VECTOR ENGINEERS

JOB NO.: U3340.0239.201
SUBJECT: WIND PRESSURE

PROJECT: Avery, Terry- Residence

Components and Cladding Wind Calculations

Label: Solar Panel Array

Note: Calculations per ASCE 7-10

SITE-SPECIFIC WIND PARAMETERS:

Basic Wind Speed [mph]:	119
Exposure Category:	C
Risk Category:	II

Notes:

ADDITIONAL INPUT & CALCULATIONS:

Height of Roof, h [ft]:	25	(Approximate)	Hip?
Comp/Cladding Location:	Gable/Hip Roofs 7° < θ ≤ 27°		No
Enclosure Classification:	Enclosed Buildings		
Zone 1 GC_p:	0.9	Figure 30.4-2B (enter negative pressure coefficients)	
Zone 2 GC_p:	1.7		
Zone 3 GC_p:	2.6		
α:	9.5	Table 26.9-1	
z_g [ft]:	900	Table 26.9-1	
K_h:	0.95	Table 30.3-1	
K_{zt}:	1	Equation 26.8-1	
K_d:	0.85	Table 26.6-1	
Velocity Pressure, q_h [psf]:	29.1	Equation 30.3-1	
GC_{pi}:	0	Table 26.11-1	

PRESSURES:

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

Zone 1, p [psf]:	26.2	psf (1.0 W, Interior Zones, beyond 'a' from roof edge)
Zone 2, p [psf]:	49.5	psf (1.0 W, End Zones, within 'a' from roof edge)
Zone 3, p [psf]:	75.7	psf (1.0 W, Corner Zones, within 'a' from roof corner) (a= 3 ft)

VECTOR ENGINEERS

JOB NO.: U3340.0239.201
SUBJECT: CONNECTION

PROJECT: Avery, Terry- Residence

Calculate Uplift Forces on Connection

	Pressure (0.6 Wind) (psf)	Max Connection Spacing[1] (ft)	Max Trib. Area[2] (ft^2)	Max Uplift Force (lbs)
Zone 1	15.7	4.0	11.2	176
Zone 2	29.7	4.0	11.2	332
Zone 3	45.4	4.0	11.2	507

Calculate Connection Capacity

Lag Screw Size [in]:	5/16	
C_d:	1.6	NDS Table 2.3.2
Embedment[3] [in]:	2.5	
Grade:	SPF (G = 0.42)	
Nominal Capacity [lbs/in]:	205	NDS Table 12.2A
Number of Screws:	1	
Prying Coefficient:	1.4	
Total Capacity [lbs]:	586	

Determine Result

Maximum Demand [lbs]:	507
Lag Screw Capacity [lbs]:	586

Result: **Capacity > Demand, Connection is adequate.**

Notes

1. 'Max Connection Spacing' is the spacing between connections along the rails.
2. 'Max Trib Area' is the product of the 'Max Connection Spacing' and 1/2 the panel width/height perpendicular to the rails. (2) rails per row of panels. Length or panels perpindicular to the rails shall not
3. 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.

VECTOR ENGINEERS

JOB NO.: U3340.0239.201
SUBJECT: GRAVITY LOADS

PROJECT: Avery, Terry- Residence

CALCULATE ESTIMATED GRAVITY LOADS

Roof Pitch: 3.9 :12

ROOF DEAD LOAD (D)	Design material weight [psf]	Increase due to pitch	Material weight [psf]
Composite Shingles	2.1	1.05	2.0
1/2" Plywood	1.1	1.05	1.0
Framing	3.0		3.0
Insulation	0.5		0.5
1/2" Gypsum Clg.	2.1	1.05	2.0
M, E & Misc	1.5		1.5
Total Original Roof DL	10.3		
PV Array DL	3.2	1.05	3

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 Array	
Roof Slope [x:12]:	3.9	3.9	
Roof Slope [°]:	18	18	
Snow Ground Load, p_g [psf]:	10	10	ASCE 7-10, Section 7.2
Terrain Category:	C	C	ASCE 7-10, Table 7-2
Exposure of Roof:	Fully Exposed	Fully Exposed	ASCE 7-10, Table 7-2
Exposure Factor, C_e:	0.9	0.9	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]:	7	7	ASCE 7-10, Equation 7.3
Minimum Roof Snow Load, p_m [psf]:	0	0	ASCE 7-10, Section 7.3.4
Unobstructed Slippery Surface?	No	Yes	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	0.87	ASCE 7-10, Figure 7-2
Sloped Roof Snow Load, p_s [psf]:	7	6	ASCE 7-10, Equation 7.4
Design Snow Load, S [psf]:	7	6	

VECTOR ENGINEERS

JOB NO.: U3340.0239.201
SUBJECT: LOAD COMPARISON

PROJECT: Avery, Terry- Residence

Summary of Loads

	Existing	With PV Array
D [psf]	10	13
Lr [psf]	20	0
S [psf]	7	6

Maximum Gravity Loads:

	Existing	With PV Array	
(D + Lr) / Cd [psf]	24	15	ASCE 7-10, Section 2.4.1
(D + S) / Cd [psf]	15	17	ASCE 7-10, Section 2.4.1

(Cd = Load Duration Factor = 0.9 for D, 1.15 for S, and 1.25 for Lr)

Maximum Gravity Load [psf]:	24	17

Ratio Proposed Loading to Current Loading: **70%** **OK**

The gravity loads and; thus, the stresses of the structural elements, in the area of the solar array are either decreased or increased by no more than 5%. Therefore, the requirements of Section 807.4 of the 2018 NCEBC (2015 IEBC) are met and the structure is permitted to remain unaltered.

PROJECT NAME: TERRY AVERY

DESIGN SUMMARY	
SIZE:	10.720 KW PV SOLAR SYSTEM (32 MODULES)
STYLE:	RESIDENTIAL, ASPHALT SHINGLE, FLUSH MOUNT, GRID TIED, NET-METERED
LOCATION:	EAST AND WEST FACINGS ROOFS OF HOME
ORIENTATION:	PORTRAIT,18° PITCH ROOFS, 100° AND 280° AZIMUTHS
MODULE:	Q-CELLS Q.PEAK DUO BLK-G6 335, 68.5" X 40.6", 32MM THICK, 43.87LBS
RACKING:	IRONRIDGE FLASHFOOT + XR100
INVERTER:	MICROINVERTERS
VOLTAGE:	120/240V, 1Ø
MONITORING:	ENPHASE ENVOY ONLINE MONITORING
ADDITIONAL WORK:	
NOTE	

PV SOLAR ARRAY WITH MICROINVERTERS
ROOF OF HOME

CB — AC COMBINER BOX
HOME EXTERIOR

D — AC SOLAR DISCONNECT
HOME EXTERIOR

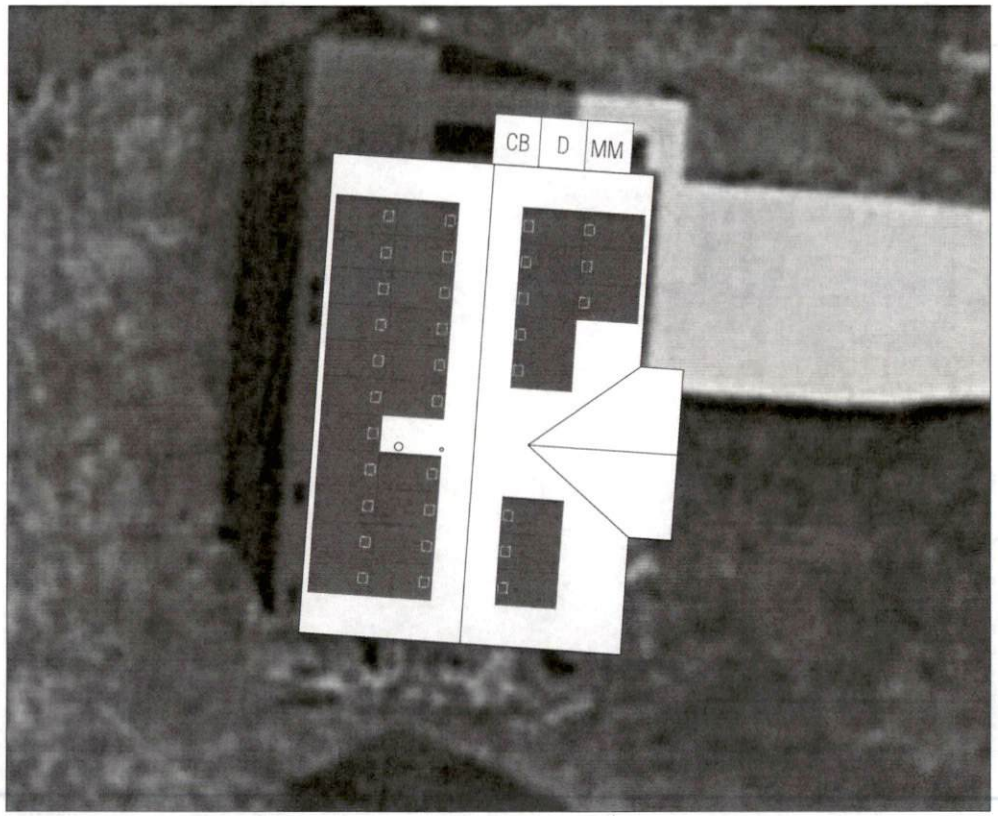
MM — UTILITY METER AND MAIN ELECTRICAL PANEL
HOME EXTERIOR

VECTOR engineering

NORTH CAROLINA PROFESSIONAL SEAL 044374 ENGINEER TREVOR P HAWKES

09/04/2020

Firm License Number: COA #P-0742
VSE Project Number: 123340-0239-201



1/01 SITE MAP
NO SCALE

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(800) 452-2777

REVISIONS

DESIGN SUMMARY

01

PROJECT NAME: TERRY AVERY

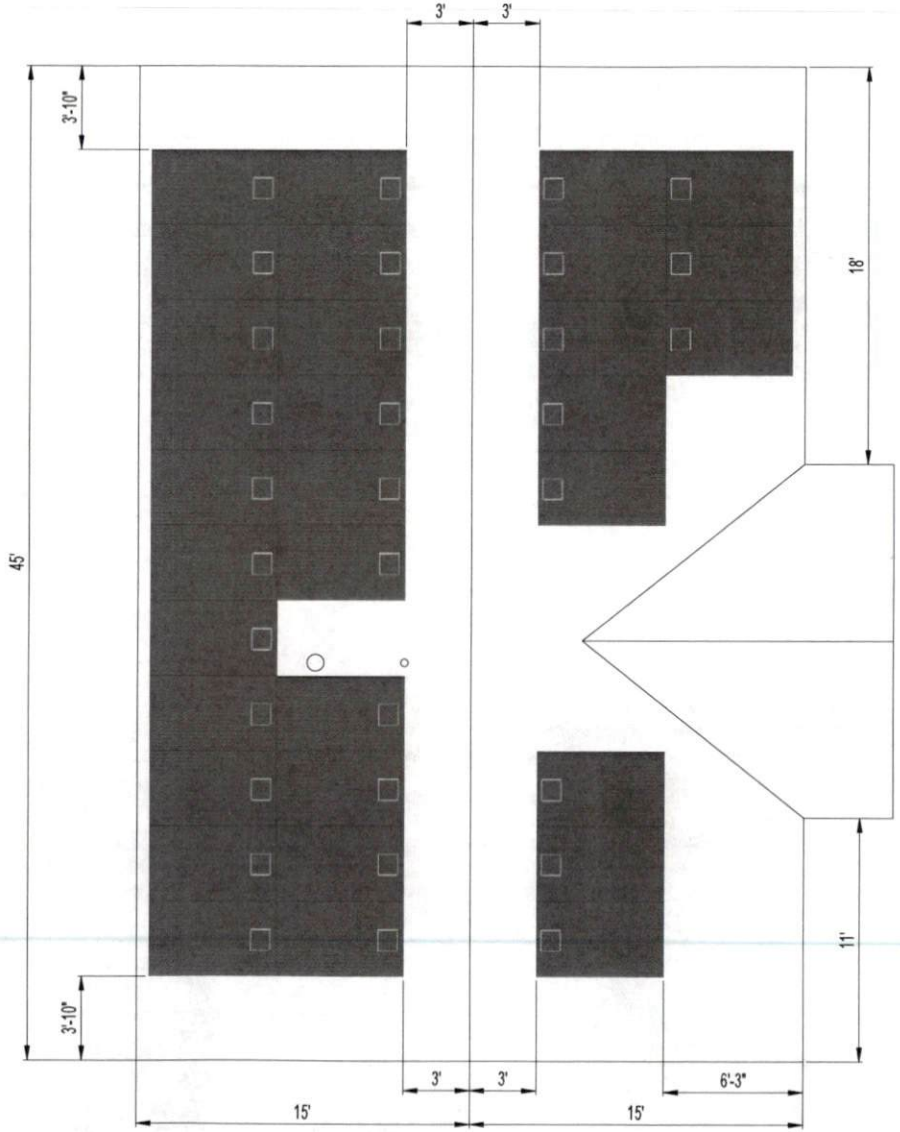
BUILD SUMMARY	
MODULE:	QTY(32) Q-CELLS Q.PEAK DUO BLK-G6 335, 68.5" X 40.6", 32MM THICK, 43.87LBS
STRUCTURE:	TRUSS 2X6", 24" OC.
RACKING:	IRONRIDGE FLASHFOOT, RUN RAILS NORTH-SOUTH ACROSS TRUSSES. STAGGER THE PENETRATIONS PER RAIL SO ALL ROOF MEMBERS ARE ENGAGED. PENETRATEEVERY 4FT OR LESS INTO RAFTERS. INSTALLER MUST VERIFY ALL PENETRATIONS ARE SECURE AND CENTERED IN WOOD MEMBERS. ANY DAMAGED WOOD MEMBERS MUST BE REPAIRED IMMEDIATELY BY SCAB, SISTER, OR FULL REPLACEMENT. MAX RAIL OVERHANG = 19" FROM LAST ATTACHMENT POINT. MODULE OVERHANG = 18".
ACCESS:	P2-STORY BUILDING LADDER NEEDED
INVERTER:	MOUNT INVERTER BEHIND SOLAR PANEL
MONITORING:	HARDLINE TO ROUTER INSIDE IN HOME
NOTE:	

VECTOR ENGINEERING

NORTH CAROLINA PROFESSIONAL SEAL 044374 ENGINEER TREVOR P. HAWKES

09/04/2020

Firm License Number: COA #P-0743
VSE Project Number: 173349-0239-201



1/02 ARRAY LAYOUT
NO SCALE

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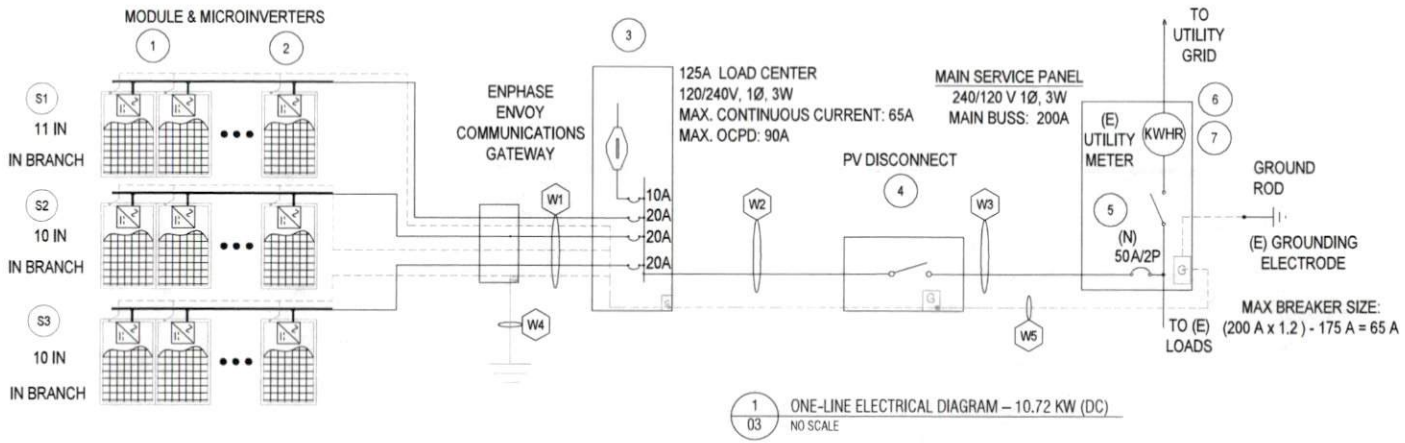
REVISIONS

BUILD SUMMARY

02

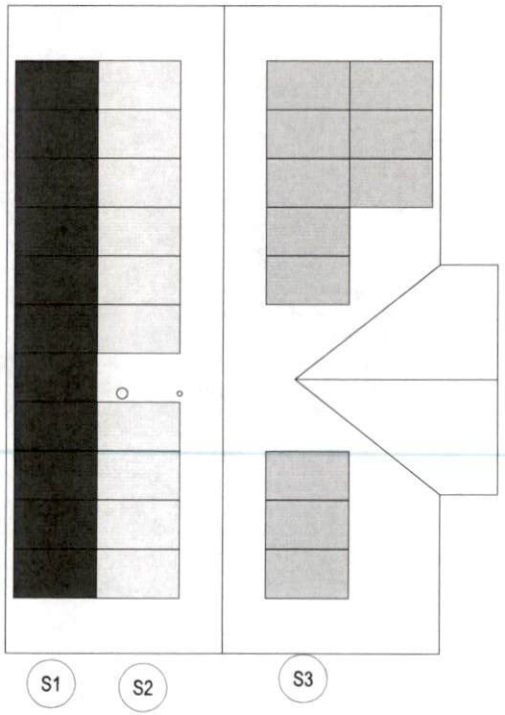
PROJECT NAME: TERRY AVERY



1/03 ONE-LINE ELECTRICAL DIAGRAM – 10.72 KW (DC)
NO SCALE

EQUIPMENT SCHEDULE						
TAG	ITEM	MAKE	MODEL	VOLTAGE	QTY	LOCATION
1	MODULE	Q-CELLS	Q.PEAK DUO BLK-G6 335W	DC	32	ROOF OF HOME
2	INVERTER	ENPHASE	ENPHASE IQ7PLUS-72-2-US	120/240V, 1Ø	32	ROOF OF HOME
3	AC COMBINER PANEL	ENPHASE	ENPHASE-IQ3-PANEL 3X20A, 2P, 1X10A, 2P		1	HOME EXTERIOR
4	PV DISCONNECT	EATON	60A ENCLOSURE NON FUSED		1	HOME EXTERIOR
5	BACK-FED BREAKER	EATON	50A, 2P		1	MAIN PANEL
6	MAIN ELECTRICAL PANEL	EATON	200A MAIN (N)EW MAIN BREAKER DERATING: 175A		1	HOME EXTERIOR
7	UTILITY METER	ITRON	FORM 2S		1	

WIRE SCHEDULE					
TAG	RUN	CONDUCTOR TYPE	GAUGE	CONDUIT	RUN LENGHT
W1	PV HOMERUNS	THWN-2, CU	#10	3/4"	~150 FT
W2	COMBINER BOX TO DISCONNECT	THWN-2, CU	#8	3/4"	~10 FT
W3	BACK-FED BREAKER	THWN-2, CU	#8	3/4"	~10 FT
W4	GROUNDING ELECTRODE	BARE, CU	#6	-	-
W5	EQUIPMENT GROUND	THWN-2, CU	#6 (MIN)	-	~70 FT



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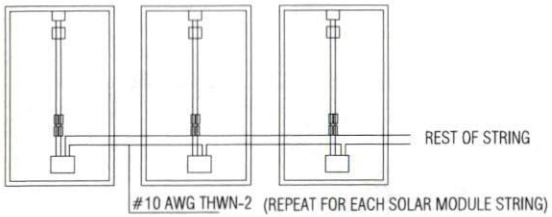
REVISIONS

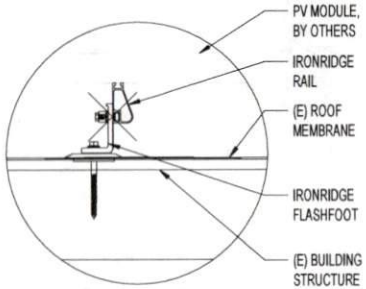
ELECTRICAL

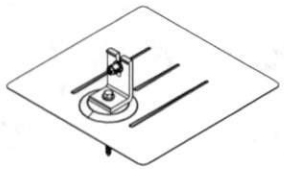
03

PROJECT NAME: TERRY AVERY



1/04 MODULE AND MOCROINVERTER CONNECTION DETAIL
NO SCALE





2/04 IRONRIDGE FLASHFOOT ASPHALT SHINGLE ROOF FLASHING DETAIL
NO SCALE

ENPHASE IQ7PLUS-72-2-US INVERTERS	
PHOTOVOLTAIC SYSTEM DC DISCONNECT	
OPERATING CURRENT:	1.21 AMPS
MAXIMUM SYSTEM VOLTAGE:	240 VDC
SHORT CIRCUIT CURRENT:	15 AMPS

SYSTEM AC DISCONNECT AT SERVICE	
PHOTOVOLTAIC SYSTEM AC DISCONNECT	
MAXIMUM AC OPERATING CURRENT:	38.72 AMPS
NOMINAL OPERATING AC VOLTAGE:	120/240 VAC

3/04 PHOTOVOLTAIC MARKING AND LABLING
NO SCALE

CODE REVIEW & CALCULATIONS	
SOLAR PHOTOVOLTAIC (PV) SYSTEM WITH MICROINVERTERS	
INVERTER TYPE:	ENPHASE IQ7PLUS-72-2-US
MAXIMUM STRING LENGTH:	13 MODULES
NOMINAL STRING VOLTAGE:	@ 240V (AC)
Q-CELLS Q.PEAK DUO BLK-G6 335	
NEC 690.7 MAXIMUM VOLTAGE	
690.7(A): MAXIMUM PHOTOVOLTAIC SYSTEM VOLTAGE	
Q-CELLS Q.PEAK DUO BLK-G6 335W MODULE VOC = 40.41V	
CORRECTION FACTOR AT (-32°C - 25°C) X -0.1091V/C + 40.41V = 46.629V	
NEC 690.8 CIRCUIT SIZING AND CURRENT	
690.8(A)(3): INVERTER OUTPUT CIRCUIT CURRENT.	
INVERTER I1 MAX CONTINUOUS OUTPUT CURRENT: 1.21 AMPS (AC)	
690.8(A)(5): DC-TO-DC CONVERTER OUTPUT CURRENT.	
INVERTER I1 MAXIMUM INPUT CURRENT: 15 AMPS (DC)	
higher current source may be used, the inverter will limit its input current to the value stated above.	
NEC 690.9 OVERCURRENT PROTECTION	
690.9(B): OVERCURRENT DEVICE RATINGS	
FUSE SIZE: 38.72A X 125% = 48.4A <= 50 AMP OCPD	
NEC 690.12 RAPID SHUTDOWN OF PV SYSTEMS ON BUILDINGS	
PLAN: ENPHASE IQ7PLUS-72-2-US WITH RAPID SHUTDOWN ENABLED DISCONNECT SHALL BE LOCATED NEXT TO THE SERVICE AND BE LABELED IN ACCORDANCE WITH 690.56(B) AND (C).	

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REVISIONS

DETAILS & CALCULATIONS

04