

Structural Assessment Associated with Future Solar Array Installation

For

Lee's Summit Subaru
2101 NE Independence, Ave.
Lee's Summit, MO

Prepared by



December 23, 2020

December 23, 2020

Artisun Solar
Attn: Mr. Kirk Kreisel
12916 5th Street
Grandview, MO 64030

Ref. Structural Assessment – Roof Top Solar Installation
Lee's Summit Subaru

Dear Mr. Kreisel,

At your request, we have performed a structural assessment of the existing roof framing at the above referenced facility. The planned roof top solar installation can be described as a ballasted system with multiple array locations as shown in the attached calculation documents. This letter describes our assessment of the existing structural framing that will support the planned solar installation.

Impact to Structural Elements Carrying Gravity Loads

We examined the worst case loading for each of the roof areas (3 areas) where the roof framing was consistent with respect to secondary framing members. The back row of the multiple arrays were aligned with the greater number of ballast blocks and created the worst case loading. The secondary framing members were examined with the worst case loading and determined to have the capacity to support the planned ballasted solar array's (see attached calculations).

Impact to Existing Structural Elements Carrying Lateral Loads (Wind)

The proposed ballasted solar array presents an increased profile for lateral wind loads. The attached solar panels extend approximately 2 feet above the roof surface. The existing eave height of the building is 28'-0". Therefore the vertical profile of the building is increased by approximately $(28+2)/28 = 1.0714$ or an increase in profile of 7.14%. The less than 10% increase in the Lateral Loads (Wind) satisfies IBC Section 3404.4 Existing Structural Elements Carrying Lateral Loads.

Our assessment of the steel joist/deck metal roof structure, at the above referenced location, has sufficient structural capacity in the gravity load and lateral load resisting system to support the proposed roof ballasted solar array.

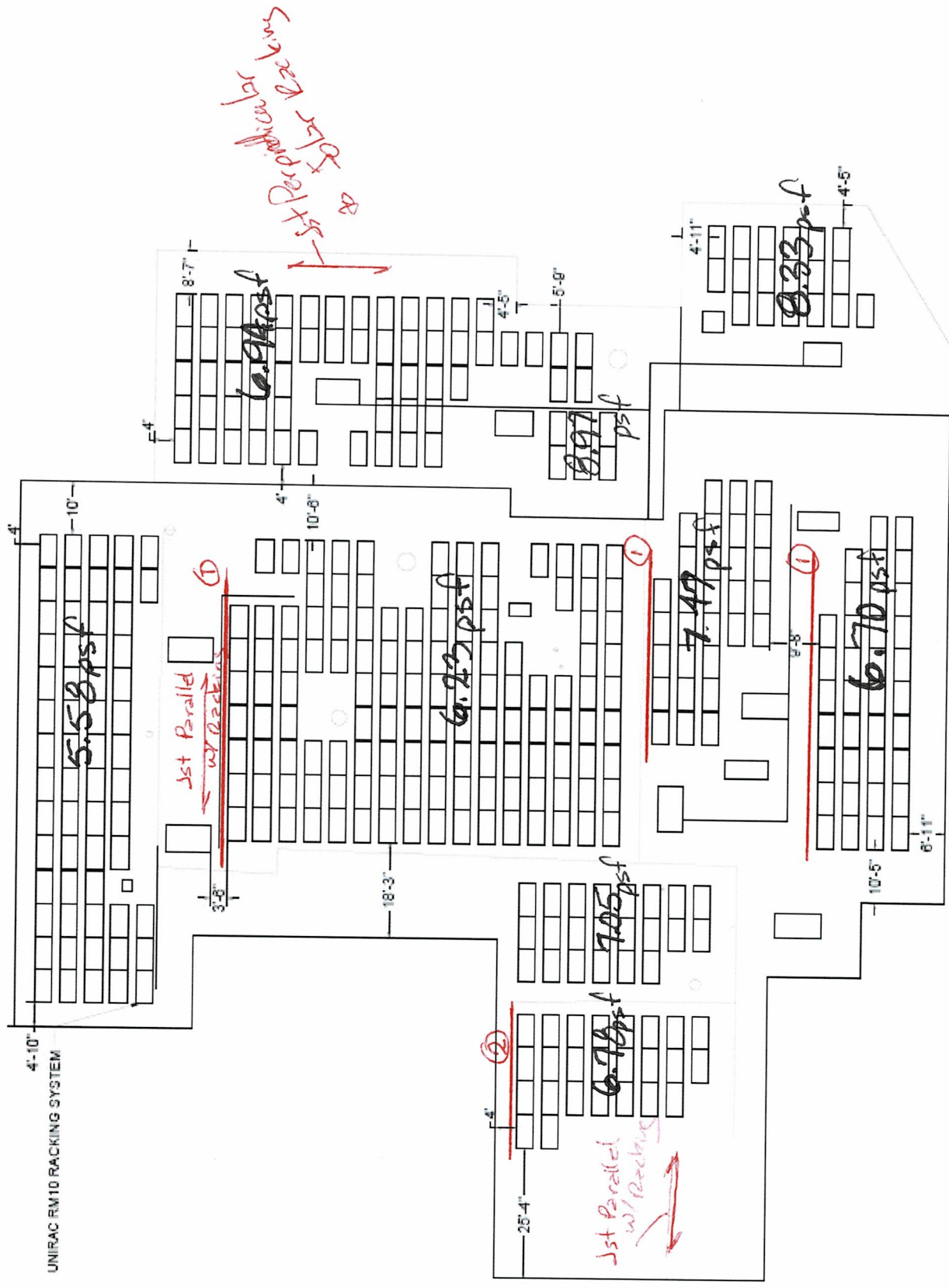
Please call if you have any questions or require further information regarding this assessment.

Best regards,

A handwritten signature in black ink, reading 'Gerald L. Charlton'.

Gerald L. Charlton, P.E.

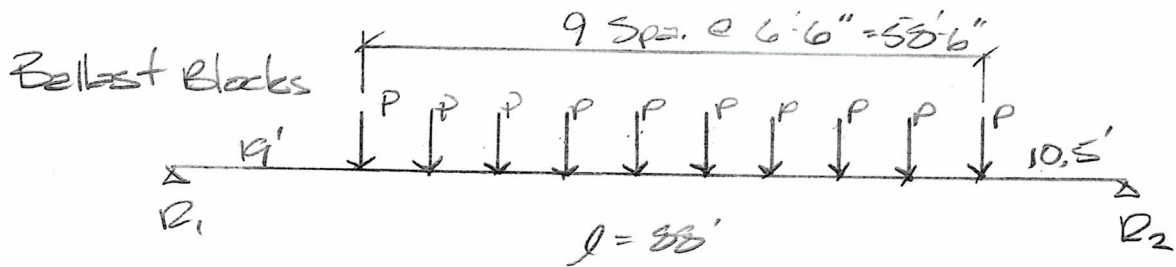
Enc. Structural Assessment



① 43LH12

Lee's Summit

Subaru - Roof Area ①



$$P = 192 \text{ lb}$$

$$R_1 = 192(61.5 + 75 + 68.5 + 62 + 55.5 + 49 + 42.5 + 36 + 29.5 + 23 + 16.5 + 10) / 33$$

$$R_1 = 1,200 \text{ lb} \quad R_2 = 10 \times 192 - 1,200 = 720 \text{ lb}$$

Solar/Rack Loads

$$\text{Additional } q_{\text{roof}} \sim 4.5 \times 6 = 39 \text{ lb}$$

$$P + P_{\text{add}} = 192 + 39 = 231$$

$$R_1 = 1,200 \times 231 / 192 = 1,444 \text{ lb} \quad \leftarrow \text{Controls Shear}$$

$$R_2 = 720 \times 231 / 192 = 846 \text{ lb}$$

For worst Case Bending Moment $\sim$ Move Array to by Sym.

$$W_{\text{solar}} = 231 / 6.5 = 35.5 \text{ plf}$$

Existing Condition

$$\begin{array}{l} \text{DL: } 3 \text{ psf Roof/Deck} \\ \quad 4 \text{ psf Self wt} \\ \quad 1 \text{ psf MEP} \\ \hline 8 \text{ psf} \times 6.67 \Rightarrow 53.4 \text{ plf} \end{array}$$

$$\text{Lr: } 20 \text{ psf} \times 6.67 \Rightarrow 133.4 \text{ plf}$$

$$\begin{array}{l} \text{Sn: } P_{\text{fmin}} = I_p F_s = 10 \times 20 \\ \quad \quad \quad = 20 \times 6.67 = 133.4 \text{ plf} \end{array}$$

$$\text{Wind: } 1/2 \times 116 \text{ psf} \times 6.67 \Rightarrow 106.7 \text{ plf}$$

Existing Condition (Continued)

Load Comb 3 $DL + (S \text{ or } L_r)$

$$53.4 + 133.4 = 186.8 \text{ pcf}$$

Load Comb 62 $DL + .75(.6W) + .75(S \text{ or } L_r)$

$$53.4 + .75(.6 \times 106.7) + .75(133.4) = 201.5 \text{ pcf}$$

Add Solar

$$R_s = 35.5 \times 58.5 / 2 = 1,038$$

$$\text{Equiv. } w = 2 \times 1,038 / 88 = 23.6 \text{ pcf}$$

$$\text{Uniform Load } w / \text{Solar} = 201.5 + 23.6 = 225.1 \text{ pcf}$$

Examine 48LH12 @ 88'

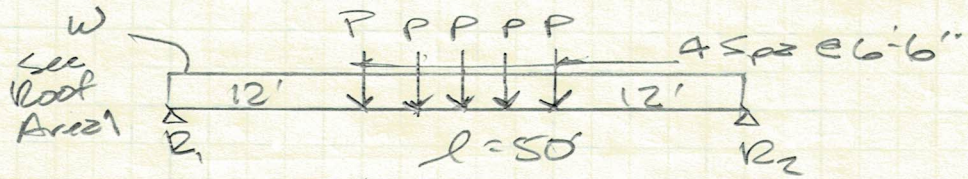
$$\text{Allowable Load} = 289 \text{ pcf} > \text{Actual Load } 225 \text{ pcf}$$

Okay
↓

Lee's Summit
Subaru

Roof Area 2

Examine Existing 28k9 @ 6'-6" spacing
50ft Span



Black Panel
 $P = 6 \times 32 + 6 \times 6.5 = 231 \text{ lb}$

Worst Case Trib. Load Existing Condition
 $w = 201.5 \text{ pef}$

Equiv. $w_{w/ \text{ solar}} = 5 \times 231 \div 50' = 23.1 \text{ pef}$

Equiv. $w = 201.5 + 23.1 = 224.6 \text{ pef}$

28k9 Allowable Load @ 50ft = 228 pef

Actual Load w/ Solar = 224.8 pef

Okay
}

Lee's Summit

Subaru - Roof Area (3)

2 Spans @ 36 ft

Examine 18k7 Sp. 4'0" O.C.

Loads:

$$\begin{array}{rcl} \text{DL} & 3 \text{ psf} & \text{Roof/Deck} \\ & 2 \text{ psf} & \text{Self wt.} \\ & \underline{2 \text{ psf}} & \text{MEP} \\ & 7 \text{ psf} & \times 6' \Rightarrow \end{array}$$

$$42 \text{ psf}$$

$$\text{Lr: } 20 \text{ psf} \times 6' \Rightarrow$$

$$120 \text{ psf}$$

$$\begin{array}{l} \text{Snow: } P_{\text{Snow}} = I P_g \\ = 1.0 \times 20 \times 6' \Rightarrow \end{array}$$

$$120 \text{ psf}$$

$$\text{Wind: } \pm 16 \text{ psf} \times 6' \Rightarrow$$

$$96 \text{ psf}$$

$$\text{Solar: } 6.94 \text{ psf} \times 6' \Rightarrow$$

$$41.6 \text{ psf}$$

Examine Load Comb. (3) DL + (S or Lr)

$$42 + 120 = 162 \text{ w/o Solar}$$

$$\begin{array}{r} 41.6 \\ \hline 203.6 \text{ w/ Solar} \end{array}$$

Examine Load Comb. (6a) DL + .75(.6W) + .75(S or Lr)

$$42 + .75(.6 \times 96) + .75(120) = 175.2 \text{ w/o Solar}$$

$$41.6$$

$$\text{Controls} \Rightarrow \begin{array}{r} 41.6 \\ \hline 216.8 \text{ psf w/ Solar} \end{array}$$

$$\text{Allowable Load 18k7} = 232 \text{ psf}$$

$$\text{Actual Load} = 217 \text{ psf}$$

Okay
✓

PROJECT TITLE

 CED (EISENBISE) -
149.48KW

PROJECT ID

F477709F

CREATED

Dec. 10, 2020, 4:56 p.m.

NAME	Artisun Solar, LLC	Designed by sandeep.k@nuevo-sol.com
ADDRESS	2101 NE Independence Ave	ROOFMOUNT RM10
CITY, STATE	Lees Summit, MO	Boviet - copy
MODULE	Boviet - copy BVM6612M-370	404 - BVM6612M-370
		8439.14 ft ²
		149.48 KW

BILL OF MATERIALS

 LEGEND: ■ Base System Part ■ Accessory

PART NUMBER	PART TYPE	DESCRIPTION	QUANTITY	SUGGESTED QUANTITY	UNIT PRICE (USD)	TOTAL LIST PRICE (USD)
UserSupplied	Ballast Block	Ballast Block	1925	1925	0.00	0.00
310710	Ballast Bay	RM Ballast Bay 10 Degree	582	582	42.63	24810.66
310760	RM Roof Pad	RM Roof Pad	1164	1164	2.23	2595.72
310750	Module Clip	RM Module Clip	2012	2012	1.13	2273.56
310751	RM Hex Bolt	RM Hex Bolt (Module Clip)	2012	2012	0.47	945.64
008009P	Grounding Lug	ILSCO LAY IN LUG (GBL4DBT)	10	10	5.75	57.50

BASE SYSTEM PRICE
\$28029.86
 \$0.188 PER WATT

ACCESSORIES PRICE
\$2653.22
 \$0.018 PER WATT

TOTAL PRICE
\$30683.08
 \$0.205 PER WATT

This design is to be evaluated to the product appropriate Unirac Code Compliant Installation Manual which references International Building Code 2009, 2012, 2015, 2018 and ASCE 7-05, ASCE 7-10, ASCE 7-16 and California Building Code 2010, 2016. The installation of products related to this design is subject to requirements in the above mentioned installation manual.

DETAILED PARTS DESCRIPTION

QTY

	Ballast Block UserSupplied Ballast Block	1925
Standard 4x8x16 inch cap blocks. Nationwide availability. Please confirm the weight of your ballast block as this will affect the total blocks required for your installation.		
	Ballast Bay 310710 RM Ballast Bay 10 Degree	582
Aluminum ballast bay attaches to north and south module edges (for 10 degree tilt installations) and provides ballast placement location.		
	RM Roof Pad 310760 RM Roof Pad	1164
TPE 201-73 BK Santoprene Roof Pad. PLEASE NOTE: Depending on your roof type and seismic conditions, some quantity of roof pads may be required. These will be listed separately on your bill of materials.		
	Module Clip 310750 RM Module Clip	2012
Aluminum clip fastens module frame to ballast bay and provides bonding path from module to bay to module.		
	RM Hex Bolt 310751 RM Hex Bolt (Module Clip)	2012
Hex bolt with integrated locking patch.		
	Grounding Lug 008009P ILSCO LAY IN LUG (GBL4DBT)	10
For electrical bonding of PV modules and rails. Accepts 4-14 AWG copper wires. Tin plated copper body, 1/4" stainless steel fasteners.		

ENGINEERING REPORT

Plan review

AVERAGE PSF	6.68 psf
TOTAL NUMBER OF MODULES	404
TOTAL KW	149.48 KW
TOTAL AREA	~13233 ft ²
TOTAL WEIGHT ON ROOF	88403 lbs
RACKING WEIGHT	2037 lbs
MODULE WEIGHT	23602 lbs
BALLAST WEIGHT	61600 lbs
MAX BAY LOAD (DEAD)	254 lbs

Loads Used for Design

BUILDING CODE	ASCE 7-16
BASIC WIND SPEED	110.00 mph
GROUND SNOW LOAD	20.00 psf
SEISMIC (SS)	0.10
ELEVATION	1000.00 ft
WIND EXPOSURE	C
MRI	50

Loads Determined by Zip64064

CITY, STATE	Lees Summit, MO
BASIC WIND SPEED	103.00 mph
GROUND SNOW LOAD	20.00 psf

Inspection

PRODUCT	ROOFMOUNT RM10
MODULE MANUFACTURER	Boviet - copy
MODEL	BVM6612M-370
MODULE WATTS	370 watts
MODULE LENGTH	77.01"
MODULE WIDTH	39.06"
MODULE THICKNESS	1.57"
MODULE WEIGHT	58.42 lbs
BALLAST BLOCK (CMU) WEIGHT	32.0 lbs
MAX BLOCKS PER BAY	4
BUILDING HEIGHT	25.00 ft
ROOF TYPE	TPO
PARAPET HEIGHT	> 1 Array Height (> 12 inches)

Roof Area 1 - Array 1

AVERAGE PSF		5.58 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		60	ARRAY TO ARRAY:	12.0"
TOTAL KW:		22.20 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		2006 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		11188 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		287 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		3505 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		7232 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 1 - Array 2

AVERAGE PSF		6.23 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		128	ARRAY TO ARRAY:	12.0"
TOTAL KW:		47.36 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		4114 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		25644 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		585 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		7478 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		17248 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 1 - Array 3

AVERAGE PSF		7.47 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		30	ARRAY TO ARRAY:	12.0"
TOTAL KW:		11.10 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		1013 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		7568 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		158 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		1753 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		5568 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 1 - Array 4

AVERAGE PSF	6.70 psf
TOTAL NUMBER OF MODULES:	44
TOTAL KW:	16.28 KW
TOTAL AREA:	1479 ft ²
TOTAL WEIGHT ON ROOF:	9904 lbs
RACKING WEIGHT:	228 lbs
MODULE WEIGHT:	2570 lbs
BALLAST WEIGHT:	6976 lbs

MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
ARRAY TO ARRAY:	12.0"
TO FIXED OBJECT ON ROOF:	24.0"
TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MAX NUMBER OF NORTH-SOUTH ROWS:	64
MAX NUMBER OF EAST-WEST COLUMNS:	282
*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 1 - Array 5

AVERAGE PSF	7.05 psf
TOTAL NUMBER OF MODULES:	23
TOTAL KW:	8.51 KW
TOTAL AREA:	744 ft ²
TOTAL WEIGHT ON ROOF:	5248 lbs
RACKING WEIGHT:	123 lbs
MODULE WEIGHT:	1344 lbs
BALLAST WEIGHT:	3712 lbs

MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
ARRAY TO ARRAY:	12.0"
TO FIXED OBJECT ON ROOF:	24.0"
TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MAX NUMBER OF NORTH-SOUTH ROWS:	64
MAX NUMBER OF EAST-WEST COLUMNS:	282
*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 1 - Array 6

AVERAGE PSF	6.78 psf
TOTAL NUMBER OF MODULES:	32
TOTAL KW:	11.84 KW
TOTAL AREA:	1034 ft ²
TOTAL WEIGHT ON ROOF:	7013 lbs
RACKING WEIGHT:	158 lbs
MODULE WEIGHT:	1869 lbs
BALLAST WEIGHT:	4896 lbs

MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
ARRAY TO ARRAY:	12.0"
TO FIXED OBJECT ON ROOF:	24.0"
TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MAX NUMBER OF NORTH-SOUTH ROWS:	64
MAX NUMBER OF EAST-WEST COLUMNS:	282
*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 2 - Array 1

AVERAGE PSF		6.94 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		52	ARRAY TO ARRAY:	12.0"
TOTAL KW:		19.24 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		1685 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		11691 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		273 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		3038 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		8224 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 2 - Array 2

AVERAGE PSF		8.97 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		6	ARRAY TO ARRAY:	12.0"
TOTAL KW:		2.22 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		207 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		1857 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		42 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		351 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		1440 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 2 - Array 3

AVERAGE PSF		10.11 psf	MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
TOTAL NUMBER OF MODULES:		6	ARRAY TO ARRAY:	12.0"
TOTAL KW:		2.22 KW	TO FIXED OBJECT ON ROOF:	24.0"
TOTAL AREA:		207 ft ²	TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TOTAL WEIGHT ON ROOF:		2092 lbs	TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
RACKING WEIGHT:		49 lbs	MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MODULE WEIGHT:		351 lbs	MAX NUMBER OF NORTH-SOUTH ROWS:	64
BALLAST WEIGHT:		1664 lbs	MAX NUMBER OF EAST-WEST COLUMNS:	282
			*See ASCE 7-16 Section 13.6.12 for more details	

Roof Area 2 - Array 4

AVERAGE PSF	8.33 psf
TOTAL NUMBER OF MODULES:	23
TOTAL KW:	8.51 KW
TOTAL AREA:	744 ft ²
TOTAL WEIGHT ON ROOF:	6198 lbs
RACKING WEIGHT:	137 lbs
MODULE WEIGHT:	1344 lbs
BALLAST WEIGHT:	4640 lbs

MINIMUM SEISMIC SEPARATION (UNATTACHED ARRAYS) *	
ARRAY TO ARRAY:	12.0"
TO FIXED OBJECT ON ROOF:	24.0"
TO ROOF EDGE WITH QUALIFYING PARAPET:	24.0"
TO ROOF EDGE WITHOUT QUALIFYING PARAPET:	48.0"
MAX ARRAY (SEISMIC) (FOR UNATTACHED ARRAYS) *	
MAX NUMBER OF NORTH-SOUTH ROWS:	64
MAX NUMBER OF EAST-WEST COLUMNS:	282
*See ASCE 7-16 Section 13.6.12 for more details	

RM10 U-BUILDER PRODUCT ASSUMPTIONS

RM10 – Ballasted Flat Roof Systems

Limitations of Responsibility: It is the user's responsibility to ensure that inputs are correct for your specific project.

Unirac is not the solar, electrical, or building engineer of record and is not responsible for the solar, electrical, or building design for this project.

Building Assumptions

1. Risk Category II
2. Building Height ≤ 50 ft
3. Building Height > 50 ft: only where $(\text{longest length of building} \times \text{building height})^{0.5} \leq 100$ ft
4. Roof Slope $\geq 0^\circ$ (0:12) and $\leq 3^\circ$ (5/8:12) for Seismic Design Category C, D, E and F. For low seismic regions Seismic Design Category A and B (provided Array Importance factor = 1.0), Roof Slope $\geq 0^\circ$ (0:12) and $\leq 7^\circ$ (1 1/2:12).
5. Roofing Material Types: EDPM, PVC, TPO, or Mineral Cap
6. Surrounding Building Grade: Level

Ballast Blocks

The installer is responsible for procuring the ballast blocks (Concrete Masonry Units – CMU) and verifying the required minimum weight needed for this design. CMU should comply with ASTM standard specification for concrete roof pavers designation (C1491 or C90 with an integral water repellent suitable for the climate it is placed. It is recommended that the blocks are inspected periodically for any signs of degradation. If degradation of the block is observed, the block should immediately be replaced.

The CMU ballast block should have nominal dimensions of 4"x8"x16". The actual block dimensions are 3/8" less than the nominal dimensions. Ballast blocks should have a weight as specified for the project in the "Inspection" section of this report.

Design Parameters

1. Risk Category II
2. Wind Design
 - a. Basic Wind Speed: 85-120 mph (ASCE 7-05)/110-150 mph (ASCE 7-10)/90-180 mph (ASCE 7-16)
 - b. Exposure: B, C or D (ASCE 7-05/ASCE 7-10)
 - c. 25 year Design Life/50 year Design Life for ASCE 7-16
 - d. Elevation: Insertion of the project at - grade elevation can result in a reduction of wind pressure. If your project is in a special case study region or in an area where wind studies have been performed, please verify with your jurisdiction to ensure that elevation effects have not already been factored into the wind speed. If elevation effects have been included in your wind speed, please select 0 ft as the project site elevation.
 - e. Wind Tunnel Testing: Wind tunnel testing coefficients have been utilized for design of the system.
3. Snow Design
 - a. Ground Snow Load: 0-80 psf (ASCE 7-10/ASCE 7-16)
 - b. Exposure Factor: 0.9
 - c. Thermal Factor: 1.2
 - d. Roof Snow Load: Calculation per Section 7.3 (ASCE 7-05/ASCE 7-10/ASCE 7-16)
 - e. Unbalanced/Drifting/Sliding: Results are based on the uniform snow loading and do not consider unbalanced, drifting, and sliding conditions
4. Seismic Design
 - a. Report *SEAOC PV1-2012/ASCE 7-16 SECTION 13.6.12 – Structural Seismic Requirements and Commentary for Rooftop Solar Photovoltaic Arrays*
 - b. Seismic Site Class: A, B, C, or D (ASCE 7-05/ASCE 7-10/ASCE 7-16)
 - c. Importance Factor Array (Ip): 1.0
 - d. Importance Factor Building (Ie): 1.0
 - e. Site Class: D

Properties

1. Bay Weight: ~3.5 lbs
2. Module Gaps (E/W) = 0.25 in
3. Bays: North row bays overhang the module by ~19.5 inches.

Module Properties

1. Module return flange: Minimum of 0.9in (when using 1-3/4 in. clip bolts) is required.
2. Module return flange: Minimum of 0.65in (when using 2 in. clip bolts) is required.

Testing

1. Coefficient of Friction
2. Wind Tunnel
3. UL 2703
4. Component Testing (Bay and Clamp)

Setbacks

For the wind tunnel recommendations in U-Builder to apply, the following setbacks should be observed/followed for U-Builder wind design:

1. Modules should be placed a minimum of 3 feet from the edge of the building in any direction.
2. If the array is located near an obstruction that is 3.5 feet wide and 3.5 feet high or larger, the nearest module of the array must be located a distance from the obstruction that is greater than or equal to the height of the obstruction.
Exception: When using ASCE 7-16 Building Code and using the obstruction feature in the module editor to accurately model the size and location of obstruction.
3. Installations within the setbacks listed above require site specific engineering²
4. The setbacks above are for wind. High seismic areas, fire access isles, mechanical equipment, etc., may require larger setbacks than listed above for wind.

Site Specific Engineering

Conditions listed below are beyond the current capabilities of U-Builder. Site specific engineering is required.

1. Wind designs for a project design life exceeding 25 years¹/ASCE 7-16
2. Building assumptions and design parameters outside of U-Builder assumptions²
3. Attachments²
4. Risk Category III or IV projects (U-Builder can be adjusted for the correct wind, but not the seismic or snow design)²
5. Wind tunnel testing reduction factors are not permitted by the Authority Having Jurisdiction (AHJ)³
6. Seismic designs that fall outside SEAOC PV1-2012/ASCE 7-16 SECTION 13.6.12 recommendations (>3% roof slope, or AHJ's that require shake table testing or non-linear site-specific response history analysis)³
7. Signed and sealed site-specific calculations, layouts, and drawings³

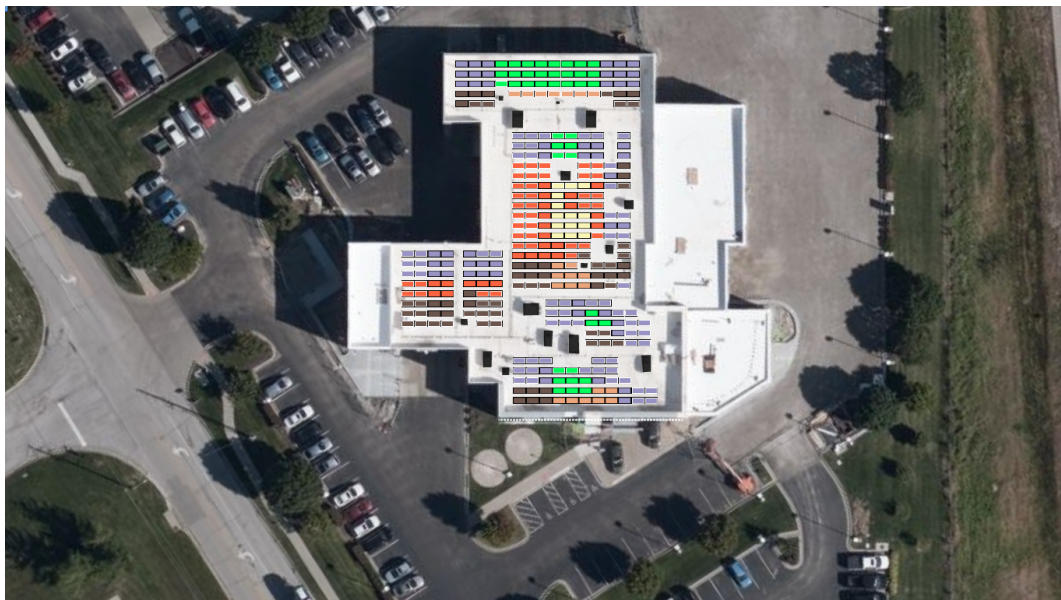
Notes:

¹Please contact info@unirac.com.

²Please contact EngineeringServices@unirac.com for more information.

³Please contact Theresa Allen with PZSE Structural Engineers at theresa@pzse.com. These items will require direct coordination with PZSE to complete the requested services.

Roof Area 1



LEGEND



Module



Standard corner bay with CMU block count



Supplemental bay with CMU block count

NOTE

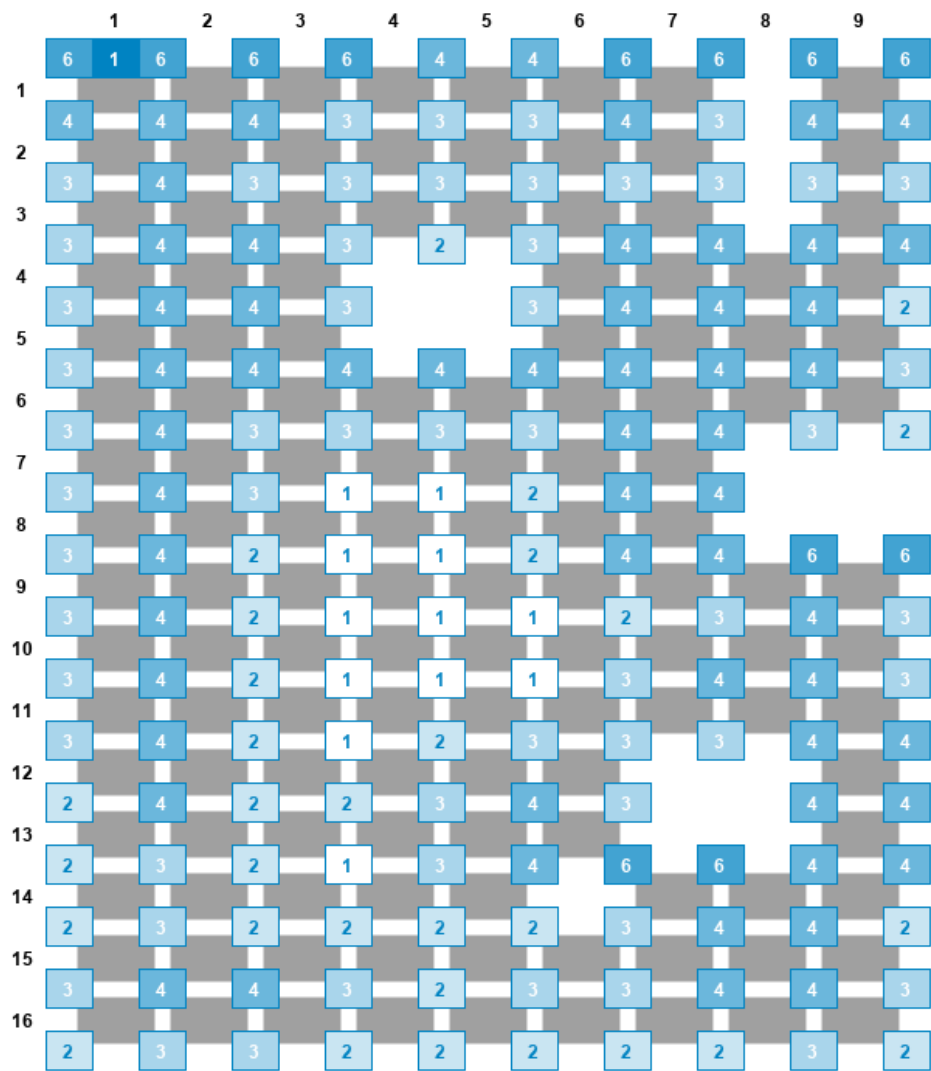
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 25.78 ft
EW DIMENSION	~ 90.14 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	14	15	59	1888
2	14	15	37	1184
3	14	15	29	928
4	13	15	43	1376
5	5	15	41	1312
6	0	7	17	544

Roof Area 1 / Roof Area 1 - Array 2



LEGEND

- Module
- 1 Standard corner bay with CMU block count
- 4 Supplemental bay with CMU block count

NOTE

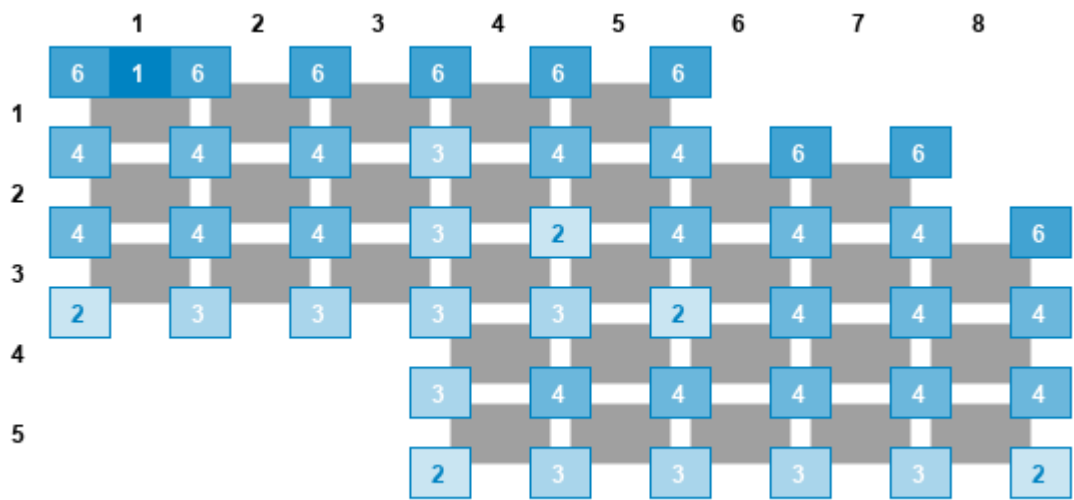
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 78.91 ft
EW DIMENSION	~ 57.95 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	8	11	57	1824
2	8	10	36	1152
3	8	10	31	992
4	7	10	35	1120
5	7	9	31	992
6	9	10	38	1216
7	7	10	32	1024
8	7	8	22	704
9	9	10	33	1056
10	9	10	24	768
11	9	10	26	832
12	7	10	29	928
13	7	9	28	896
14	8	10	35	1120
15	9	10	26	832
16	9	10	33	1056
17	0	10	23	736

Roof Area 1 / Roof Area 1 - Array 3



LEGEND

- Module
- 1

Standard corner bay with CMU block count
- 4

Supplemental bay with CMU block count

NOTE

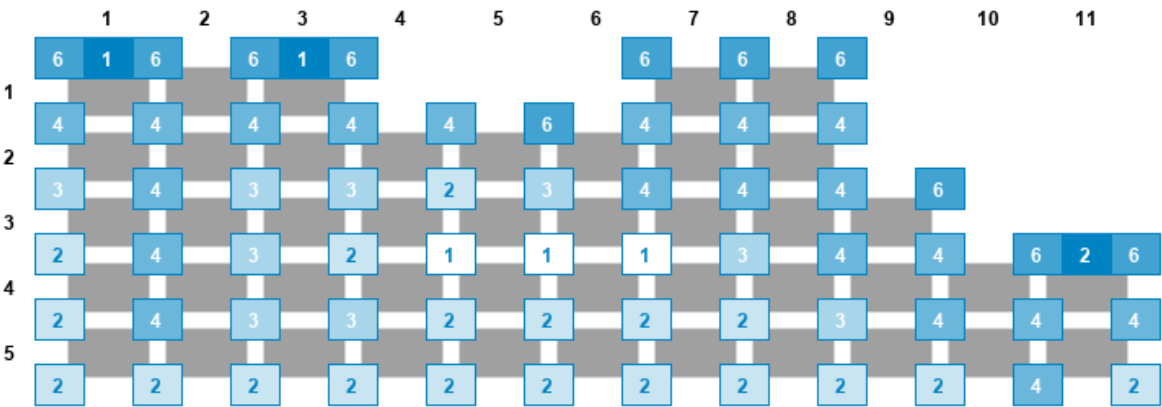
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 25.78 ft
EW DIMENSION	~ 51.51 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	5	7	37	1184
2	7	8	35	1120
3	8	9	35	1120
4	5	9	28	896
5	5	6	23	736
6	0	6	16	512

Roof Area 1 / Roof Area 1 - Array 4



LEGEND

- Module
- 1

Standard corner bay with CMU block count
- 4

Supplemental bay with CMU block count

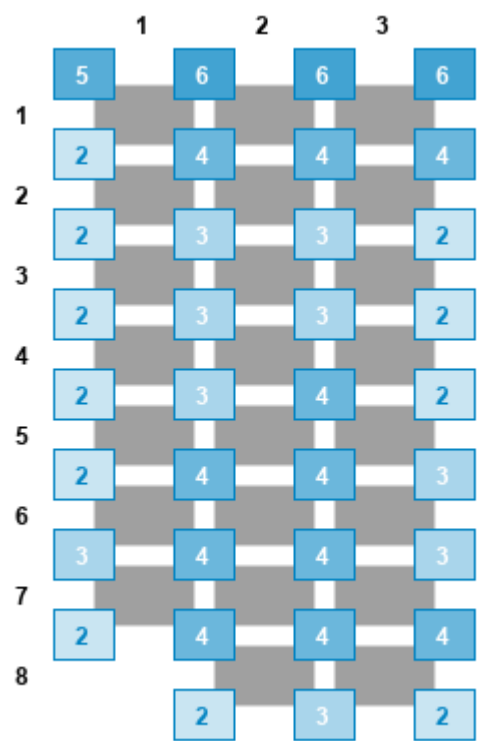
NOTE

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION		~ 25.78 ft		
EW DIMENSION		~ 70.82 ft		
ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	5	9	44	1408
2	8	9	38	1216
3	9	10	36	1152
4	11	13	39	1248
5	11	12	35	1120
6	0	12	26	832

Roof Area 1 / Roof Area 1 - Array 5



LEGEND

- Module
- 1 Standard corner bay with CMU block count
- 4 Supplemental bay with CMU block count

NOTE

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

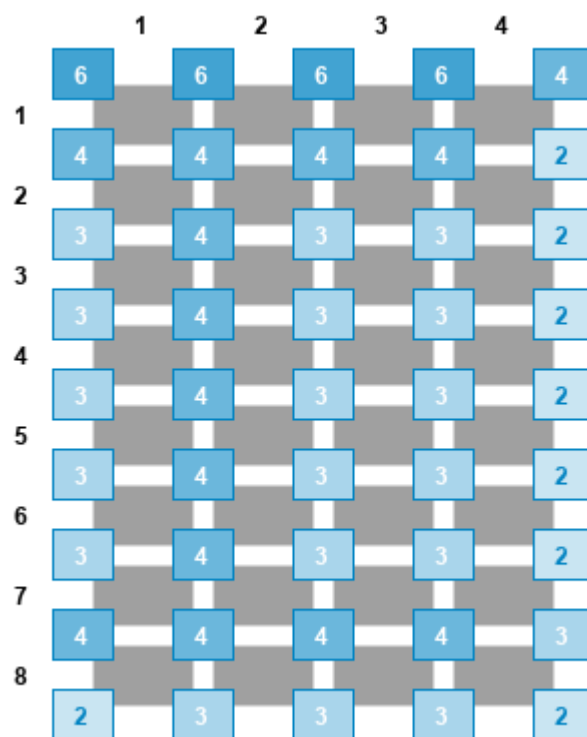
Layout Dimensions

NS DIMENSION	~ 40.27 ft
EW DIMENSION	~ 19.32 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	3	4	23	736
2	3	4	14	448
3	3	4	10	320

4	3	4	10	320
5	3	4	11	352
6	3	4	13	416
7	3	4	14	448
8	2	4	14	448
9	0	3	7	224

Roof Area 1 / Roof Area 1 - Array 6



LEGEND

-  Module
-  1 Standard corner bay with CMU block count
-  4 Supplemental bay with CMU block count

NOTE

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

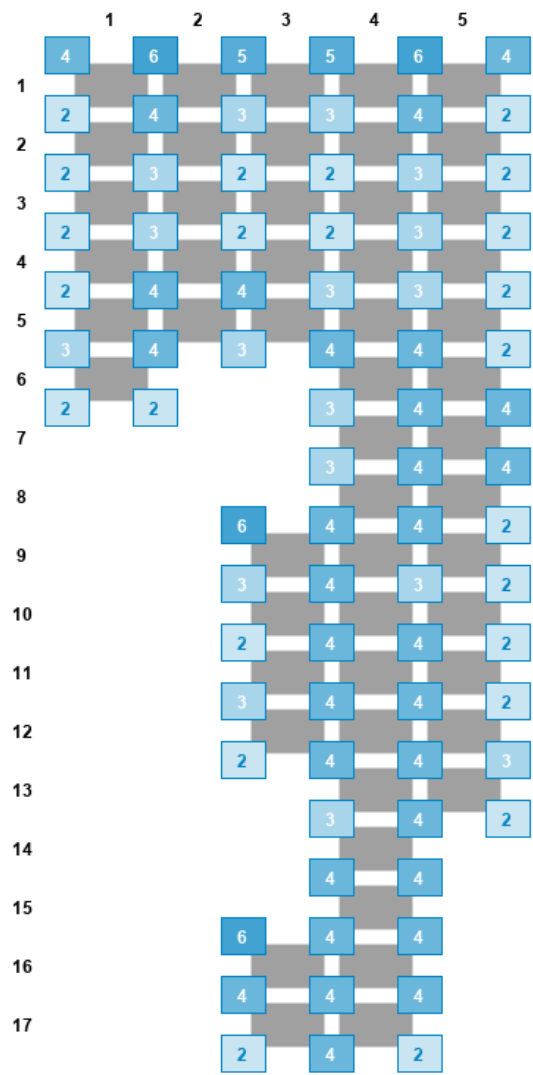
NS DIMENSION	~ 40.27 ft
EW DIMENSION	~ 25.75 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	4	5	28	896
2	4	5	18	576
3	4	5	15	480
4	4	5	15	480
5	4	5	15	480
6	4	5	15	480
7	4	5	15	480
8	4	5	19	608
9	0	5	13	416

Roof Area 2



Roof Area 2 / Roof Area 2 - Array 1



LEGEND

- Module
- 1 Standard corner bay with CMU block count
- 4 Supplemental bay with CMU block count

NOTE

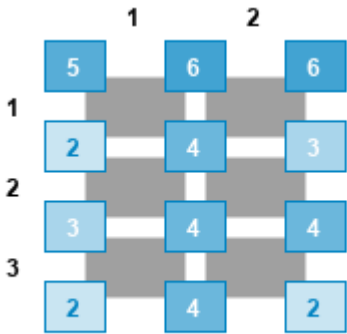
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 83.74 ft
EW DIMENSION	~ 32.19 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	5	6	30	960
2	5	6	18	576
3	5	6	14	448
4	5	6	14	448
5	5	6	18	576
6	3	6	20	640
7	2	5	15	480
8	2	3	11	352
9	3	4	16	512
10	3	4	12	384
11	3	4	12	384
12	3	4	13	416
13	2	4	13	416
14	1	3	9	288
15	1	2	8	256
16	2	3	14	448
17	2	3	12	384
18	0	3	8	256

Roof Area 2 / Roof Area 2 - Array 2



LEGEND

- Module
- 1

Standard corner bay with CMU block count
- 4

Supplemental bay with CMU block count

NOTE

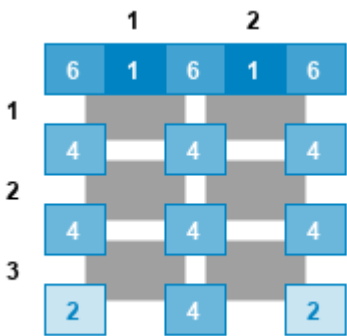
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 16.12 ft
EW DIMENSION	~ 12.88 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	2	3	17	544
2	2	3	9	288
3	2	3	11	352
4	0	3	8	256

Roof Area 2 / Roof Area 2 - Array 3



LEGEND

- Module
- 1

Standard corner bay with CMU block count
- 4

Supplemental bay with CMU block count

NOTE

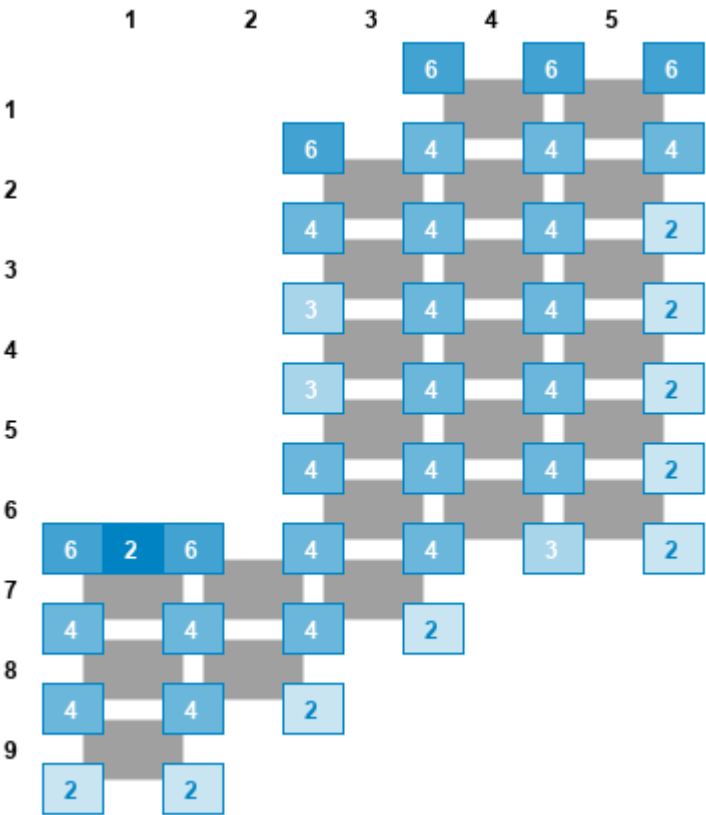
Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 16.12 ft
EW DIMENSION	~ 12.88 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	2	5	20	640
2	2	3	12	384
3	2	3	12	384
4	0	3	8	256

Roof Area 2 / Roof Area 2 - Array 4



LEGEND

- Module
- 1

Standard corner bay with CMU block count
- 4

Supplemental bay with CMU block count

NOTE

Blocks above with values greater than 4 require extra ballast bays, except north-most bays which require extra bays for values greater than 6. The proper number of bays are provided in the Bill of Materials. The installer must install these extra bays as near to the indicated location as possible.

Layout Dimensions

NS DIMENSION	~ 45.10 ft
EW DIMENSION	~ 32.19 ft

ROW	MODULES	BAYS	BALLAST BLOCKS (CMU)	BALLAST WEIGHT (LBS)
1	2	3	18	576
2	3	4	18	576
3	3	4	14	448
4	3	4	13	416
5	3	4	13	416
6	3	4	14	448
7	3	7	27	864
8	2	4	14	448
9	1	3	10	320
10	0	2	4	128