hr)
Building Width =	45.00	ft. (Normal to Building Ridge)
Building Length =	66.00	ft. (Parallel to Building Ridge)
Roof Type =	Gable	(Gable or Monoslope)
Topo. Factor, Kzt =	1.00	(Sect. 26.8 & Figure 26.8-1)
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Enclosed? (Y/N)	Y	(Sect. 28.6-1 & Figure 26.11-1)
Hurricane Region?	N	
Component Name =	Decking	(Purlin, Joist, Decking, or Fastener)
Effective Area, Ae =	11.1	ft.^2 (Area Tributary to C&C)
Overhangs? (Y/N)	N	(if used, overhangs on all sides)



**Resulting Parameters and Coefficients:**

Roof Angle, $\theta$ =	14.04	deg.
Mean Roof Ht., h =	22.81	ft. (h = (hr+he)/2, for roof angle >10 deg.)

Roof External Pressure Coefficients, GCp:

GCp Zone 1-3 Pos. =	0.49	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 1 Neg. =	-0.90	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 2 Neg. =	-1.68	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)
GCp Zone 3 Neg. =	-2.57	(Fig. 30.4-2A, 30.4-2B, and 30.4-2C)

Positive & Negative Internal Pressure Coefficients, GCpi (Figure 26.11-1):

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$\alpha$ =	9.50	(Table 26.9-1)
zg =	900	(Table 26.9-1)
Kh =	0.93	(Kh = Kz evaluated at z = h)

Velocity Pressure:  $q_z = 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2$  (Sect. 30.3.2, Eq. 30.3-1)

qh =	28.57	psf	qh = 0.00256 * Kh * Kzt * Kd * V^2 (qz evaluated at z = h)
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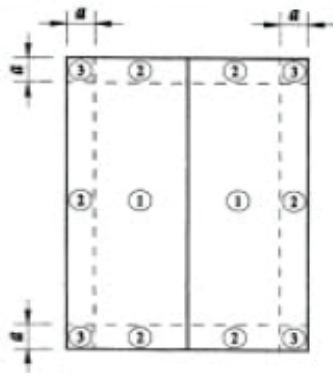
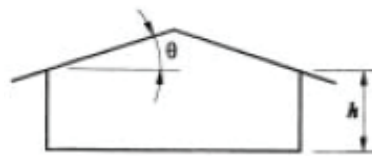
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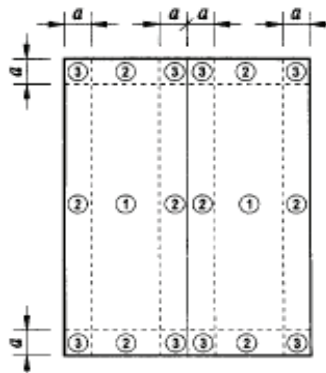
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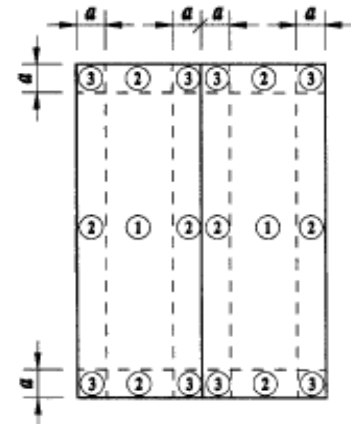
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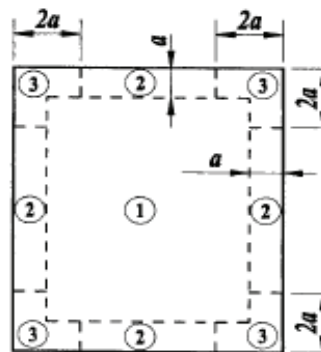


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