ILLUMINE i
Illumine Industries, Inc.
1205 BMC Drive, #110
Cedar Park, TX 78613
(512) 823-0438
csnook@illuminei.com
mwassef@illuminei.com

Structural Report for Solar Array Installation

Illumine-i Project #: SUP-73664
Issued Date: 05/25/2023

Project Information:	**Structure:**	Multi-Story Residence
	Address:	1611 Wood Avenue Colorado Springs, Colorado 80907, El Paso County
Design Requirements:	**Codes & Standards:**	2015 IRC (ASCE 7-10), 2015 IBC, 2015 IEBC w/Local Amendments
	Jurisdiction:	City of Colorado Springs

To whom it may concern,

This structural report shall state the structural adequacy of the existing building structure to support the solar array installation proposed in Permit Drawings by Illumine-i (Project: SUP-73664, dated 05/25/2023, Rev G).

Based upon our analysis of the proposed installation to the existing structure, we have determined the adequacy of the following components to be as follows:

Solar Array Components	**Adequate[1]**
Solar Array Anchorage to Roof	**Adequate**
Roof Structure	**Adequate**

Note:

1) Only includes items listed in Table 1.

This analysis will be affected if any conditions throughout the report or associated permit drawings are not also represented on-site. Contractor shall notify the engineer of record of any discrepancies and receive written approval from the engineer of record before proceeding with installation. If there are any questions or further assistance required, please call.

Respectfully,

Professional Engineering Team
Illumine Industries, Inc.

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1) INTRODUCTION

The solar panel array shall be installed on the existing multi-story residence. The structure is wood framed. The roof structure is composed of 2x4 wood trusses spaced at 2'-0" on center. Original building drawings were provided by MiTek USA, Inc, Dated 02/04/2022.

The solar panel array is composed of components shown in Table 1.

Table 1 – List of Solar Panel Array Components

Component	Description	Rating Letter Info	Source
HiKu Mono 400 W - 425W	Solar Panels	PV Module Product Datasheet v2.6_EN by CanadianSolar, dated Nov 2020.	CanadianSolar
Unirac U-Builder 2.0 SOLARMOUNT Flush Rail	Rail System	Report Name: Engineering Certification for the Unirac U-Builder 2.0 SOLARMOUNT Flush Rail by PZSE Structural Engineers, dated 3/31/20	UNIRAC
FlashLoc Duo (Rafter Mount)	Roof Attachment System	Design and Engineering guide by UNIRAC	UNIRAC

Note:

1) All components are verified to withstand design criteria either based upon referenced rating letters or by calculations provided in this report.

2) DESIGN CRITERIA

Code & Standards:		2015 IRC (ASCE 7-10), 2015 IBC, 2015 IEBC w/Local Amendments	
Dead Loads		**Snow Loads**	
Wood Truss Framing:	10 psf	Ground Snow Load, p_g:	43 psf
Solar Array:	3 psf	Snow Exposure Factor, C_e:	1.0
		Snow Importance Factor, I_s:	1.0
Asphalt Shingles:	2 psf	Thermal Factor, C_t:	1.0
1/2" Plywood:	1.6 psf	Slope Factor, C_s:	0.9
		Flat Roof Snow Load, p_f:	30 psf

Live Loads

Roof Live Load:	20 psf

Wind Loads

Ultimate Design Wind Speed, Vult:	130 mph
Allowable Stress Design Wind Speed, V_{asd}:	101 mph
Risk Category:	II
Exposure Category:	C
GC_{pi} (+/-):	0.18

Seismic Loads

Risk Category:	II
Seismic Importance Factor, I_E:	1.0
Design Spectral Response Acceleration Parameters:	SDS: 0.188, SD1: 0.096
Site Class (Assumed):	D
Seismic Design Category:	B

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3) DISCLAIMERS

3.1 ASSUMPTIONS

1. Wood framing meets the following specifications in accordance with the ANSI/AWC "National Design Specification" (2015 Edition).

Roof Framing	No. 2 Southern Pine
Wall Framing	No. 2 Spruce Pine Fir

2. All solar panel array components listed in Table 1 shall be designed and installed per the manufacturer's approved installation specifications.
3. The existing building structure was properly constructed and maintained in good condition.

3.2 LIMITATIONS

1. Waterproofing around the roof penetrations is the responsibility of others.
2. No allowance has been made in this report for any existing deficiency in design, material, construction, or lack of maintenance for the existing structure or proposed equipment.
3. Any miscellaneous items not explicitly listed in this report have not been designed or detailed by Illumine-i. It is recommended that material of suitable size and strength be obtained from a reputable manufacturer for miscellaneous items.
4. The referenced permit plans are schematic representations of the installation of proposed equipment to the existing structure. The contractor shall be responsible for field verifying existing conditions, proper fit, and clearances in the field.
5. Construction documents depicting the required modifications for installation are obtainable from Illumine-i, but are beyond the scope of this report.

I. Component & Cladding Wind Calculations

Site Data

Ultimate Design Wind Speed, Vult:	130	mph
Exposure Category:	C	
Risk Category:	II	
Topo Factor, K_{zt}:	1.00	

Building Data

Mean Roof Height, h:	30	ft
Building Type:	Enclosed	
Roof Type:	Gable	
Roof Slope:	34	°
Least Horizontal Building Length:	27	ft
Largest Horizontal Building Length:	38	ft
Estimated Building Area:	1030	ft^2
Roof dimension, 'a' per ASCE7:	3	ft

Wind Data

Velocity Pressure Coef, K_z:	0.980	
Wind Directionality Factor, K_d:	0.85	
Ground Elevation Factor, K_e:	N/A	
Velocity Pressure @ Height, q_h:	36.0	psf
Effective Wind Area, A:	18.0	ft^2

Component & Cladding Wind Pressures

Positive Pressure for Effective Area, A = 18 SF*

Roof Zone	(GC_p)	(GC_{pi}, +/-)	Max Positive Pressure (psf)
All Zones	0.87	0.18	38.00

Positive notation indicates wind pressure acting downwards on roof

Negative Pressure for Effective Area, A = 18 SF*

Roof Zone	(GC_p)	(GC_{pi}, +/-)	Max Negative Pressure (psf)
1	-0.95	0.18	-40.69
2 & 3	-1.15	0.18	-47.89

Negative notation indicates wind pressure acting away from roof

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Wind calculations according to ASCE 7-10

II. Wind Forces on Solar Panel System

Panel Data

Short Length of Panel:	42	in
Long Length of Panel:	77	in
Quantity of Panels:	16	

*Panel Pressure

Panel Location (Roof Zone)	Eff. Wind Area, A	Positive Pressure (psf)	Uplift Pressure (psf)	Service Uplift Pressure (psf)
1	21.9	37.69	-40.07	-24.05
2 & 3	21.9	37.69	-47.28	-28.37

Panel pressures only calculated for roof zones where solar panels are present.

Attachment Data

Connection # 1:

Max CNX Spacing:	4.00	ft
Attachments are along..*(x)*.. of panel:	Short Side	

Panel Attachments, Withdrawal

CNX #	Attach. Location (Roof Zone)	Trib. Wind Area, A	Uplift Pressure (psf)	Withdrawal Force (lbs)	Service Withdrawal Force (lbs)
1	2 & 3	12.7	-48.98	-623.6	-374.2

Wind calculations according to ASCE 7-10

III. Gravity Loads

Roof Dead Loads

Asphalt Shingles:	2	psf
1/2" Plywood:	1.6	psf
		psf
		psf
		psf
		psf
Total Existing Dead Load:	3.6	psf

Roof Dead Loads with Panels

Solar Array	3	psf
		psf
Total New Dead Load:	6.6	psf

Roof Live Loads

Existing Design Roof Live Load (reduced for sloped roof):	16.0	psf

Roof Live Loads with Panels

Roof Live Load @ Location w/ Solar Array:	0	psf

Snow Loads

Ground Snow Load, pg:	43	psf
Snow Exposure Factor, Ce:	1.0	
Snow Importance Factor, Is:	1.0	
Thermal Factor, Ct:	1.0	
Flat Roof Snow Load, pf:	30	psf
Slope Factor, Cs:	0.9	
Sloped Roof Snow Load, ps:	30	psf

Snow Loads with Panels

Thermal Factor, Ct:	1.0	
Flat Roof Snow Load, pf:	30.0	psf
Slope Factor, Cs:	0.6	
Sloped Roof Snow Load, ps:	16.7	psf

Gravity Load Comparison

Factored Load Combinations	*Exist. Weight (psf)*	*New Weight (psf)*
1.4 DL:	5.0	9.2
1.2 DL + 1.6 L_r:	29.9	7.9
1.2 DL + 1.6 S:	52.3	34.6
Maximum Factored Gravity Loads:	52.3	34.6
% Increase in Factored Weight:	-33.9%	

Per Section 403.3 of the 2015 IEBC, any existing gravity load-carrying structural element for which an alteration causes an increase in design dead, live, or snow load, including drift effects, of more than 5% shall be replaced or altered as needed to carry the gravity loads by the IBC for new structures.

Since there is no increase of gravity load greater than 5%, the existing structure is adequate for the alteration.

IV. Seismic Loads

Seismic Weight

Existing Roof Dead Load:	13.6	psf
Roof Dead Load @ Panel Locations:	16.6	psf
Quantity of Pre-Existing Panels:	0	
% of Roof w/ Solar Panels:	34.2%	
Equiv. Seismic Weight Increase:	7.5%	

Per Section 403.4 of the 2015 IEBC, any existing lateral load-carrying element whose demand-capacity ratio with the alteration considered is not more than 10% greater than its demand-capacity ratio with the alteration ignored shall be permitted to remain unaltered.

Since there is no increase of seismic weight greater than 10%, the existing lateral load-carrying elements are adequate for the alteration.

DEAD LOAD CALCULATIONS

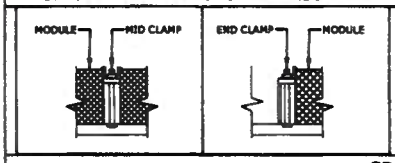
BOM	QUANTITY	LBS/UNIT	TOTAL WEIGHT (LBS)
MODULES	16	49.9	798.40
MID-CLAMP	28	0.14	3.92
END-CLAMP	8	0.24	1.92
RAIL LENGTH	114	0.56	63.84
SPLICE BAR	8	0.56	4.48
UNIRAC FLASHLOC DUO	32	0.55	17.60
TOTAL WEIGHT OF THE SYSTEM (LBS)			890.16
TOTAL ARRAY AREA ON THE ROOF (SQ. FT.)			350.59
WEIGHT PER SQ. FT.(LBS)			2.54
WEIGHT PER PENETRATION (LBS)			27.82

MODULE DATA

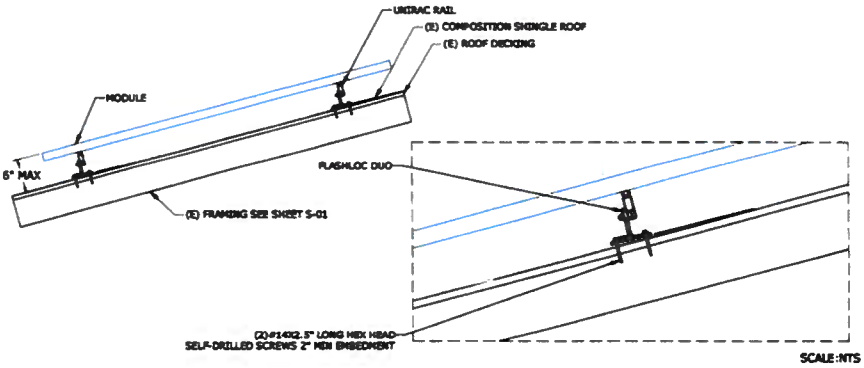
CANADIAN SOLAR HIKU CS3N-425MS (425W)

MODULE DIM	76.4"x41.3"x1.38"
LAG SCREW	(2)#14X2.5" LONG HEX HEAD SELF-DRILLED SCREWS 2" MIN EMBEDMENT

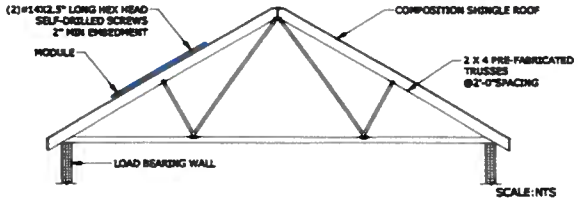
MID-CLAMP AND END-CLAMP ASSEMBLY



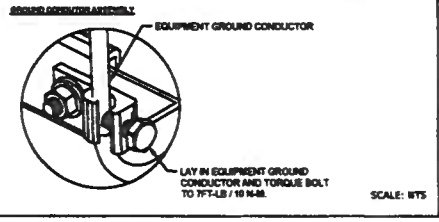
ATTACHMENT DETAIL-UNIRAC FLASHLOC DUO



ROOF FRAMING DETAILS



GROUNDING DETAILS



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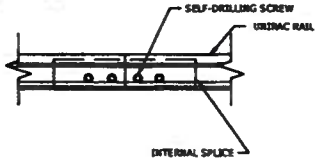

CUSTOMER INFORMATION	CONTRACTOR INFORMATION
NAME: MARIO SOTO ADDRESS: 1611 WOOD AVE, COLORADO SPRINGS, CO 80907 38.857034, -104.825354 APN: 6406313010 UTILITY: COLORADO SPRINGS AHJ: CO-CITY OF COLORADO SPRINGS	

DRAWING INFORMATION

PRN NUMBER: SUP-73664 REV: G
DRAFTED BY: R.KARTHICK
QC'ED BY: S.PRAKASH
SCALE: AS NOTED
PAPER SIZE: 17"X11"

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STRUCTURAL DETAILS
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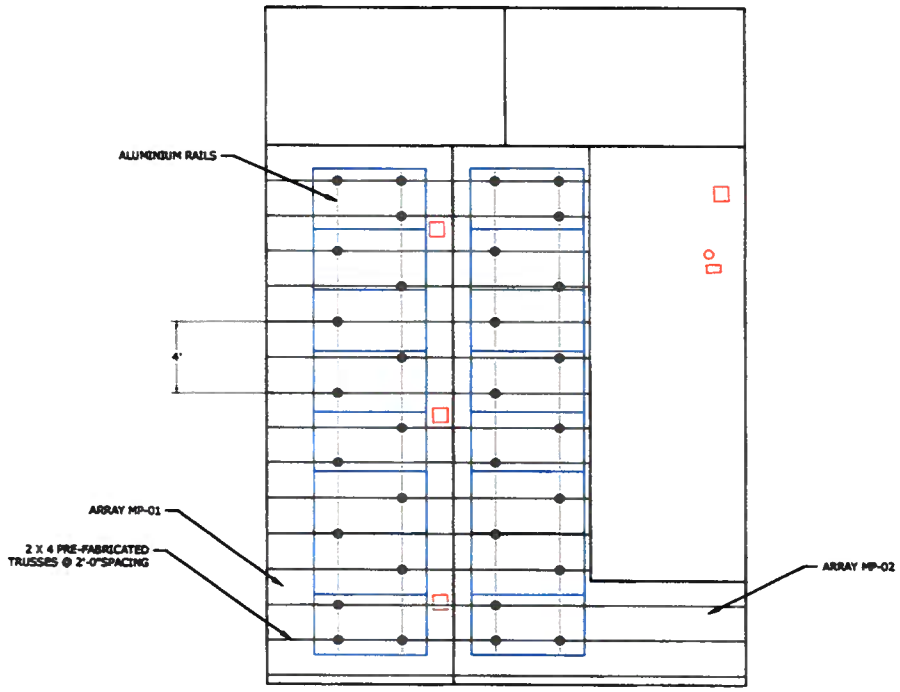
NOTE:PENETRATIONS ARE STAGGERED



SCALE:3/16" = 1'-0"

SITE INFORMATION

S.NO	AZIMUTH	PITCH	NO. OF MODULES	ARRAY AREA (SQ. FT.)	ROOF TYPE	ATTACHMENT	ROOF EXPOSURE	FRAME TYPE	FRAME SIZE	FRAME SPACING	MAX RAIL SPAN	OVER HANG
MP-01	88°	34°	8	175.3	COMPOSITION SHINGLE	UNIRAC FLASHLOC DUO	ATTIC	PRE-FABRICATED TRUSSES	2 X 4	2'-0"	4'-0"	1'-6"
MP-02	268°	34°	8	175.3	COMPOSITION SHINGLE	UNIRAC FLASHLOC DUO	ATTIC	PRE-FABRICATED TRUSSES	2 X 4	2'-0"	4'-0"	1'-6"

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ADDRESS: 1611 WOOD AVE, COLORADO SPRINGS, CO 80907

38.857034, -104.825354
APN: 6406313010
UTILITY: COLORADO SPRINGS
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CONTRACTOR INFORMATION

Sun Power

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MOUNTING DETAILS
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