JA Structural Consulting
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PHONE 1.617.416.2023
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June 25, 2025

ATTN: ReVision Energy
1980 Turnpike St building 2
North Andover, MA 01845

RE: Santo Residence Solar Panel Installation
212 Lions Mouth Rd
Amesbury, MA 01913

To Whom It May Concern,

Pursuant to your request, JA Engineers has conducted a limited structural evaluation of the roof framing at the above-referenced site to determine if the roof has adequate capacity to support the proposed solar panels. Our analysis was based on the framing information and configurations provided by ReVision Energy. We understand that the structural components of the existing roof framing are in good condition. It is further understood that all existing connections between the various roof framing members are adequate to resist the current loading conditions and behave in the manner typical of a rafters and ceiling tie system or truss system prior to the installation of the solar panel.

Results:

Roof 1 (MP1) - adequate to support the proposed solar panels.

Roof Attachment Guidelines: The spacing of the solar standoffs should be maintained as stated in the wind section of these calculations. Additionally, it is important that the locations of the solar standoffs be staggered between adjacent rails so that no single rafter supports more load than under the existing conditions.

Design Criteria and Code Information

Ground Snow Load, Pg:	50 psf
Basic Wind Speed:	116 mph
Risk Category:	II
Code Used:	Massachusetts Residential Code, 10th Edition, ASCE 7-16, and 2018 NDS

Do not hesitate to contact my office at 617-416-2023 should you have any questions or if you require any additional information.

Respectfully,
JA Structural Consulting
Pola Arsanious, P.E.

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Roof Attachment Spacing

Attachment spacing for the entire site: For roof-specific, please check the wind load section

Spacing of the solar standoffs panel Portrait Orientation			
Zones	**Zones 1&2e**	**Zones 2n&2r&3r**	**Zone 3e**
Group	**1**	**2**	**3**
Roof Attachment - Rafter attached Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached Exposed	14 inch	14 inch	14 inch
Spacing of the solar standoffs panel Landscape orientation			
Zones	**Zones 1&2e**	**Zones 2n&2r&3r**	**Zone 3e**
Group	**1**	**2**	**3**
Roof Attachment - Rafter attached Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached Exposed	26 inch	26 inch	26 inch

Note:

The spacing listed above is based on the Ironridge Quickmount HUG attachment system (1 layer of shingles only) with:

Rafter attachment hardware: (2) #14 screws x 3"

Deck attachment hardware: (6) #14 screws x 3"

When using other attachment hardware products, ensure that the attachment capacity matches the capacity listed in the wind calc section in blue text. The following screws are approved replacements for those listed above, and the spacing of the attachments must remain the same:

Rafter attachment hardware: For one layer of shingles: (1) 5/16" D x 4" lag screw. For two layers of shingles: (1) 5/16" D x 5" lag screw.

Deck attachment hardware: For shingle roofs: (6) 5/16" D x 2" lag screws or more. For metal roofs: (1) metal clamp/bracket to the metal roof deck.

Design loads (+ and - psf) for modules		
Zones	*- psf	*+psf
Zones 1&2e	-26.08 psf	26.17 psf

*For the purposes of the table above, the wind speed has been adjusted according to Risk Category I, and the snow load has been adjusted to be normal to the module.

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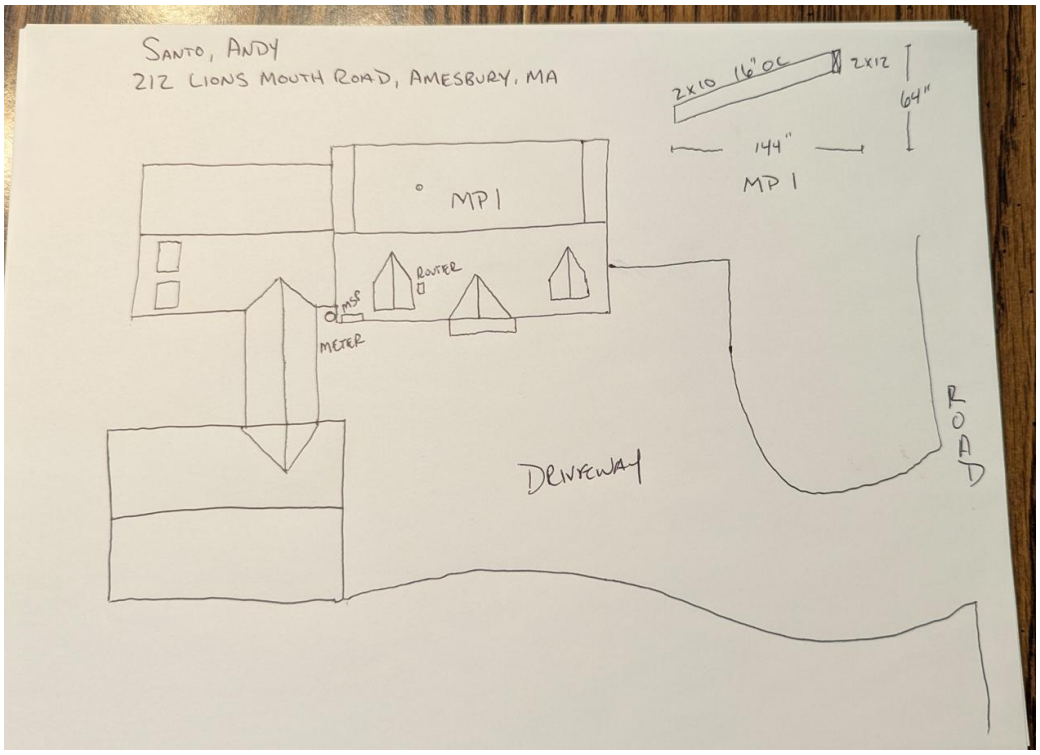
The pertinent data of the existing roof structure is listed below:

Roof 1 MP1

Roof Rafters:	**1.5X9.25 Rafters @ 16"o.c" (SPRUCE-PINE-FIR No.2 Assumed)**
Roof Slope:	**25 Degrees**
Length of Rafter (Horizontal Projection):	**13.5 feet**
Ceiling Joists:	**YES**
Condition of Framing:	**Good**
Roof Covering:	**Asphalt Shingles**



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Gravity Loading

Roof Snow Load Calculations		
pg = Ground Snow Load =	50 psf	ASCE, Figure 7.2-1
Ce = Exposure Factor =	1	ASCE, Table 7.3-1
Ct = Thermal Factor =	1.1	ASCE,Table 7.3-2
I = Importance Factor =	1	ASCE, Table 1.5-2
pf = 0.7 Ce Ct I pg =	38.5 psf	ASCE, Eq. 7.3-1
where pg ≤ 20 psf, pf min = I x pg =	N/A	ASCE, 7.3.4
where pg > 20 psf, pf min = I x 20 =	N/A	
Per ASCE 7, min values of pf shall apply to hip and gable roofs with slopes less than 15 degree		
Therefore, pf = Flat Roof Snow Load =	38.5 psf	
ps = Cspf		ASCE, Eq. 7.4-1
Cs = Slope Factor =	0.75	Roof 1
ps = Sloped Roof Snow Load =	**28.9 psf**	Roof 1

PV Dead Load = 3 psf per (ReVision Energy)

Roof 1 Dead Load		
Asphalt Shingles	4.00	
Roof Plywood	2.00	
1.5X9.25 Rafters @ 16"o.c	2.89	
Vaulted Ceiling	0.00	(Ceiling Not Vaulted)
Miscellaneous	0.25	
Total Roof DL Roof 1	**9.1 psf**	
DL Adjusted to 25 Degree Slope	10.1 psf	

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Wind Calculations Roof 1

Per ASCE 7 Components and Cladding

Input Variables	
Wind Speed	116 mph
Exposure Category	C
Roof Shape	Gable
Roof Slope	25 degree
Mean Roof Height	30 ft
Building Least Width	16 ft
Effective Wind Area	20.9 sf
Roof Zone Edge Distance, a	3.0 ft

Design Wind Pressure Calculations		
Wind Pressure P = qh*(GCp)(ɣe)(ɣa)		ASCE 7 - Eq 29.4-7
qh = 0.00256 * Kz * Kzt * Kd * V^2		ASCE, Eq 26.10-1
Kz (Exposure Coefficient) =	0.98	ASCE, Table 26.10-1
Kzt (topographic factor) =	1	ASCE, Fig 26.8-1
Kd (Wind Directionality Factor) =	0.85	ASCE, Table 26.6-1
V (Design Wind Speed) =	116 mph	
I Importance Factor =	1	
qh =	28.76 psf	
ɣe =	1.5	ASCE, Fig 29.4-7
ɣa =	0.77	ASCE, Fig 29.4-8

Standoff Uplift Calculations					
	Zones 1&2e	Zones 2n&2r&3r	Zone 3e	Positive	
GCp =	-1.49	-2.15	-2.43	0.46	Fig 30.3-2
Uplift Pressure =	-49.39 psf	-71.26 psf	-80.51 psf	15.28 psf	
Attachment Dead Load =	3.00 psf	3.00 psf	3.00 psf		
Max Rail Span Length Rafter Attached=	4.00 ft	4.00 ft	4.00 ft		
Max Rail Span Length Deck Attached=	1.20 ft	1.20 ft	1.20 ft		
Longitudinal Length =	3.21 ft	3.21 ft	3.21 ft		
Attachment Tributary Area Rafter attached=	12.84 sf	12.84 sf	12.84 sf		
Attachment Tributary Area Deck attached=	3.85 sf	3.85 sf	3.85 sf		
Footing Uplift Rafter Attached=	-357 lb	-526 lb	-597 lb		
Footing Uplift Deck Attached=	-107 lb	-158 lb	-179 lb		

Standoff Uplift Check Rafter Attached	
Maximum Design Uplift =	-597 lb
Standoff Uplift Capacity =	1004 lb
1004 lb capacity > 597 lb demand	**Therefore, OK**

Standoff Uplift Check Deck Attached	
Maximum Design Uplift =	-179 lb
Standoff Uplift Capacity =	195 lb
195 lb capacity > 179 lb demand	**Therefore, OK**

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Rafter Fastener Capacity Check Per NDS		
Fastener =	#14	inch
Number of Fasteners =	2	
Embedment Depth =	2.0 inch	
Pullout Capacity Per Inch =	121 lb	
Fastener Capacity =	774 lb	
774.4 lb capacity > 597 lb demand	**Therefore, OK**	

Deck Fastener Capacity Check Per E830E		
Fastener =	#10	inch
Number of Fasteners =	6	
Embedment Depth =	0.5 inch	
Pullout Capacity =	82 lb	
Fastener Capacity =	787 lb	
787.2 lb capacity > 179 lb demand	**Therefore, OK**	

Spacing of the solar standoffs panel Portrait Orientation			
Zones	Zones 1&2e	Zones 2n&2r&3r	Zone 3e
Roof Attachment - Rafter attached Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached Exposed	14 inch	14 inch	14 inch
Roof Attachment - Rafter attached not Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached not Exposed	22 inch	22 inch	22 inch
Spacing of the solar standoffs panel Landscape orientation			
Zones	Zones 1&2e	Zones 2n&2r&3r	Zone 3e
Roof Attachment - Rafter attached Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached Exposed	26 inch	26 inch	26 inch
Roof Attachment - Rafter attached not Exposed	48 inch	48 inch	48 inch
Roof Attachment - Deck attached not Exposed	26 inch	26 inch	26 inch

Note:
The spacing listed above is based on the Ironridge Quickmount HUG attachment system (1 layer of shingles only) with:

Rafter attachment hardware: (2) #14 screws x 3"
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Deck attachment hardware: For shingle roofs: (6) 5/16" D x 2" lag screws or more. For metal roofs: (1) metal clamp/bracket to the metal roof deck.

Design loads (+ and - psf) for modules		
Zones	*- psf	*+psf
Zones 1&2e	-17.38 psf	26.17 psf
Zones 2n&2r&3r	-25.08 psf	26.17 psf
Zone 3e	-28.34 psf	26.17 psf

*For the purposes of the table above, the wind speed has been adjusted according to Risk Category I, and the snow load has been adjusted to be normal to the module.

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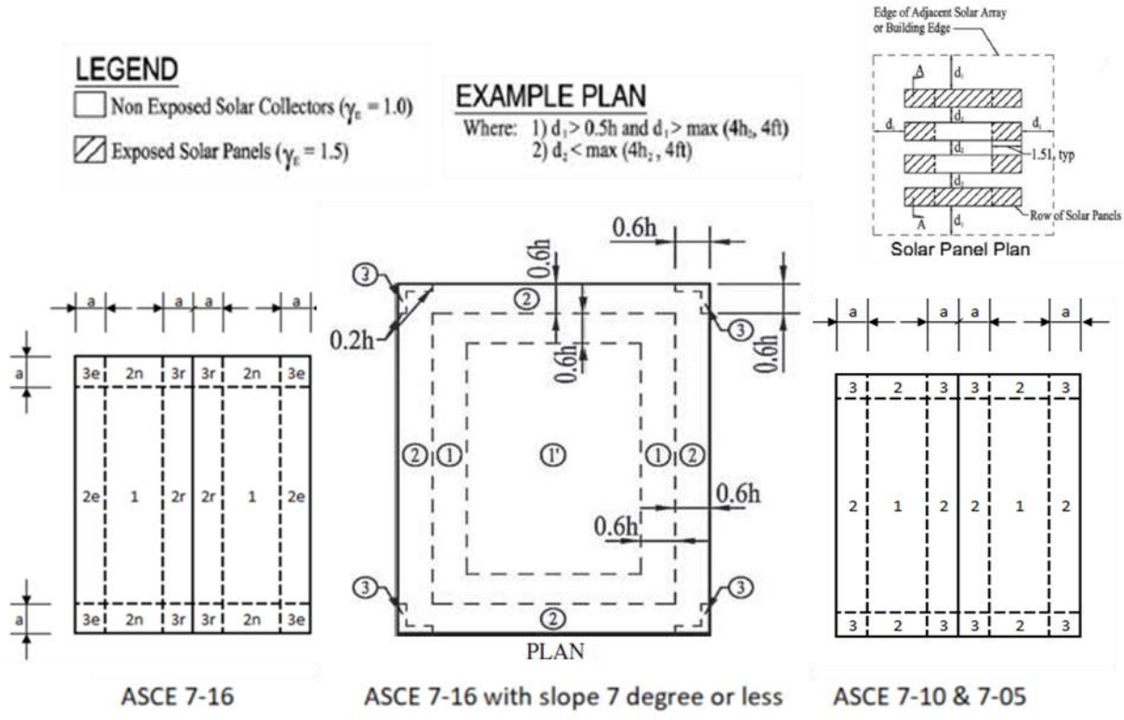

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Framing Check Roof 1

PASS

w = 56 plf

Dead Load	10.1 psf	
PV Load	3.0 psf	
Snow Load	28.9 psf	
Wind Load	15.3 psf	Downward
	-71.3 psf	Uplift

Governing Load Combo. DL + SL

Total Load **42.0 psf**

Member Properties

Member Size	S (in^3)	I (in^4)	Lumber Sp/Gr	Member Spacing
1.5X9.25	21.39	98.93	SPRUCE-PINE-FIR No.2	@ 16"o.c

Check Bending Stress

Fb (psi) =	f'b	X	Cd	X	Cf	X	Cr	X	Cm	(NDS Table 4.3.1)
	875	X	1.15	X	1.10	X	1.15	X	1.00	

Allowed Bending Stress = 1272.9 psi

Maximun Moment = (wL^2) / 8
= 1274.67 ft#
= 15296.0 in#

Actual Bending Stress = (Maximum Moment) / S
= 715.1 psi

Allowed > Actual -- 56% Stressed -- Therefore, OK

Check Deflection

Allowed Deflection (Total Load) = L/180 (E = 1400000 psi Per NDS)
= 0.900 in

Deflection Criteria Based on = Simple Span

Actual Deflection (Total Load) = (5*w*L^4) / (384*E*I)
= 0.302 in

Allowed > Actual -- Therefore OK

Allowed Deflection (Live Load) = L/180
= 0.900 in

Actual Deflection (Live Load) = (5*w*L^4) / (384*E*I)
= 0.159 in

Allowed > Actual -- Therefore OK

Check Shear

Member Area = 13.9 in^2 Fv (psi) = 135 psi (NDS Table 4A)

Allowed Shear = Fv * A = 1873 lb Max Shear (V) = w * L / 2 = 378 lb

Allowed > Actual -- 20.2% Stressed -- Therefore, OK