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STRUCTURAL CALCULATIONS

# Waste Transfer Station Solar Panel Addition

Madison, WI



01/26/2022

PREPARED FOR:

City of Madison

DCE JOB #:

21COMD04





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# **ROOF ANALYSIS**



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Careful listening. Dynamic solutions.

JOB \_\_\_\_\_

SHEET NO. \_\_\_\_\_ OF \_\_\_\_\_

CALCULATED BY \_\_\_\_\_ DATE \_\_\_\_\_

CHECKED BY \_\_\_\_\_ DATE \_\_\_\_\_

SCALE \_\_\_\_\_

## Project Summary

Adding 64 additional solar panel modules to roof of existing waste transfer building. The solar panels will be directly attached to the roof deck via S5 clamps at each tilt leg. Additional loading to roof/framing is 3.2 PSF.

\*Per 2015 IEBC Section 707.2, 5% allowable stress increase in existing framing.

## Roof Analysis

### Original design loads

Ground snow load = 30 PSF

Roof snow load = 30 PSF

Dead load:

18 GA metal deck = 3 PSF

Code required minimum MEP/collateral = 4.5 PSF

Purlin self weight = 6 PLF

Total DL = 43.5 PLF (= 8.7 PSF)

### Existing purlins:

Span = 20'; Trib = 5' O.C.

Original max. stresses

M = 9.68 K-FT

V = 1.94 K

### New max. stresses

\*Assume 1/2 of new loading can be accounted for in code required MEP/collateral loading requirements, net add'l load = 1.6 PSF

M = 9.93 K-FT

V = 1.99 K

### % Increase

M = 2.6%

V = 2.6%

### Existing frames:

Span = 45', Trib = 20'

Original max. stresses

M = 195.9 K-FT

V = 17.4 K

### New max. stresses

M = 202.9 K-FT

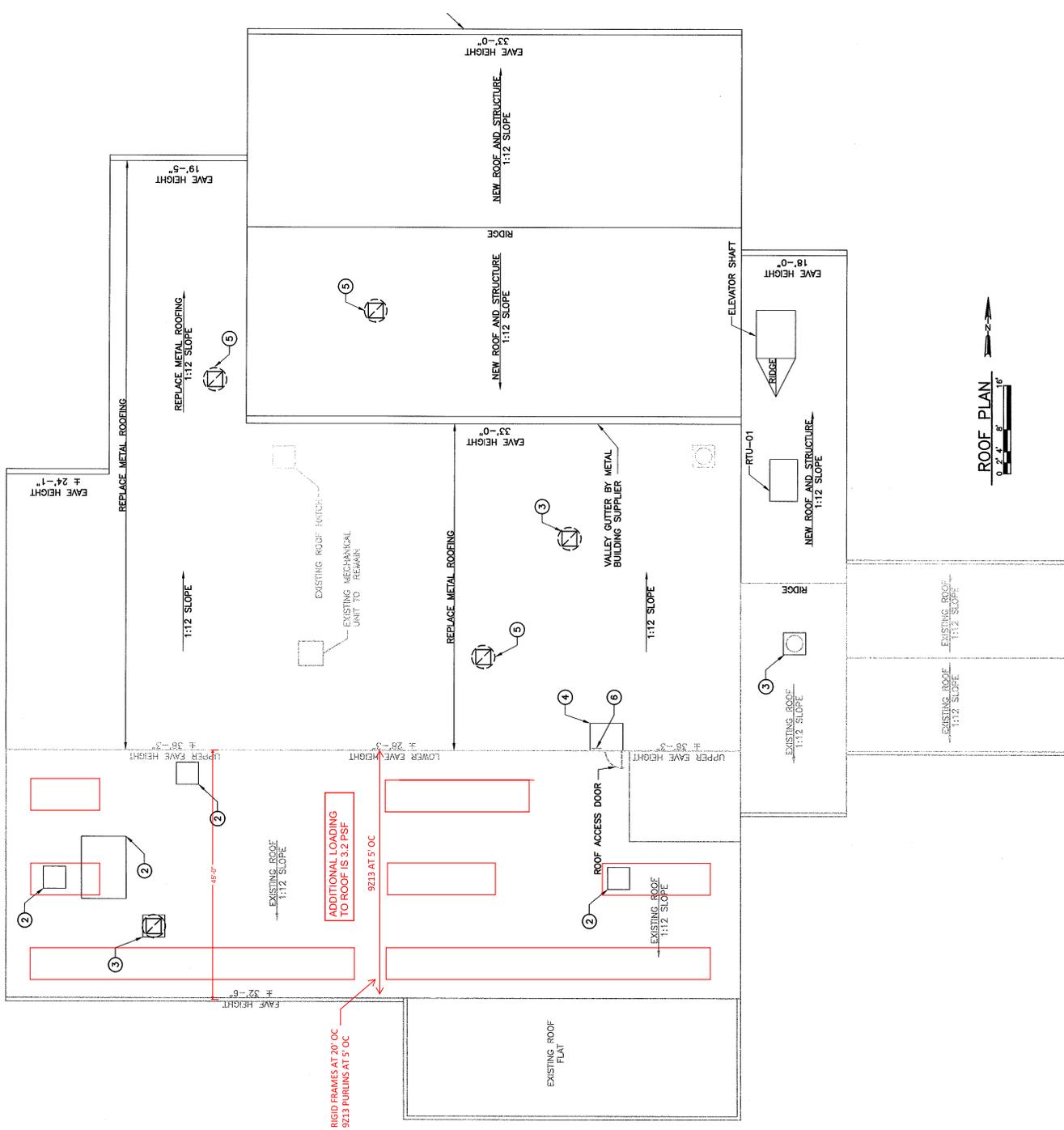
V = 17.9 K

### % Increase

M = 3.6%

V = 2.9%

Existing purlings and frames acceptable as-built. Stress increase <5% allowable per code.



RIGID FRAMES AT 20' OC  
 9213 PURLINS AT 5' OC

ADDITIONAL LOADING  
 TO ROOF IS 32 PSF

9213 AT 5' OC





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# **SOLAR PANEL AND MOUNTING INFORMATION**

Project Details			
<b>Name</b>	Waste Transfer Station 2 Draft	<b>Date</b>	10/01/2021
<b>Location</b>	121 East Olin Avenue, Madison, WI 53713	<b>Total modules</b>	64
<b>Module</b>	Hanwha Q.Cells: Q.PEAK DUO L-G5.2 380 (35mm)	<b>Total watts</b>	24,320
<b>Dimensions</b>	79.33" x 39.37" x 1.38" (2014.98mm x 1000.0mm x 35.0mm)	<b>Attachments</b>	82
<b>ASCE</b>	7-10	<b>Tilt</b>	30°

Roof Information			
<b>Roof attachment</b>	None	<b>Rafter spacing</b>	24"

Load Assumptions	
<b>Wind exposure</b>	C
<b>Wind speed</b>	115 mph
<b>Ground snow load</b>	30 psf
<b>Attachment spacing</b>	5.5'

Building Details	
<b>Roof slope</b>	0-7°
<b>Risk category</b>	II
<b>Building height</b>	35 ft

Span Details XR1000 - Portrait		
Zone	Max span	Max cantilever
1	5' 9"	2' 4"
2	5' 9"	2' 4"
3	5' 9"	2' 4"

Reaction Forces XR1000 - Portrait				
Zone	Down (lbs)	Uplift (lbs)	Lateral (lbs)	Moment (lbs-ft)
1	684	511	354	166
2	684	620	354	166
3	684	620	354	166

System Weight	
Total system weight	3,955.2 lbs
Weight/attachment	48.2 lbs
Racking weight	638.7 lbs
Distributed weight	3.2 psf

Roof Section 1		
Definition	Roof Section Weights	Roof Section (all segments)
64 modules	Total weight: 3,955.2 lbs	Provided rail: 444' [20 x 14', 8 x 17', 4 x 7']
Portrait module orientation	Weight/attachment: 48.2 lbs	Attachments: 82
Textual entry	Total Area: 1,219.0 sq ft	Splices: 18
	Distributed weight: 3.2 psf	

**Segments**

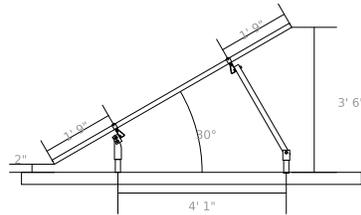
Columns	Length	Cantilever	Cantilever Violations	Rail	Attachments	Splices
18	59' 9"	2' 5"	This array segment exceeds the maximum allowable cantilever for all roof zones. Adding an additional attachment will reduce the cantilever length, if your rafter spacing allows.	124' [4 x 14', 4 x 17']	22	6
			<b>Row segment totals (x 2) →</b>	<b>248' [8 x 14', 8 x 17']</b>	<b>44</b>	<b>12</b>
8	26' 8"	2' 4"	This array segment exceeds the maximum allowable cantilever for all roof zones. Adding an additional attachment will reduce the cantilever length, if your rafter spacing allows.	56' [4 x 14']	10	2
4	13' 5"	1' 2"	None	28' [2 x 14']	6	0
			<b>Row segment totals (x 2) →</b>	<b>56' [4 x 14']</b>	<b>12</b>	<b>0</b>
6	20'	1' 9"	None	42' [2 x 7', 2 x 14']	8	2
			<b>Row segment totals (x 2) →</b>	<b>84' [4 x 7', 4 x 14']</b>	<b>16</b>	<b>4</b>

**Side View Portrait**

South attachment



7" Tilt Leg



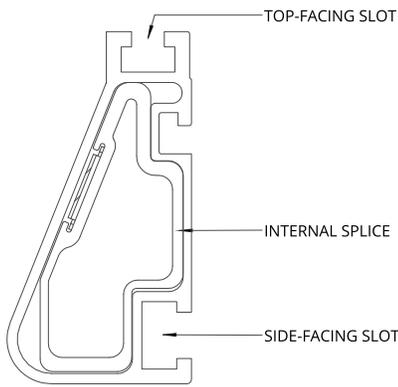
North attachment



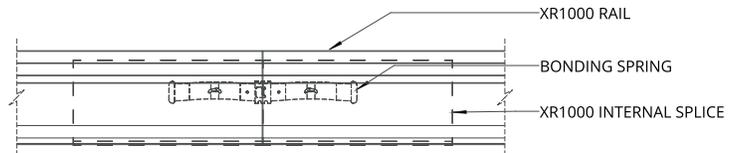
30" Tilt Leg

SOUTH EDGE CLEARANCE DIMENSION ASSUMES 3.75" STANDOFFS ARE USED BELOW BOTH THE NORTH AND SOUTH LEGS

**Splice Details**

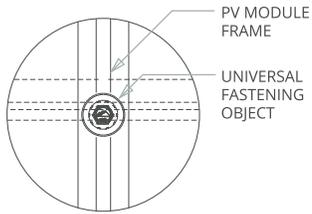


XR1000

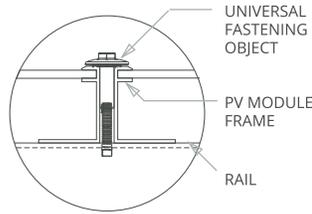


Splice Connection

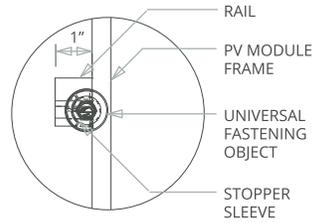
**Clamp Detail**



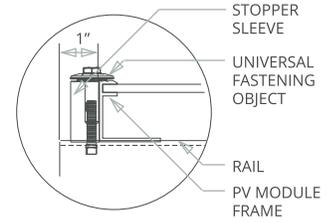
Mid Clamp, Plan



Mid Clamp, Front

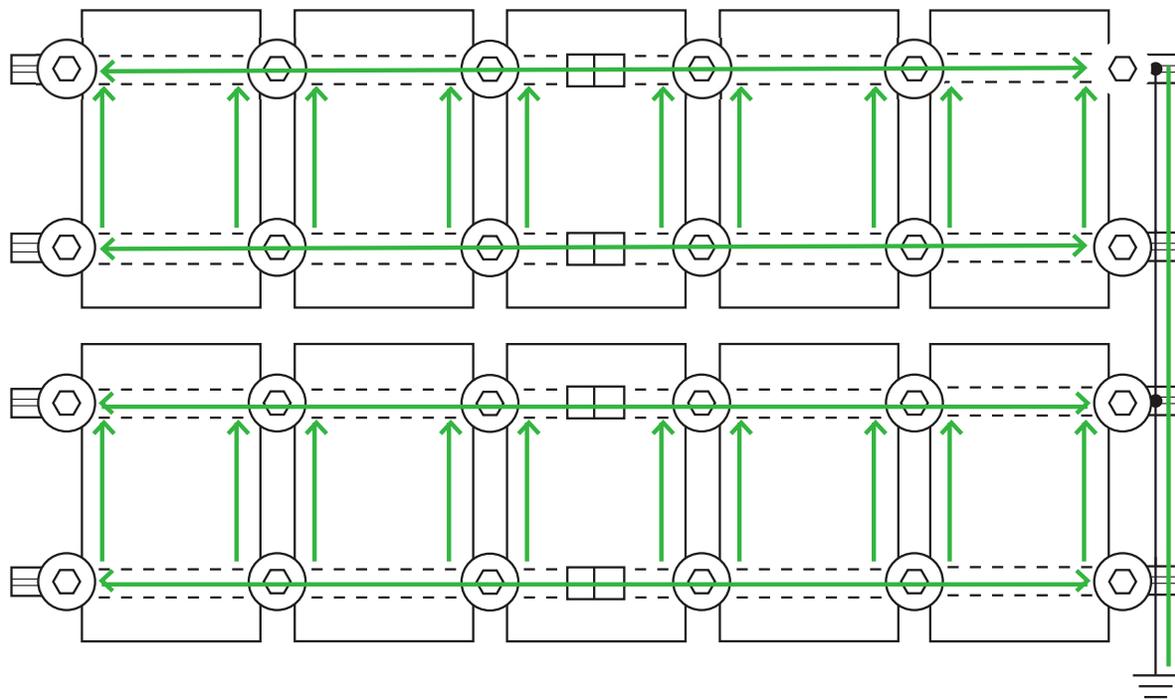


End Clamp, Plan



End Clamp, Front

**Grounding Diagram**



\* Grounding Lugs and Wire are not required in systems using Enphase microinverters.

**Bill of Materials**

Part	Spares	Total Qty
<b>Rails &amp; Splices</b>		
XR-1000-204A XR1000, Rail 204" (17 Feet) Clear	0	8
XR-1000-168A XR1000, Rail 168" (14 Feet) Clear * 2 x 14' rail to be cut on-site into 7' sections	0	22
XR1000-BOSS-01-M1 Bonded Splice, XR1000	0	18
<b>Clamps &amp; Grounding</b>		
UFO-CL-01-A1 Universal Module Clamp, Clear	0	142
UFO-STP-35MM-M1 Stopper Sleeve, 35MM, Mill	0	28
XR-LUG-03-A1 Grounding Lug, Low Profile	0	7
<b>Tilt Kits &amp; Attachments</b>		
TM-FTL-030 Kit, Fixed Tilt Leg, 30"	0	41
<b>Accessories</b>		
XR-1000-CAP Kit, End Cap XR1000 (10 sets per bag)	0	2