



Project Number: U2716-094-191

January 24, 2020

Sunmodo  
14800 NE 65<sup>th</sup> Street  
Vancouver, WA 98682

**REFERENCE: Sunmodo Sunturf Ground Mount B1  
Ground Mount PV Array Installation**

To Whom It May Concern:

Per request of Sunmodo, we have been asked to prepare the structural design of a ground-mounted PV solar array system with several foundation options as shown in the attached calculations. The adopted building code in this jurisdiction is the Ohio Building Code (2015 IBC). Vector Structural Engineering requires that we review each site specific install, and we are not liable for installs at site specific locations we have not reviewed. The following design parameters are used in our analysis:

- Minimum Design Loads for Buildings and Other Structures (ASCE 7-10)
- Design wind speed for risk category I structures: 105 mph
- Wind exposure: C
- Ground snow load: 30 psf
- The ground screws and helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below. A minimum of one ground screw or helical pier must be tested.

Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	2400	1.5	3600
LATERAL	1710	2	3420

Foundation concrete shall have a minimum compressive strength of 2500 psi at 28 days. Cement for all concrete shall be Type I or II with a minimum of 6% entrained air with a water/cement ratio of 0.50. Maximum aggregate size shall be 3/4". No special inspection of concrete strength is required.

Footings are designed based on an allowable soil bearing pressure of 1500 psf an allowable skin friction of 250 psf, an allowable lateral bearing pressure of 150 pcf, and a coefficient of friction of 0.3. Vector Structural Engineering strongly recommends independent soils testing be performed by a licensed geotechnical engineer to verify the assumed soil parameters.

All ground mounts are to be installed per manufacturer’s recommendations. The use of solar panel support span tables provided by the manufacturer is allowed only where the site conditions and solar panel configuration match the description of the span tables. Electrical engineering is beyond our scope. All work performed must be in accordance with accepted industry-wide methods and applicable safety standards. Vector Structural Engineering assumes no responsibility for improper installation of the solar panels.

Very truly yours,

VECTOR STRUCTURAL ENGINEERING, LLC  
OH Firm License: 3392

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Russell Emery, P.E.  
License: PE.84657 - Expires: 12/31/2021  
Project Engineer

Enclosures

RNE/stb

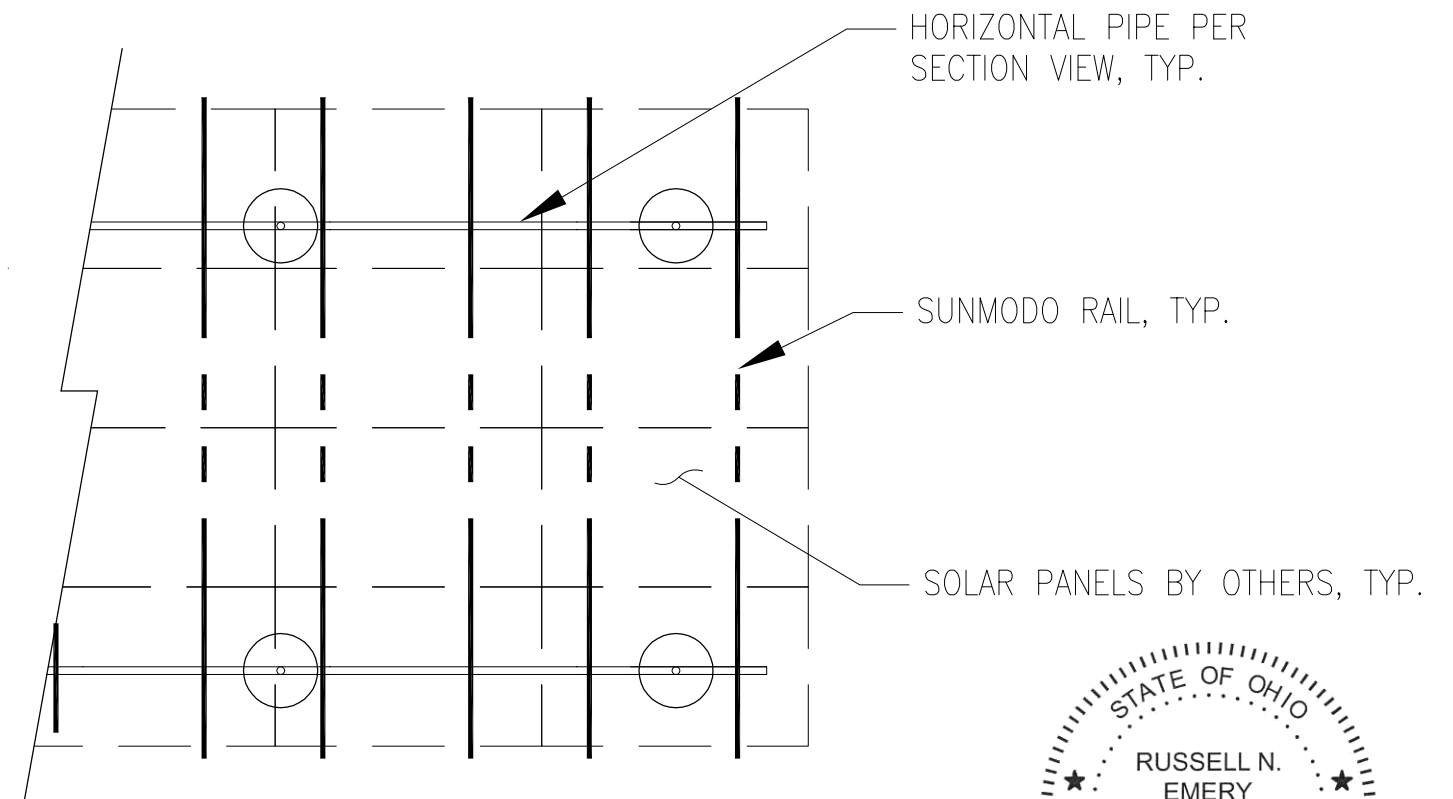
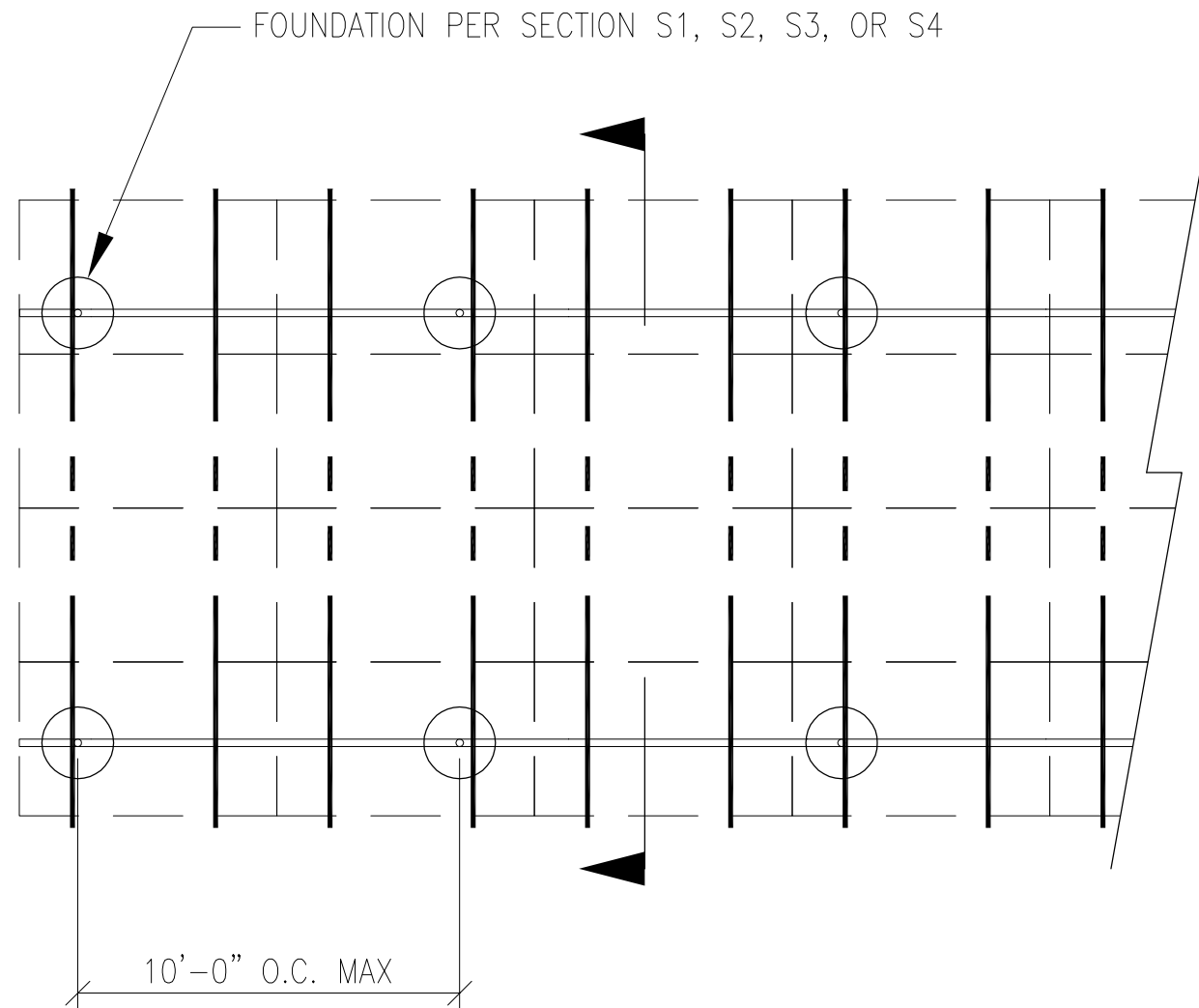


01/24/2020



JOB NO. U2716-094-191  
 PROJECT SUNMODO SUNTURF GROUND MOUNTS B1  
 SUBJECT ALL OPTIONS

651 W GALENA PARK BLVD. #101 (801) 990-1775  
 DRAPER, UTAH 84020 (801) 990-1776 FAX



**PV ARRAY PLAN**

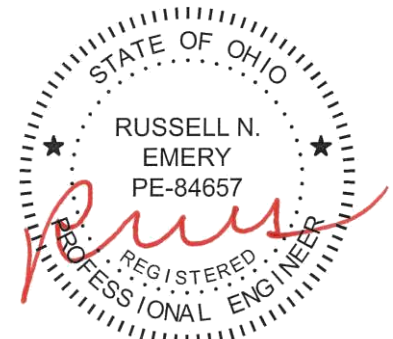
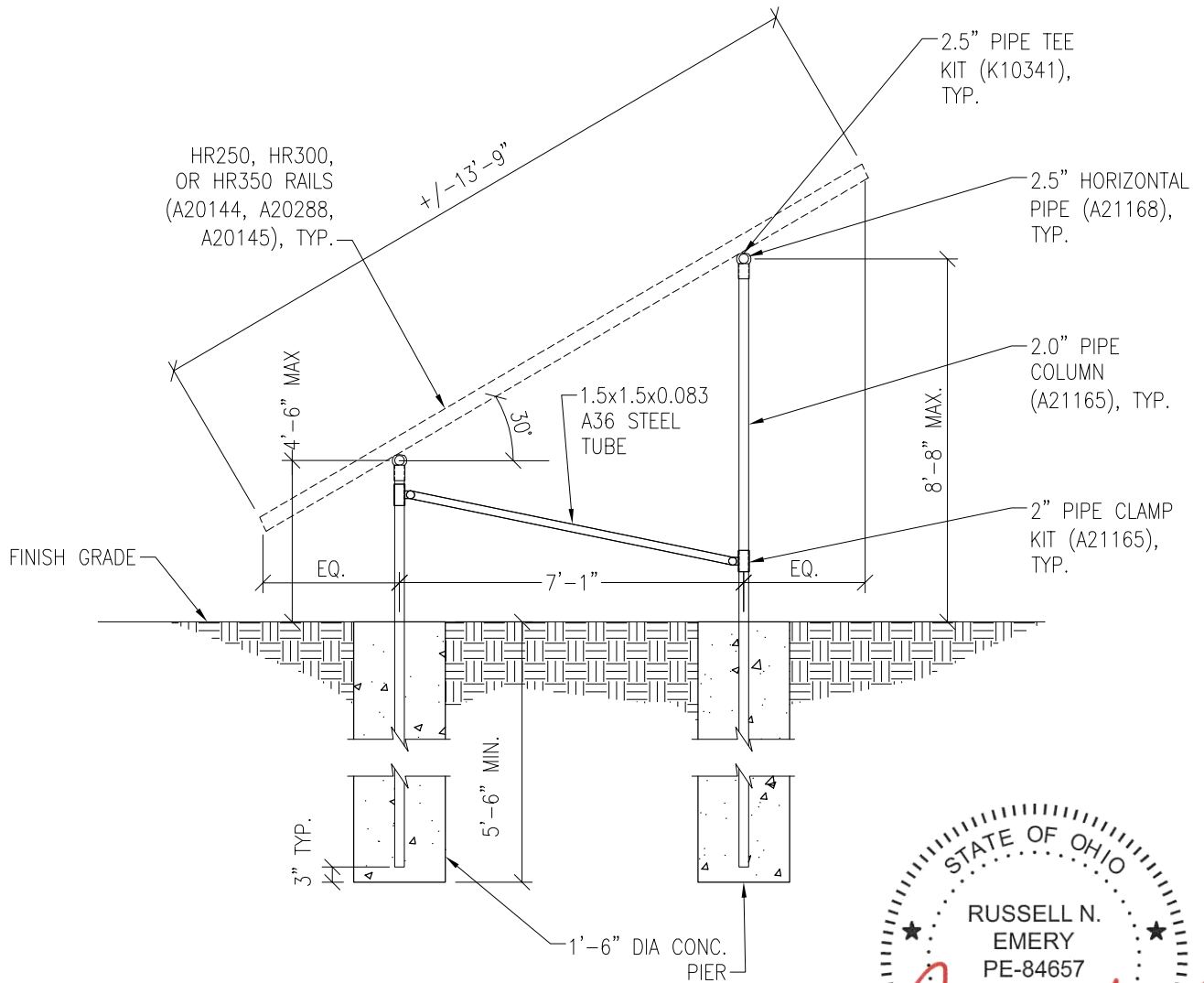
N.T.S.

**P1**

Vector Engineers requires that we review each site specific install and is not liable for installs at site specific locations we have not reviewed.

PROJECT SUNMODO SUNTURF GROUND MOUNTS B1

SUBJECT DRILLED PIER OPTION



01/24/2020

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**PV ARRAY SECTION**

N.T.S.

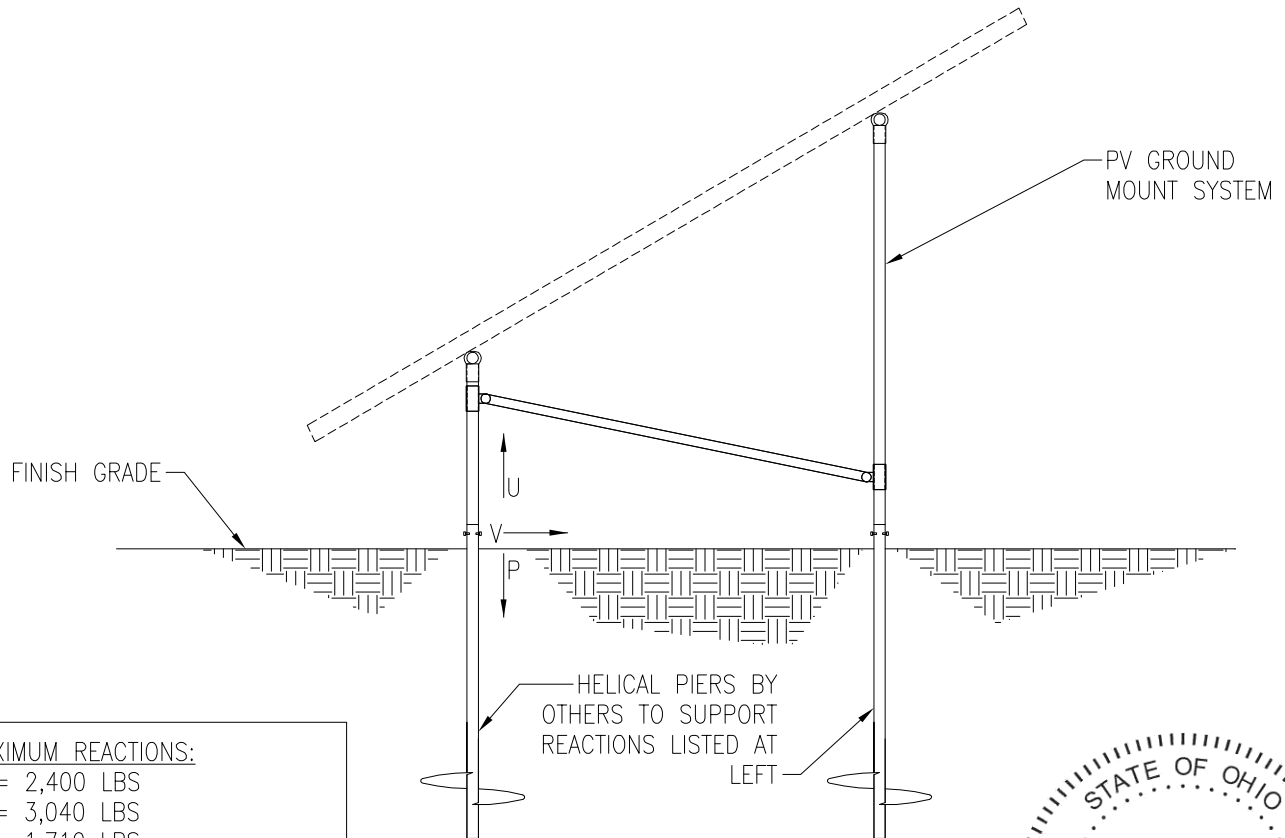
**S1**

PROJECT SUNMODO SUNTURF GROUND MOUNTS B1

SUBJECT HELICAL PIER OPTION

**NOTES:**

1. For ground mount components see Section S1.
2. A minimum of (1) helical pier must be load-tested as follows:
  - 2.1. Safety factor for uplift = 1.5,
  - 2.2. Safety factor for lateral loads = 2.0
  - 2.3. Upward deflection limit = 1/2"
  - 2.4. Lateral deflection limit = 1"
  - 2.5. The load tests must be performed by an approved contractor.



**MAXIMUM REACTIONS:**  
 U = 2,400 LBS  
 P = 3,040 LBS  
 V = 1,710 LBS

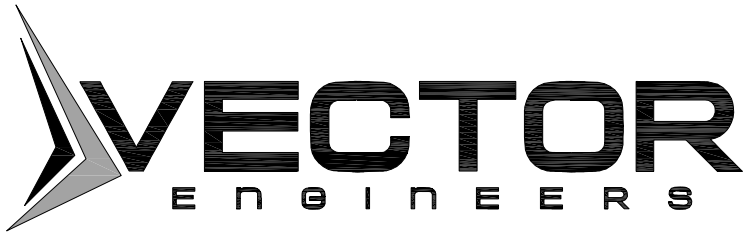


**PV ARRAY SECTION**

03/26/2020

N.T.S.

**S2**



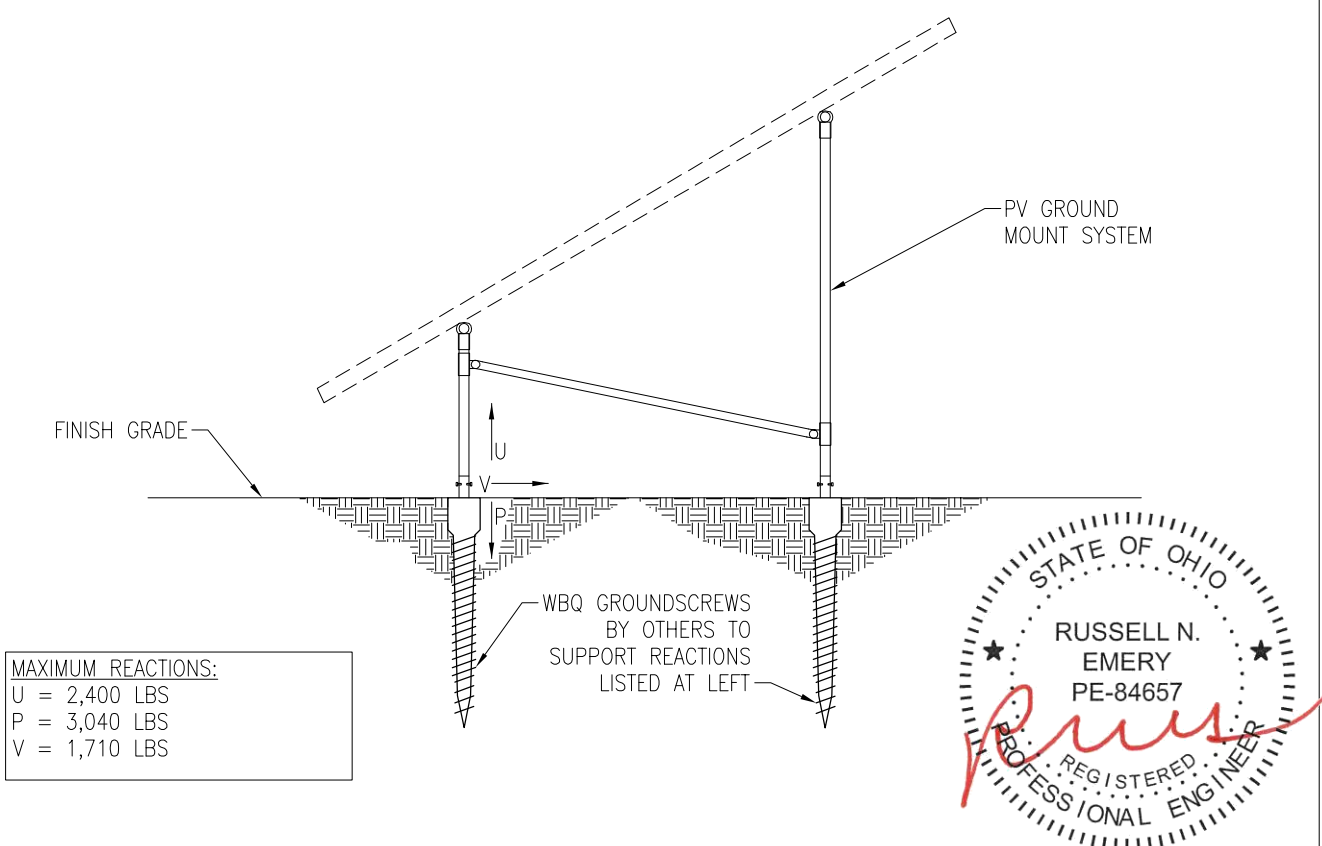
JOB NO. U2716-094-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS B1

SUBJECT GROUND SCREW OPTION

NOTES:

- 1. For ground mount components see Section S1.
- 2. A minimum of (1) ground screw must be load-tested as follows:
  - 2.1. Safety factor for uplift = 1.5,
  - 2.2. Safety factor for lateral loads = 2.0
  - 2.3. Upward deflection limit = 1/2"
  - 2.4. Lateral deflection limit = 1"
  - 2.5. The load tests must be performed by an approved contractor.



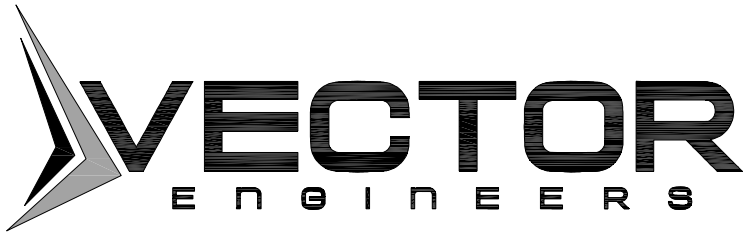
MAXIMUM REACTIONS:  
 U = 2,400 LBS  
 P = 3,040 LBS  
 V = 1,710 LBS

PV ARRAY SECTION

03/26/2020

N.T.S.

S3



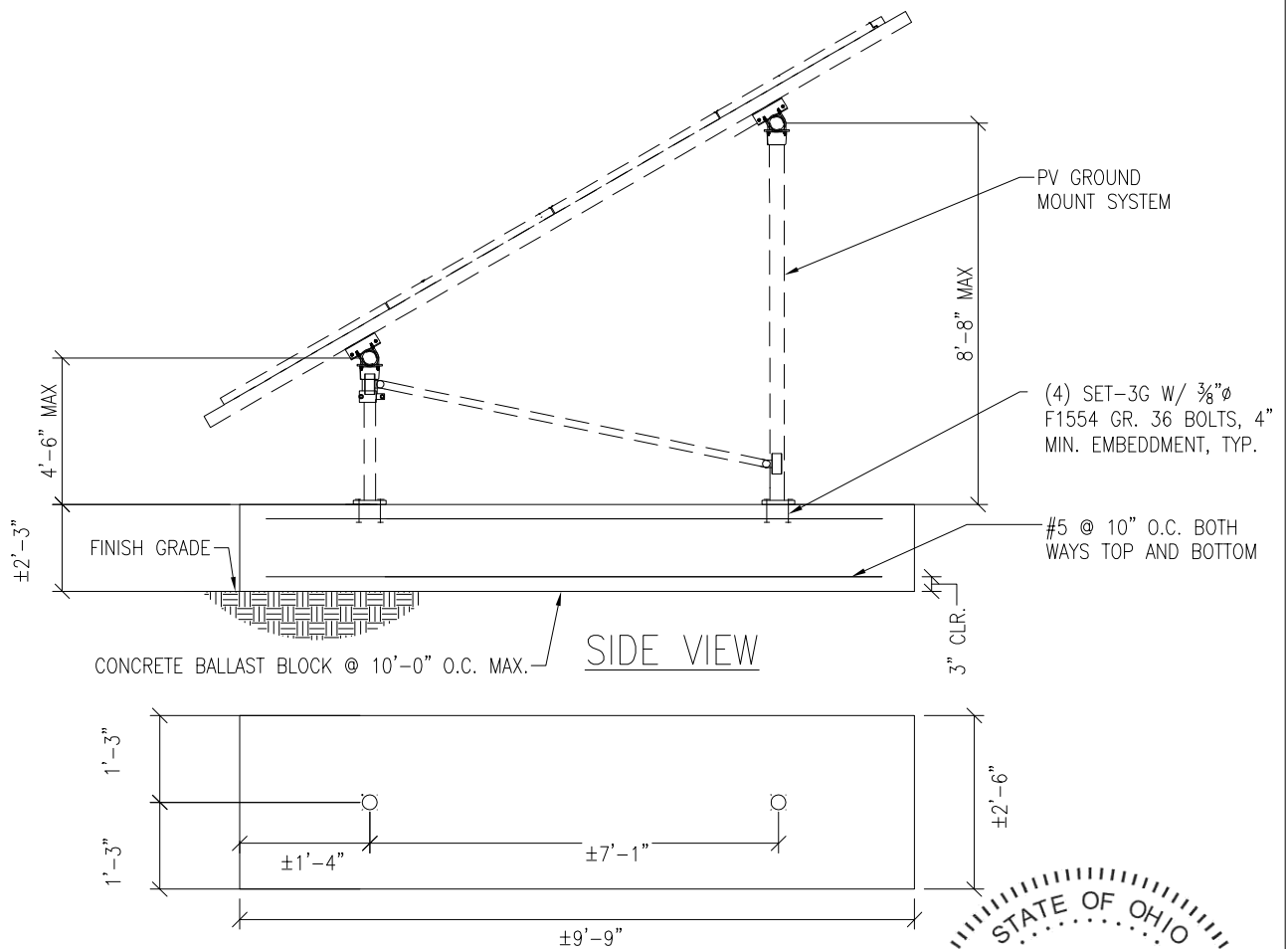
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PROJECT SUNMOD0 SUNTURF GROUND MOUNTS B1

SUBJECT BALLASTED BLOCK OPTION

NOTES:

1. For ground mount components see Section S1.



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PV ARRAY SECTION

N.T.S.

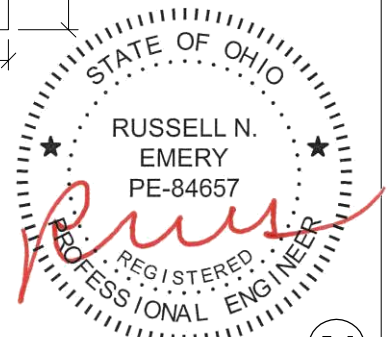
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S4

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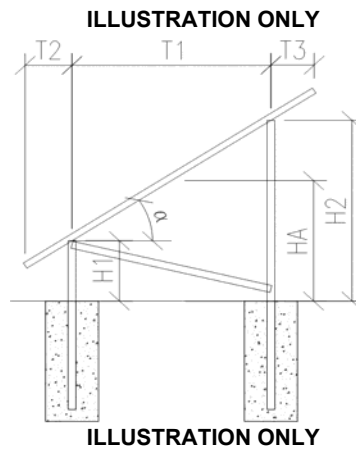
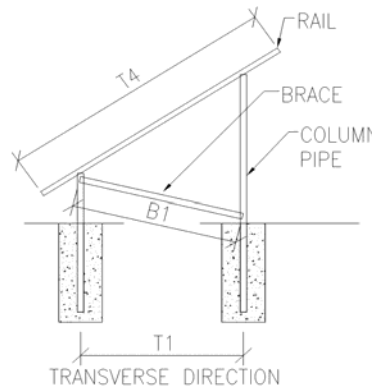
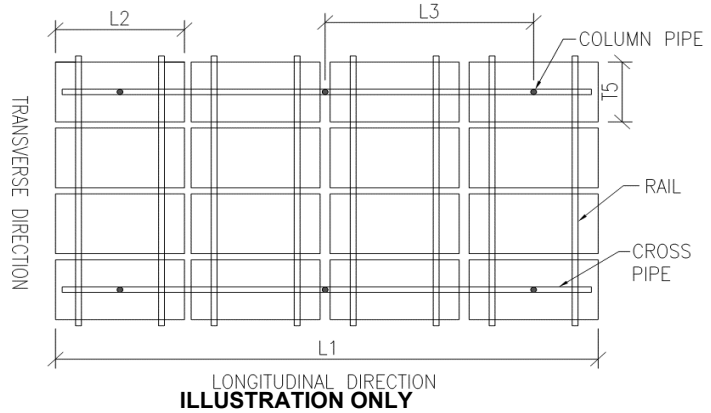


PROJECT: B1 – Sunmodo Sunturf GM

SUBJECT: Dead Load

**Design Weight:**

Individual Panel Weight [lb]:	50.7
Panel Transverse Length (T5) [in]:	41.2
Panel Transverse Length (T5) [ft]:	3.4
Panel Longitudinal Length (L2) [in]:	81.4
Panel Longitudinal Length (L2) [ft]:	6.8
Individual Panel Area [ft <sup>2</sup> ]:	23.3
Individual Panel Weight [psf]:	2.2
# of Panels in Transverse Direction:	4
Approximate Transverse Length (T4) [ft]:	13.7
# of Panels in Longitudinal Direction:	12
Approximate Longitudinal Length (L1) [ft]:	81.4
Transverse Column Spacing (T1) [ft]:	7.1
Longitudinal Column Spacing (L3) [ft]:	10.0
# of Columns in Longitudinal Direction:	9
# of Columns in Transverse Direction:	2
Total Number of Columns:	18
Panel Slope from Horizontal (a) [°]:	30.0
Short Column Height (H1) [ft]:	4.5
Approximate Tall Column Height (H2) [ft]:	8.6
Transverse Brace between Columns :	Yes
Approximate Brace Length (B1) [ft]:	9.0
Weight of Columns [plf]:	3.7
Weight of Cross Pipe [plf]:	3.7
Weight of Brace [plf]:	3.7
Tributary Transverse Length per Column [ft]:	6.9
Tributary Longitudinal Length per Column [ft]:	10.0
Tributary Area per Column [ft <sup>2</sup> ]:	68.7
Rail Weight [plf]:	1.0
Transverse Rail Weight per Column [lb]:	27.5
Longitudinal Rail Weight per Column [lb]:	36.5
Tall Column Weight [lb]:	31.4
Panel Weight per Column [lb]:	149.5
Rail Weight per Column [lb]:	27.5
Cross Pipe Weight per Column [lb]:	36.5
Brace Weight per Column [lb]:	16.4
<b>Total Weight per Column (1.0 D) [lb]:</b>	<b>261.3</b>



**Assumptions:**

- T2 = T3



JOB NO.: U2716-094-191

DESIGNED: STB

DATE: 07/25/19

PROJECT: B1 – Sunmodo Sunturf GM

SUBJECT: Snow Load

**SNOW LOAD (S):**

ASCE 7 Standard:	10	
Panel Slope from Horizontal [°]:	30.0	
Snow Ground Load, $p_g$ [psf]:	30.0	(Section 7.2)
Terrain Category:	C	(Table 7-2)
Exposure of Roof:	Fully Exposed	(Table 7-2)
Exposure Factor, $C_e$ :	0.9	(Table 7-2)
Thermal Factor, $C_t$ :	1.2	(Table 7-3)
Risk Category:	I	(Table 1.5-1)
Importance Factor, $I_s$ :	0.8	(Table 1.5-2)
Flat Roof Snow Load, $p_f$ [psf]:	18	(Equation 7.3-1)
Minimum Roof Snow Load, $p_m$ [psf]:	0	(Section 7.3.4)
Unobstructed Slippery Surface?	Yes	(Section 7.4)
Slope Factor Figure:	Figure 7-2c	(Section 7.4)
Roof Slope Factor, $C_s$ :	0.727	(Figure 7-2)
Sloped Roof Snow Load, $p_s$ [psf]:	13	(Equation 7.4-1)
Design Snow Load, $S$ [psf]:	13	
Tributary Transverse Length [ft]:	5.9	
Tributary Longitudinal Length [ft]:	10	
Tributary Area per Column [ft <sup>2</sup> ]:	59.5	
<b>Snow Load per Column (1.0 S) [lb]:</b>	<b>784.7</b>	





PROJECT: B1 – Sunmodo Sunturf GM

SUBJECT: Wind Pressure

**Design Wind Load:**

ASCE 7 Standard:	10	
Basic Wind Speed, V [mph]:	105	
Risk Category:	I	
Exposure Category	C	(Section 26.7.3)
Velocity Pressure Exposure Coefficient, $K_h$ :	0.85	(Table 27.3-1)
Topographic Factor, $K_{ht}$ :	1.0	(Section 26.8.2)
Wind Directionality Factor, $K_d$ :	0.85	(Table 26.6-1)
Internal Pressure Coefficient, $GC_{pi}$ :	0.00	(Table 26.11-1)
Velocity Pressure, $q_h$ [psf]:	20.4	(Equation 27.3-1)
Gust Effect Factor, G:	0.85	(Section 26.9.1)
Panel Slope [degrees]:	30.0	

Net Pressure Coefficients ( $C_N$ ) per: (Figure 27.4-4)

Clear Wind Flow	$C_{NW}$	$C_{NL}$
Case 1 ( $\gamma = 0^\circ$ , Load Case A)	-1.80	-1.80
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-2.50	-0.50
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	2.10	2.10
Case 4 ( $\gamma = 180^\circ$ , Load Case B)	2.60	1.00

Design Wind Pressures (p) [psf] per: (Equation 27.4-3)

Clear Wind Flow	$q_h GC_{NW}$	$q_h GC_{NL}$
Case 1 ( $\gamma = 0^\circ$ , Load Case A)	-31.2	-31.2
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-43.3	-8.7
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	36.4	36.4
Case 4 ( $\gamma = 180^\circ$ , Load Case B)	45.1	17.3

Wind Pressure on Each Side of Panels [psf]

Clear Wind Flow	Short Col. Pressure	Long Col. Pressure
Case 1 ( $\gamma = 0^\circ$ , Load Case A)	-31.2	-31.2
Case 2 ( $\gamma = 0^\circ$ , Load Case B)	-8.7	-43.3
Case 3 ( $\gamma = 180^\circ$ , Load Case A)	36.4	36.4
Case 4 ( $\gamma = 180^\circ$ , Load Case B)	45.1	17.3



JOB NO.: U2716-094-191

PROJECT: B1 – Sunmodo Sunturf GM

SUBJECT: Open Building Wind Loads

### Design Wind Load Per ASCE 7-10

$$p = q_h G C_n$$

Velocity Pressure Exposure Coefficient, $K_z$ :	0.85	(Table 27.3-1)
Topographic Factor, $K_{zt}$ :	1.0	(Section 26.8.2)
Wind Directionality Factor, $K_d$ :	0.85	(Table 26.6-1)
Ultimate Wind Speed, $V$ [mph]:	105	

Velocity Pressure, $q_h$ [psf]:	20.4	(Equation 27.3-1)
Gust Effect Factor, $G$ :	0.85	(Section 26.9.1)

$\gamma = 90^\circ$  or  $270^\circ$

Force Coefficient,  $C_N$ :

Horizontal Distance from Winward Edge	Roof angle			Obstructed Wind Flow
	30	A	CN	
$\leq h$	30	A	-0.8	CN
		B	0.8	
$> h, \leq 2h$	30	A	-0.6	CN
		B	0.5	
$> 2h$	30	A	-0.3	CN
		B	0.3	

Design Wind Pressure,  $p$  [psf]:

Horizontal Distance from Winward Edge	Roof angle			Obstructed Wind Flow
	30	A		
$\leq h$	30	A	-13.9	CN
		B	13.9	
$> h, \leq 2h$	30	A	-10.4	CN
		B	8.7	
$> 2h$	30	A	-5.2	CN
		B	5.2	



JOB NO.: U2716-094-191

DESIGNED: STB

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# Foundation Option 1: Drilled Concrete Pier



JOB NO.: U2716-094-191  
DATE: 07/25/19

DESIGNED: STB

PROJECT: B1 – Sunmodo Sunturf GM

**Drilled Pier Design**

**Design Loads:**

Max. Shear, V [k]:	1.7	Max. Down, P <sub>d</sub> [k]:	3.0
Max. Moment, M [k-ft]:	0.0	Max. Uplift, P <sub>u</sub> [k]:	2.4

**Pier Properties:**

Pier Diameter, b [ft]:	1.5	Volume of Concrete [ft <sup>3</sup> ]:	10
Min. Pier Diameter, b <sub>min</sub> (opt'l) [ft]:		Volume of Concrete [yd <sup>3</sup> ]:	0.4
Top of Pier Elevation [ft]:	0.00	Weight of Concrete [k]:	1.5
Pier Depth, d [ft]:	5.5		
Min. Pier Depth, d <sub>min</sub> (opt'l) [ft]:			
Max. Pier Depth, d <sub>max</sub> (opt'l) [ft]:			

**Soil Properties:**

Allow. Bearing Pressure [psf]:	1,500	<u>Optional Parameters for Uplift:</u>	
1/3 increase for short term loads?	No	Skin Friction [psf]:	250 (IBC 1810.3.3.1.4)
Lateral Bearing, S [pcf]:	150	Top Length to Ignore [ft]:	0.0
Max. Lateral Bearing (opt'l) [psf]:		1/3 increase for short term loads?	No
Top Depth to Ignore [ft]:	0.0	Combine w/ Bearing:	No
1/3 increase for short term loads?	No		
1/2" deflection at t/o pier allowed:	Yes		

**Check Bearing:**

Bearing Capacity [k]: 6.5      **Bearing capacity OK.**

**Check Uplift:**

Uplift Capacity [k]: 7.8      **Uplift capacity OK.**

**Check Lateral Bearing:**

Applied Lateral Force, P [lb]:	1,710	
Point of Application, h [ft]:	0.0	
S <sub>1_max</sub> [psf]:		
S <sub>1</sub> [psf]:	550	
A = 2.34*P/(S <sub>1</sub> b):	4.85	
Required Pier Depth, d <sub>reqd</sub> [ft]:	4.9	<b>Lateral bearing capacity OK.</b>

# Foundation Option 2: Helical Pier

The ground screws and helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	2400	1.5	3600
LATERAL	1710	2	3420

# Foundation Option 3: Ground Screw

The ground screws and helical piers must be tested to 1.5 times uplift and 2.0 times lateral reactions found in the table below.

Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	2400	1.5	3600
LATERAL	1710	2	3420

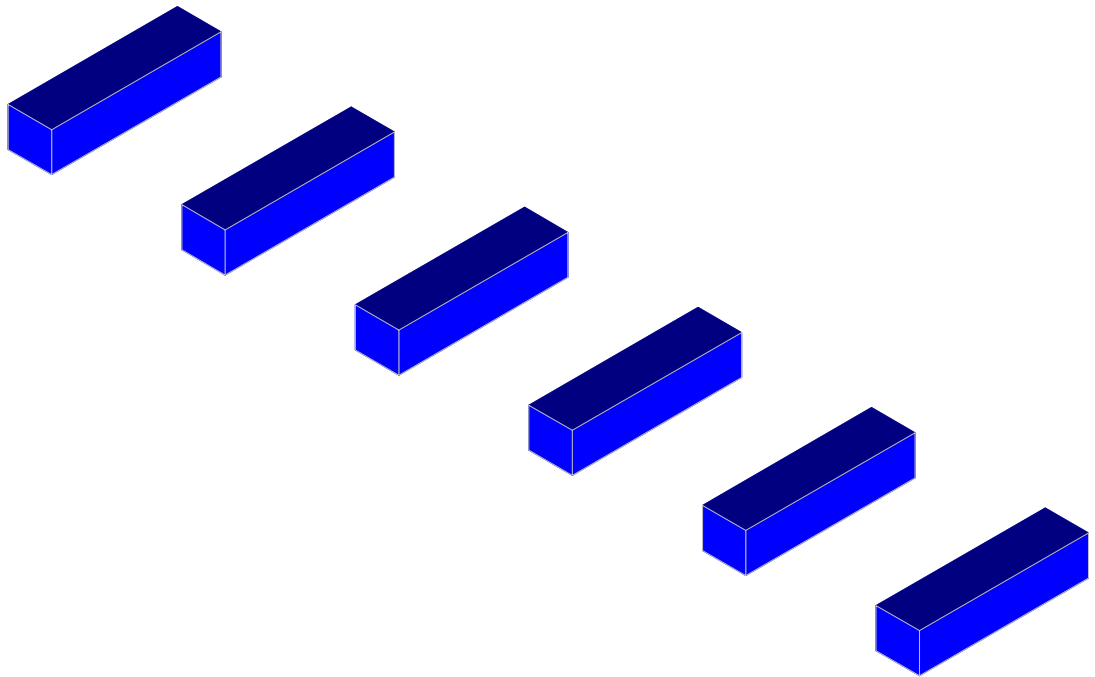


JOB NO.: U2716-094-191

DESIGNED: STB

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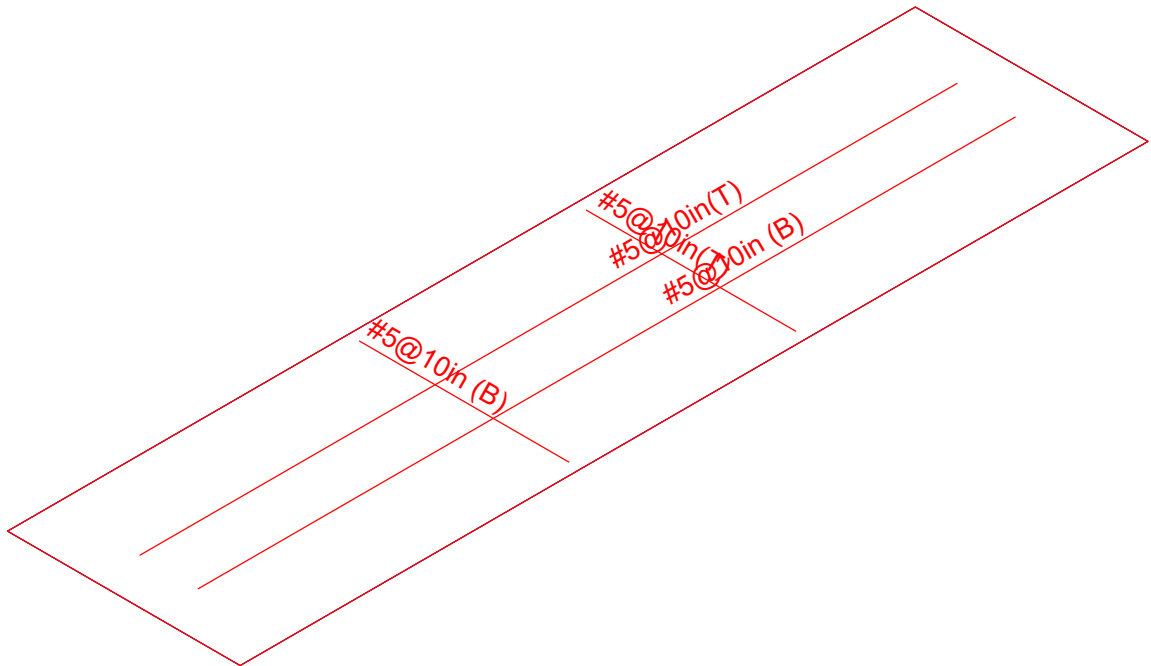
# Foundation Option 4: Ballasted Block



Results for LC 1, 1.0 D

Vector Structural Engineeri..	Ground Mount	SK - 14
STB		June 7, 2019 at 4:41 PM
U2716.094.191		USA B1 GM v3.r3d





Results for LC 1, 1.0 D

Vector Structural Engineeri..	Ground Mount	SK - 15
STB		June 7, 2019 at 4:41 PM
U2716.094.191		USA B1 GM v3.r3d









**Point Loads and Moments (Cat 19 : OL4) (Continued)**

	Label	Direction	Magnitude[lb,lb-ft]
13	R3D_N109	X	-5.646
14	R3D_N109	Y	2858.121
15	R3D_N109	Z	-2428.676
16	R3D_N110A	X	29.115
17	R3D_N110A	Y	924.253
18	R3D_N110A	Z	76.99
19	R3D_N121	X	3.695
20	R3D_N121	Y	2733.397
21	R3D_N121	Z	-2175.758
22	R3D_N122	X	-1.498
23	R3D_N122	Y	960.379
24	R3D_N122	Z	77.011
25	R3D_N133B	X	-3.715
26	R3D_N133B	Y	2734.055
27	R3D_N133B	Z	-2176.325
28	R3D_N134B	Y	959.368
29	R3D_N134B	Z	77.033
30	R3D_N137C	X	131.627
31	R3D_N137C	Y	1913.874
32	R3D_N137C	Z	-1446.231
33	R3D_N138B	X	183.113
34	R3D_N138B	Y	722.55
35	R3D_N138B	Z	58.521

**Point Loads and Moments (Cat 20 : OL5)**

	Label	Direction	Magnitude[lb,lb-ft]
1	R3D_N1_1	X	-73.937
2	R3D_N1_1	Y	1155.083
3	R3D_N1_1	Z	-649.695
4	R3D_N2_1	X	-45.664
5	R3D_N2_1	Y	25.47
6	R3D_N2_1	Z	23.184
7	R3D_N132	X	6.502
8	R3D_N132	Y	610.134
9	R3D_N132	Z	-405.766
10	R3D_N133	Y	-10.941
11	R3D_N133	Z	12.956
12	R3D_N109	X	5.707
13	R3D_N109	Y	1205.466
14	R3D_N109	Z	-779.431
15	R3D_N110A	X	20.687
16	R3D_N110A	Y	-23.332
17	R3D_N110A	Z	23.517
18	R3D_N121	X	4.552
19	R3D_N121	Y	591.517
20	R3D_N121	Z	-347.967
21	R3D_N122	Y	14.352
22	R3D_N122	Z	15.222
23	R3D_N133B	X	2.567
24	R3D_N133B	Y	620.028
25	R3D_N133B	Z	-367.49
26	R3D_N134B	X	2.885
27	R3D_N134B	Y	5.001
28	R3D_N134B	Z	13.35
29	R3D_N137C	X	54.657
30	R3D_N137C	Y	459.744















Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.094.191  
 Model Name : Ground Mount

July 25, 2019  
 4:23 PM  
 Checked By: JSP

**Slab Sliding Safety Factors (By Combination) (Continued)**

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
42	7	S6	0	94.562	2601.808	139.653	2601.808	9.999+	9.999+
43	8	S1	0	18.617	2308.564	369.999	2308.564	9.999+	6.239
44	8	S2	0	12.923	2370.513	398.123	2370.513	9.999+	5.954
45	8	S3	0	2.309	2447.779	198.101	2447.779	9.999+	9.999+
46	8	S4	0	2.918	2443.323	212.947	2443.323	9.999+	9.999+
47	8	S5	0	5.898	2447.611	235.584	2447.611	9.999+	9.999+
48	8	S6	0	3.938	2431.406	139.669	2431.406	9.999+	9.999+
49	9	S1	0	5.695	2403.877	630.973	2403.877	9.999+	3.81
50	9	S2	0	.617	2402.885	1063.145	2402.885	9.999+	2.26
51	9	S3	0	.162	2402.472	947.844	2402.472	9.999+	2.535
52	9	S4	0	.869	2402.466	948.387	2402.466	9.999+	2.533
53	9	S5	0	.367	2402.862	1063.88	2402.862	9.999+	2.259
54	9	S6	0	5.591	2403.86	626.84	2403.86	9.999+	3.835
55	10	S1	0	4.103	2451.191	528.705	2451.191	9.999+	4.636
56	10	S2	0	7.644	2498.202	892.035	2498.202	9.999+	2.801
57	10	S3	0	.231	2481.755	794.111	2481.755	9.999+	3.125
58	10	S4	0	1.07	2481.754	794.934	2481.754	9.999+	3.122
59	10	S5	0	8.787	2498.214	892.409	2498.214	9.999+	2.799
60	10	S6	0	3.709	2450.844	525.317	2450.844	9.999+	4.665
61	11	S1	0	343.072	3204.441	736.135	3204.441	9.34	4.353
62	11	S2	0	9.196	3488.701	1240.335	3488.701	9.999+	2.813
63	11	S3	0	2.497	3490.595	1105.818	3490.595	9.999+	3.157
64	11	S4	0	3.82	3490.458	1106.451	3490.458	9.999+	3.155
65	11	S5	0	11.338	3489.639	1241.193	3489.639	9.999+	2.812
66	11	S6	0	344.946	3199.808	731.313	3199.808	9.276	4.375
67	12	S1	0	295.967	3131.395	628.648	3131.395	9.999+	4.981
68	12	S2	0	14.473	3414.651	1058.259	3414.651	9.999+	3.227
69	12	S3	0	2.229	3403.342	944.436	3403.342	9.999+	3.604
70	12	S4	0	3.902	3403.228	944.681	3403.228	9.999+	3.603
71	12	S5	0	16.581	3415.484	1059.186	3415.484	9.999+	3.225
72	12	S6	0	297.828	3127.138	624.469	3127.138	9.999+	5.008
73	13	S1	0	209.095	2932.742	281.93	2932.742	9.999+	9.999+
74	13	S2	0	15.789	3063.619	340.161	3063.619	9.999+	9.006
75	13	S3	0	3.288	2986.475	149.736	2986.475	9.999+	9.999+
76	13	S4	0	.222	2988.995	159.363	2988.995	9.999+	9.999+
77	13	S5	0	2.505	2985.342	176.764	2985.342	9.999+	9.999+
78	13	S6	0	190.666	2835.291	104.74	2835.291	9.999+	9.999+
79	14	S1	0	105.076	2617.002	277.499	2617.002	9.999+	9.431
80	14	S2	0	6.716	2765.117	298.593	2765.117	9.999+	9.261
81	14	S3	0	.492	2823.575	148.576	2823.575	9.999+	9.999+
82	14	S4	0	4.42	2820.184	159.71	2820.184	9.999+	9.999+
83	14	S5	0	8.056	2823.263	176.688	2823.263	9.999+	9.999+
84	14	S6	0	122.698	2707.49	104.752	2707.49	9.999+	9.999+
85	15	S1	0	185.637	1017.576	841.297	1017.576	5.482	1.21
86	15	S2	0	5.291	865.245	1417.526	865.245	9.999+	.61
87	15	S3	0	1.437	863.94	1263.792	863.94	9.999+	.684
88	15	S4	0	1.816	864.007	1264.516	864.007	9.999+	.683
89	15	S5	0	5.312	864.732	1418.507	864.732	9.999+	.61
90	15	S6	0	186.554	1020.014	835.786	1020.014	5.468	1.22
91	16	S1	0	183.514	1080.662	704.94	1080.662	5.889	1.533
92	16	S2	0	5.725	992.334	1189.38	992.334	9.999+	.834
93	16	S3	0	1.345	969.65	1058.815	969.65	9.999+	.916
94	16	S4	0	1.548	969.724	1059.912	969.724	9.999+	.915
95	16	S5	0	5.913	991.868	1189.879	991.868	9.999+	.834
96	16	S6	0	184.045	1082.659	700.422	1082.659	5.883	1.546
97	17	S1	0	279.385	2084.995	981.514	2084.995	7.463	2.124
98	17	S2	0	7.794	2312.999	1653.781	2312.999	9.999+	1.399

**Slab Sliding Safety Factors (By Combination) (Continued)**

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
99	17	S3	0	1.677	2314.769	1474.424	2314.769	9.999+	1.57
100	17	S4	0	2.118	2314.663	1475.268	2314.663	9.999+	1.569
101	17	S5	0	9.315	2313.767	1654.925	2313.767	9.999+	1.398
102	17	S6	0	280.828	2081.279	975.084	2081.279	7.411	2.134
103	18	S1	0	216.579	1987.602	838.197	1987.602	9.177	2.371
104	18	S2	0	14.83	2214.266	1411.012	2214.266	9.999+	1.569
105	18	S3	0	1.319	2198.433	1259.248	2198.433	9.999+	1.746
106	18	S4	0	2.229	2198.356	1259.575	2198.356	9.999+	1.745
107	18	S5	0	16.306	2214.894	1412.248	2214.894	9.999+	1.568
108	18	S6	0	218.005	1984.384	832.626	1984.384	9.102	2.383
109	19	S1	0	100.749	1722.731	375.906	1722.731	9.999+	4.583
110	19	S2	0	16.585	1746.223	453.549	1746.223	9.999+	3.85
111	19	S3	0	2.731	1642.61	199.648	1642.61	9.999+	8.228
112	19	S4	0	3.271	1646.045	212.484	1646.045	9.999+	7.747
113	19	S5	0	2.462	1641.372	235.686	1641.372	9.999+	6.964
114	19	S6	0	75.122	1595.256	139.653	1595.256	9.999+	9.999+
115	20	S1	0	37.943	1301.743	369.999	1301.743	9.999+	3.518
116	20	S2	0	13.422	1348.22	398.123	1348.22	9.999+	3.386
117	20	S3	0	2.309	1425.41	198.101	1425.41	9.999+	7.195
118	20	S4	0	2.918	1420.963	212.947	1420.963	9.999+	6.673
119	20	S5	0	4.939	1425.266	235.584	1425.266	9.999+	6.05
120	20	S6	0	15.503	1424.854	139.669	1424.854	9.999+	9.999+

**Envelope Slab Soil Pressures**

	Label	UC	LC	Soil Pressure[psf]	Allowable Bearing[psf]	Point
1	S1	.405	5	607.583	1500	N1
2	S2	.482	5	722.419	1500	N16
3	S3	.476	5	714.522	1500	N20
4	S4	.476	5	714.672	1500	N24
5	S5	.482	5	722.734	1500	N28
6	S6	.404	5	605.988	1500	N34





Company:		Date:	5/14/2018
Engineer:		Page:	1/6
Project:			
Address:			
Phone:			
E-mail:			

**1. Project information**

Customer company:  
Customer contact name:  
Customer e-mail:  
Comment:

Project description:  
Location:  
Fastening description:

**2. Input Data & Anchor Parameters**

**General**

Design method: ACI 318-14  
Units: Imperial units

**Anchor Information:**

Anchor type: Bonded anchor  
Material: F1554 Grade 36  
Diameter (inch): 0.375  
Effective Embedment depth,  $h_{ef}$  (inch): 4.000  
Code report: ICC-ES ESR-4057  
Anchor category: -  
Anchor ductility: Yes  
 $h_{min}$  (inch): 5.25  
 $c_{ac}$  (inch): 7.12  
 $c_{min}$  (inch): 1.75  
 $s_{min}$  (inch): 3.00

**Base Material**

Concrete: Normal-weight  
Concrete thickness,  $h$  (inch): 24.00  
State: Cracked  
Compressive strength,  $f'_c$  (psi): 2500  
 $\Psi_{c,v}$ : 1.0  
Reinforcement condition: B tension, B shear  
Supplemental reinforcement: Not applicable  
Reinforcement provided at corners: No  
Ignore concrete breakout in tension: No  
Ignore concrete breakout in shear: No  
Hole condition: Dry concrete  
Inspection: Periodic  
Temperature range, Short/Long: 150/110°F  
Ignore 6do requirement: Not applicable  
Build-up grout pad: No

**Base Plate**

Length x Width x Thickness (inch): 4.75 x 4.75 x 0.31

**Recommended Anchor**

Anchor Name: SET-3G - SET-3G w/ 3/8"Ø F1554 Gr. 36  
Code Report: ICC-ES ESR-4057





Company:		Date:	5/14/2018
Engineer:		Page:	2/6
Project:			
Address:			
Phone:			
E-mail:			

**Load and Geometry**

Load factor source: ACI 318 Section 5.3

Load combination: not set

Seismic design: No

Anchors subjected to sustained tension: No

Apply entire shear load at front row: No

Anchors only resisting wind and/or seismic loads: No

Strength level loads:

$N_{ua}$  [lb]: 4000

$V_{uax}$  [lb]: 525

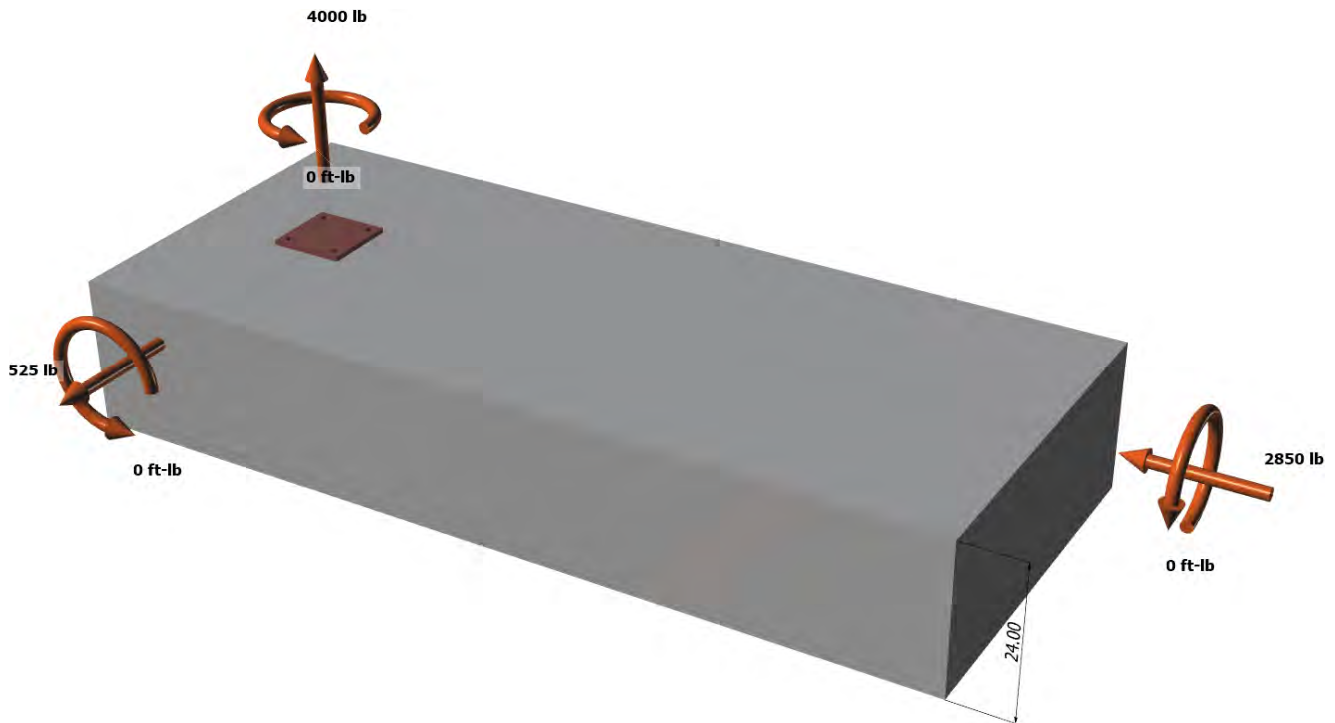
$V_{uay}$  [lb]: -2850

$M_{ux}$  [ft-lb]: 0

$M_{uy}$  [ft-lb]: 0

$M_{uz}$  [ft-lb]: 0

<Figure 1>

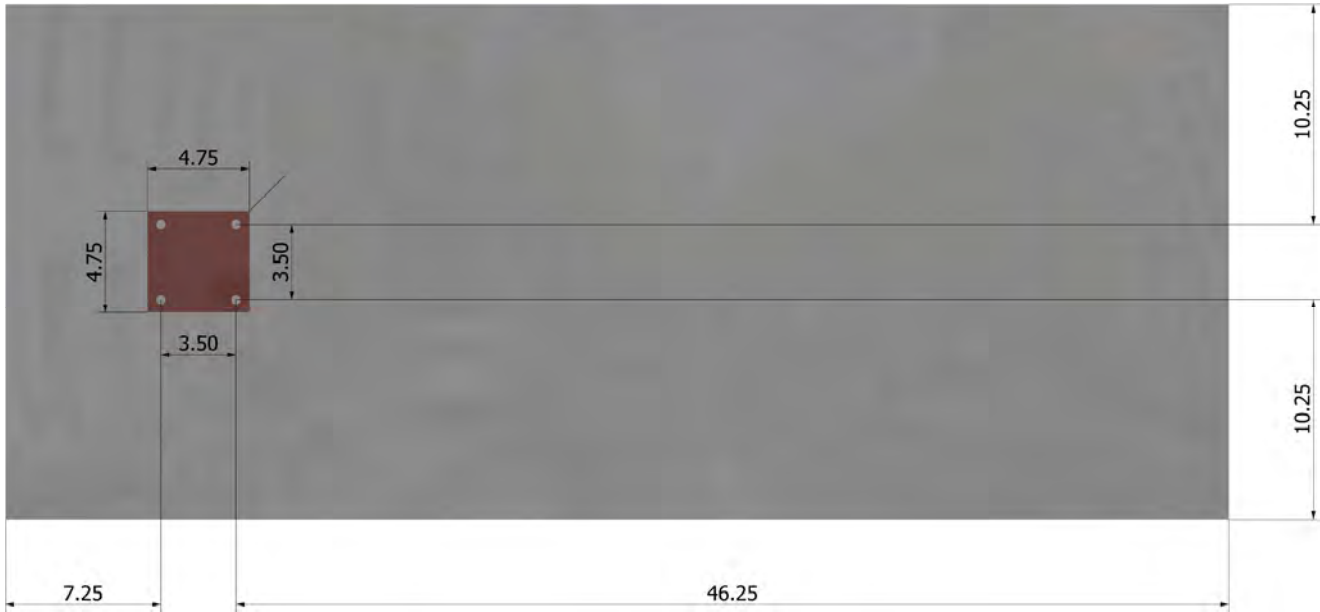


Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.



Company:		Date:	5/14/2018
Engineer:		Page:	3/6
Project:			
Address:			
Phone:			
E-mail:			

<Figure 2>







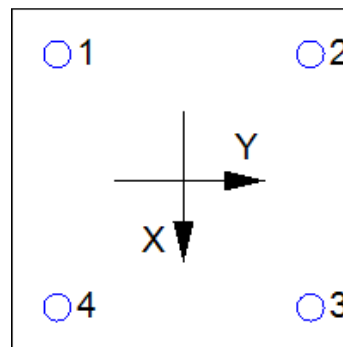
Company:		Date:	5/14/2018
Engineer:		Page:	4/6
Project:			
Address:			
Phone:			
E-mail:			

### 3. Resulting Anchor Forces

Anchor	Tension load, N <sub>ua</sub> (lb)	Shear load x, V <sub>uax</sub> (lb)	Shear load y, V <sub>uay</sub> (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	1000.0	131.3	-712.5	724.5
2	1000.0	131.3	-712.5	724.5
3	1000.0	131.3	-712.5	724.5
4	1000.0	131.3	-712.5	724.5
Sum	4000.0	525.0	-2850.0	2898.0

Maximum concrete compression strain (%): 0.00  
 Maximum concrete compression stress (psi): 0  
 Resultant tension force (lb): 4000  
 Resultant compression force (lb): 0  
 Eccentricity of resultant tension forces in x-axis, e'<sub>Nx</sub> (inch): 0.00  
 Eccentricity of resultant tension forces in y-axis, e'<sub>Ny</sub> (inch): 0.00  
 Eccentricity of resultant shear forces in x-axis, e'<sub>Vx</sub> (inch): 0.00  
 Eccentricity of resultant shear forces in y-axis, e'<sub>Vy</sub> (inch): 0.00

<Figure 3>



### 4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N <sub>sa</sub> (lb)	φ	φN <sub>sa</sub> (lb)
4525	0.75	3394

### 5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$$N_b = K_c \lambda_a \sqrt{f_c} h_{ef}^{1.5} \text{ (Eq. 17.4.2.2a)}$$

K <sub>c</sub>	λ <sub>a</sub>	f <sub>c</sub> (psi)	h <sub>ef</sub> (in)	N <sub>b</sub> (lb)
17.0	1.00	2500	4.000	6800

$$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \text{ (Sec. 17.3.1 \& Eq. 17.4.2.1b)}$$

A <sub>Nc</sub> (in <sup>2</sup> )	A <sub>Nco</sub> (in <sup>2</sup> )	c <sub>a,min</sub> (in)	ψ <sub>ec,N</sub>	ψ <sub>ed,N</sub>	ψ <sub>c,N</sub>	ψ <sub>cp,N</sub>	N <sub>b</sub> (lb)	φ	φN <sub>cbg</sub> (lb)
240.25	144.00	7.25	1.000	1.000	1.00	1.000	6800	0.65	7374

### 6. Adhesive Strength of Anchor in Tension (Sec. 17.4.5)

$$\tau_{k,cr} = \tau_{k,cr,short-term} K_{sat} (f_c / 2,500)^n$$

τ <sub>k,cr</sub> (psi)	f <sub>short-term</sub>	K <sub>sat</sub>	f <sub>c</sub> (psi)	n	τ <sub>k,cr</sub> (psi)
1346	1.00	1.00	2500	0.24	1346

$$N_{ba} = \lambda_a \tau_{cr} \pi d_a h_{ef} \text{ (Eq. 17.4.5.2)}$$

λ <sub>a</sub>	τ <sub>cr</sub> (psi)	d <sub>a</sub> (in)	h <sub>ef</sub> (in)	N <sub>ba</sub> (lb)
1.00	1346	0.38	4.000	6343

$$\phi N_{ag} = \phi (A_{Na} / A_{Na0}) \psi_{ec,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba} \text{ (Sec. 17.3.1 \& Eq. 17.4.5.1b)}$$

A <sub>Na</sub> (in <sup>2</sup> )	A <sub>Na0</sub> (in <sup>2</sup> )	c <sub>Na</sub> (in)	c <sub>a,min</sub> (in)	ψ <sub>ec,Na</sub>	ψ <sub>ed,Na</sub>	ψ <sub>cp,Na</sub>	N <sub>ba</sub> (lb)	φ	φN <sub>ag</sub> (lb)
198.45	112.09	5.29	7.25	1.000	1.000	1.000	6343	0.55	6176



Company:		Date:	5/14/2018
Engineer:		Page:	5/6
Project:			
Address:			
Phone:			
E-mail:			

**8. Steel Strength of Anchor in Shear (Sec. 17.5.1)**

$V_{sa}$ (lb)	$\phi_{grout}$	$\phi$	$\phi_{grout}\phi V_{sa}$ (lb)
2715	1.0	0.65	1765

**9. Concrete Breakout Strength of Anchor in Shear (Sec. 17.5.2)**

**Shear perpendicular to edge in x-direction:**

$V_{bx} = \min|7(l_e / d_a)^{0.2} \sqrt{d_a} \lambda_a \sqrt{f_c} c_{a1}^{1.5}; 9 \lambda_a \sqrt{f_c} c_{a1}^{1.5}|$  (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

$l_e$ (in)	$d_a$ (in)	$\lambda_a$	$f_c$ (psi)	$c_{a1}$ (in)	$V_{bx}$ (lb)
3.00	0.375	1.00	2500	13.75	16564

$\phi V_{cbgx} = \phi (A_{Vc} / A_{Vco}) \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_{bx}$  (Sec. 17.3.1 & Eq. 17.5.2.1b)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	$V_{bx}$ (lb)	$\phi$	$\phi V_{cbgx}$ (lb)
647.11	850.78	1.000	0.805	1.000	1.000	16564	0.70	7103

**Shear perpendicular to edge in y-direction:**

$V_{by} = \min|7(l_e / d_a)^{0.2} \sqrt{d_a} \lambda_a \sqrt{f_c} c_{a1}^{1.5}; 9 \lambda_a \sqrt{f_c} c_{a1}^{1.5}|$  (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

$l_e$ (in)	$d_a$ (in)	$\lambda_a$	$f_c$ (psi)	$c_{a1}$ (in)	$V_{by}$ (lb)
3.00	0.375	1.00	2500	10.75	11450

$\phi V_{cbgy} = \phi (A_{Vc} / A_{Vco}) \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_{by}$  (Sec. 17.3.1 & Eq. 17.5.2.1b)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	$V_{by}$ (lb)	$\phi$	$\phi V_{cbgy}$ (lb)
387.00	520.03	1.000	0.891	1.000	1.000	11450	0.70	5313

**Shear parallel to edge in x-direction:**

$V_{by} = \min|7(l_e / d_a)^{0.2} \sqrt{d_a} \lambda_a \sqrt{f_c} c_{a1}^{1.5}; 9 \lambda_a \sqrt{f_c} c_{a1}^{1.5}|$  (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

$l_e$ (in)	$d_a$ (in)	$\lambda_a$	$f_c$ (psi)	$c_{a1}$ (in)	$V_{by}$ (lb)
3.00	0.375	1.00	2500	7.25	6342

$\phi V_{cbgx} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_{by}$  (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	$V_{by}$ (lb)	$\phi$	$\phi V_{cbgx}$ (lb)
261.00	236.53	1.000	1.000	1.000	1.000	6342	0.70	9797

**Shear parallel to edge in y-direction:**

$V_{bx} = \min|7(l_e / d_a)^{0.2} \sqrt{d_a} \lambda_a \sqrt{f_c} c_{a1}^{1.5}; 9 \lambda_a \sqrt{f_c} c_{a1}^{1.5}|$  (Eq. 17.5.2.2a & Eq. 17.5.2.2b)

$l_e$ (in)	$d_a$ (in)	$\lambda_a$	$f_c$ (psi)	$c_{a1}$ (in)	$V_{bx}$ (lb)
3.00	0.375	1.00	2500	10.25	10661

$\phi V_{cbgy} = \phi (2)(A_{Vc} / A_{Vco}) \psi_{ec,v} \psi_{ed,v} \psi_{c,v} \psi_{h,v} V_{bx}$  (Sec. 17.3.1, 17.5.2.1(c) & Eq. 17.5.2.1b)

$A_{Vc}$ (in <sup>2</sup> )	$A_{Vco}$ (in <sup>2</sup> )	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	$V_{bx}$ (lb)	$\phi$	$\phi V_{cbgy}$ (lb)
401.67	472.78	1.000	1.000	1.000	1.000	10661	0.70	12680

**10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)**

$\phi V_{cp} = \phi \min|k_{cp} N_{ba}; k_{cp} N_{cbg}| = \phi \min|k_{cp} (A_{Na} / A_{Na0}) \psi_{ec,Na} \psi_{ed,Na} \psi_{cp,Na} N_{ba}; k_{cp} (A_{Nc} / A_{Nco}) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b|$  (Sec. 17.3.1 & Eq. 17.5.3.1b)

$k_{cp}$	$A_{Na}$ (in <sup>2</sup> )	$A_{Na0}$ (in <sup>2</sup> )	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{cp,Na}$	$N_{ba}$ (lb)	$N_a$ (lb)
2.0	198.45	112.09	1.000	1.000	1.000	6343	11230

$A_{Nc}$ (in <sup>2</sup> )	$A_{Nco}$ (in <sup>2</sup> )	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$	$N_b$ (lb)	$N_{cb}$ (lb)	$\phi$
240.25	144.00	1.000	1.000	1.000	1.000	6800	11345	0.70

Input data and results must be checked for agreement with the existing circumstances, the standards and guidelines must be checked for plausibility.



Company:		Date:	5/14/2018
Engineer:		Page:	6/6
Project:			
Address:			
Phone:			
E-mail:			

$\phi V_{cpq}$  (lb)  
15722

## 11. Results

### Interaction of Tensile and Shear Forces (Sec. R17.6)

Tension	Factored Load, $N_{ua}$ (lb)	Design Strength, $\phi N_n$ (lb)	Ratio	Status	
Steel	1000	3394	0.29	Pass	
Concrete breakout	4000	7374	0.54	Pass	
<b>Adhesive</b>	<b>4000</b>	<b>6176</b>	<b>0.65</b>	<b>Pass (Governs)</b>	
Shear	Factored Load, $V_{ua}$ (lb)	Design Strength, $\phi V_n$ (lb)	Ratio	Status	
Steel	724	1765	0.41	Pass	
T Concrete breakout x+	525	7103	0.07	Pass	
T Concrete breakout y-	2850	5313	0.54	Pass	
Concrete breakout y-	263	9797	0.03	Pass	
Concrete breakout x-	1425	12680	0.11	Pass	
<b>Concrete breakout, combined</b>	-	-	<b>0.54</b>	<b>Pass (Governs)</b>	
Pryout	2898	15722	0.18	Pass	
Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. R17.6	0.48	0.36	84.5%	1.0	Pass

**SET-3G w/ 3/8"Ø F1554 Gr. 36 with hef = 4.000 inch meets the selected design criteria.**

## 12. Warnings

- Designer must exercise own judgement to determine if this design is suitable.
- Refer to manufacturer's product literature for hole cleaning and installation instructions.

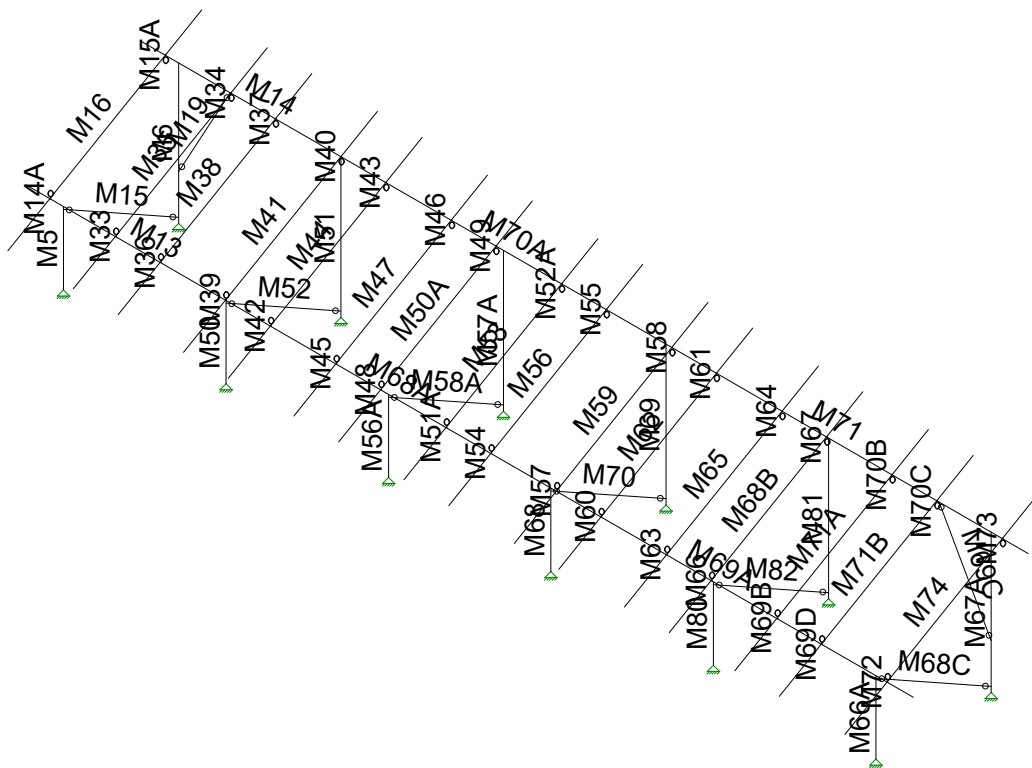


JOB NO.: U2716-094-191

DESIGNED: STB

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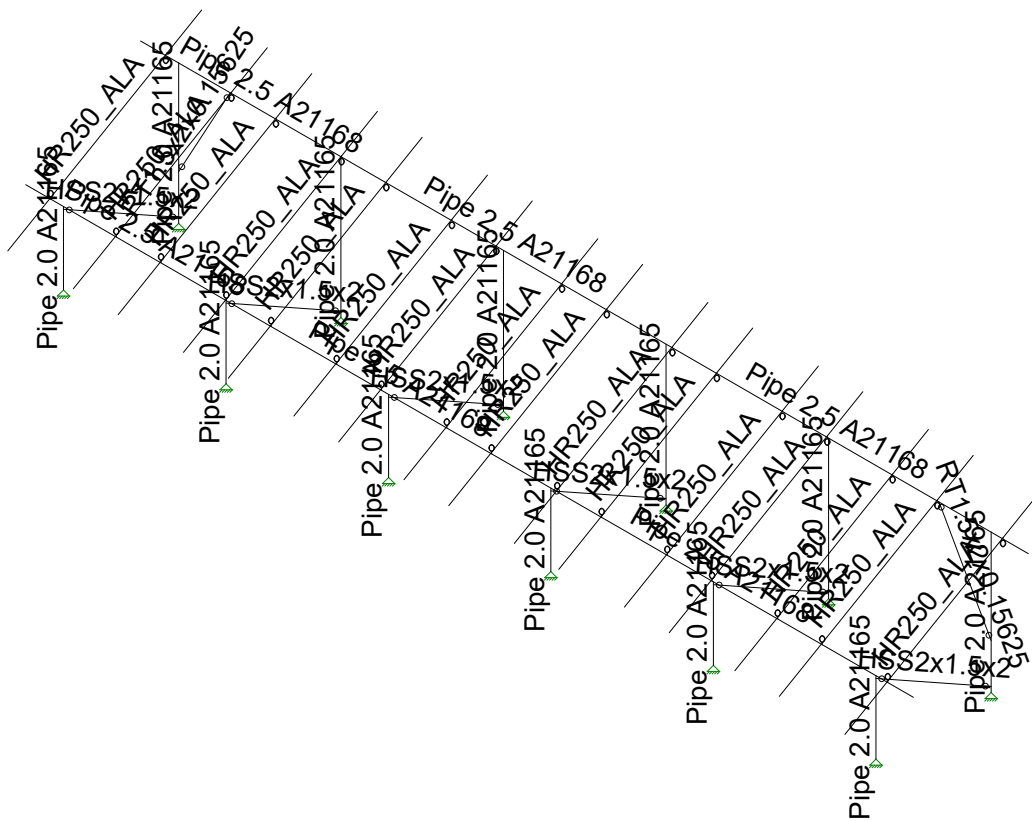
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Ground Mount

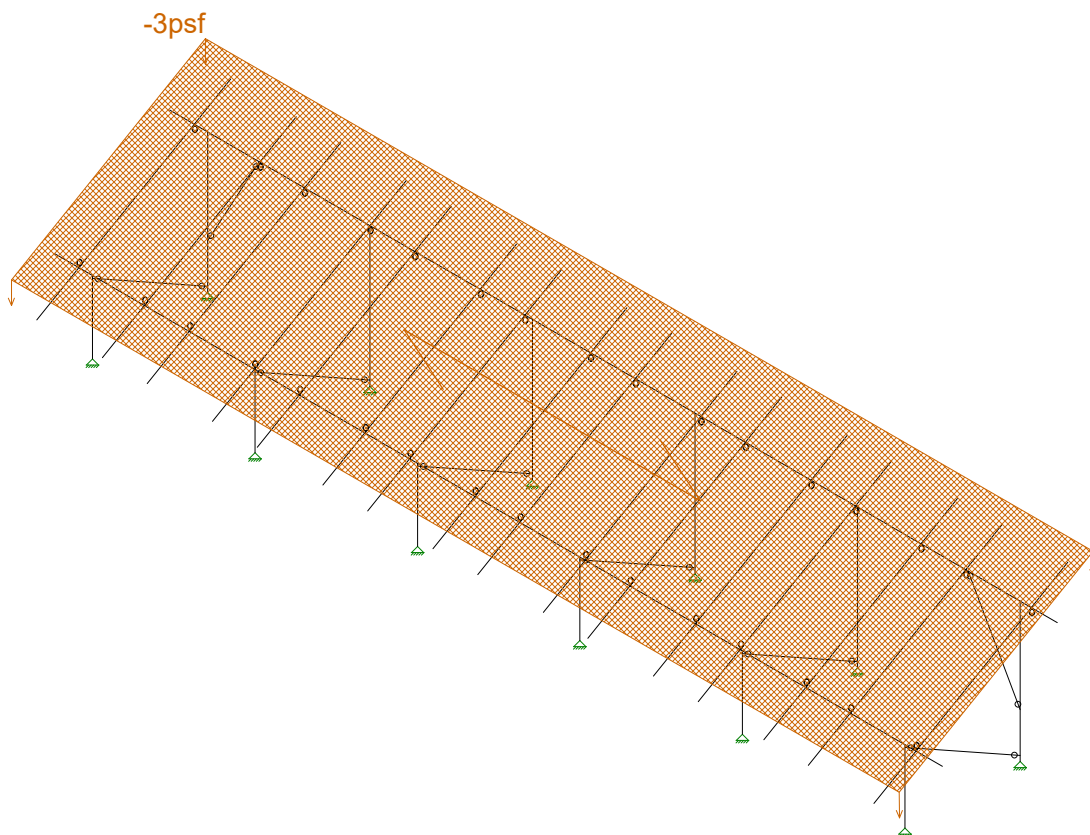
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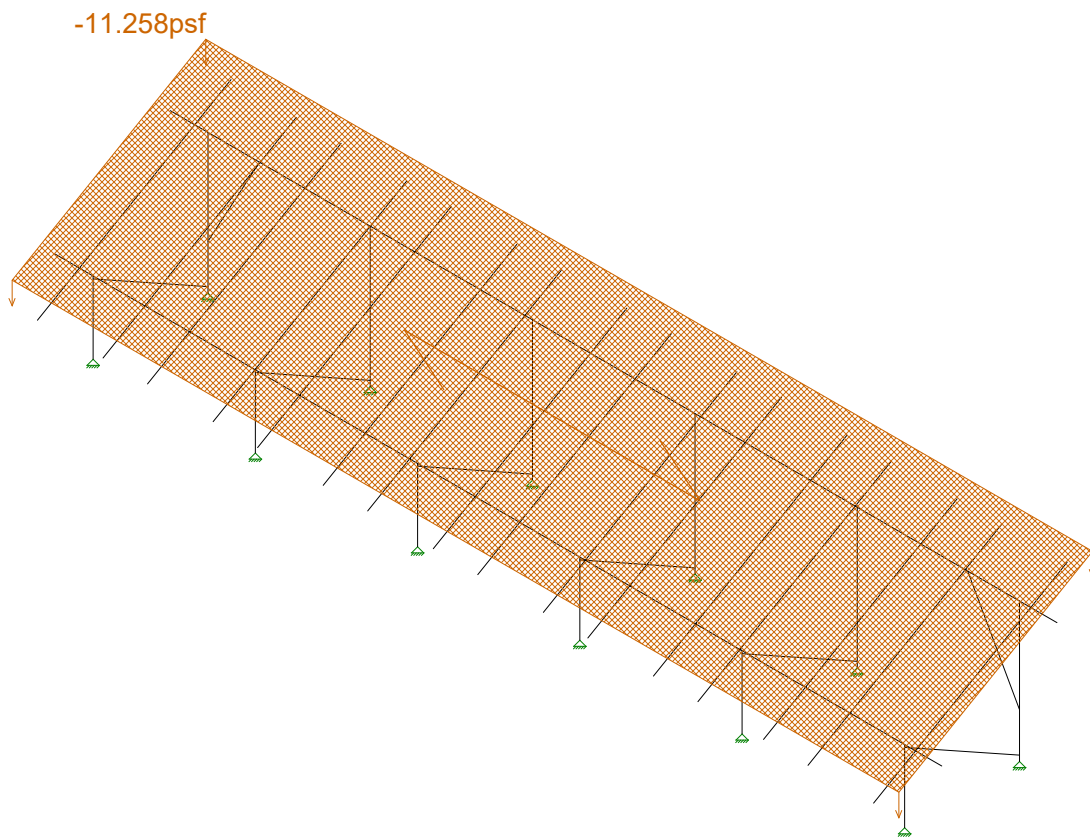
Ground Mount

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Loads: BLC 2, Solar Panel Weight

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Loads: BLC 3, Roof Live/Snow

Vector Structural Engineeri..

STB

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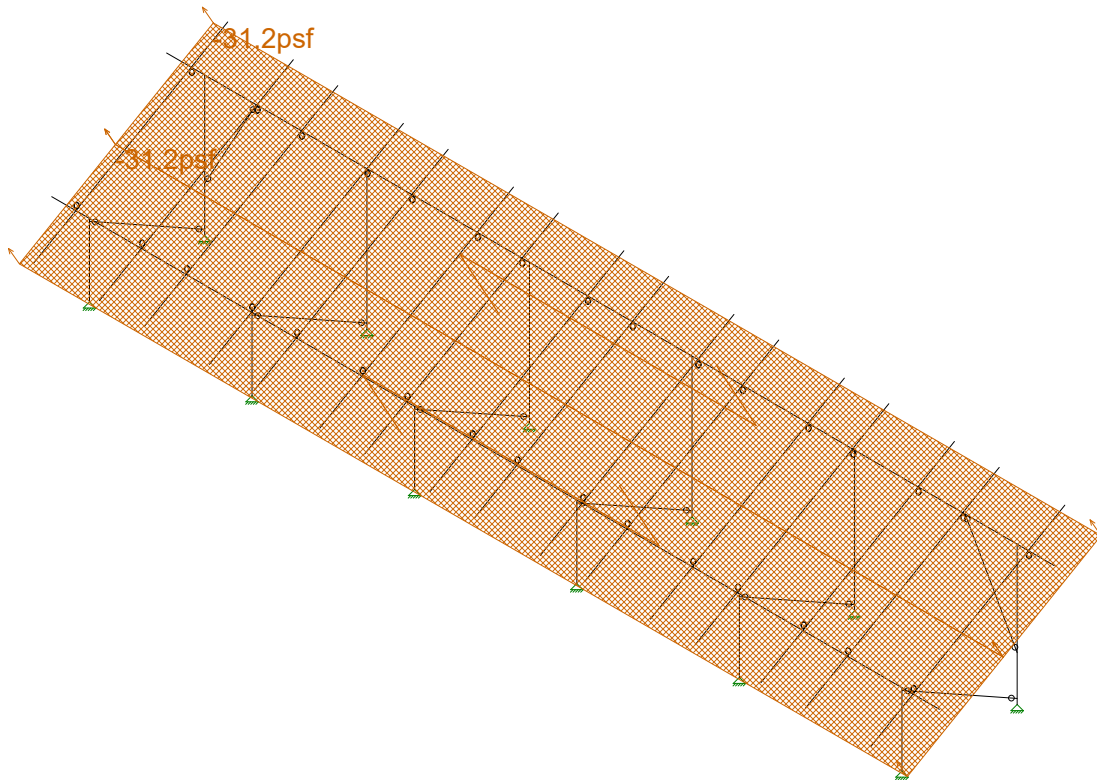
Ground Mount

SK - 1

July 25, 2019 at 4:26 PM

USA B1 GM v4.r3d





Loads: BLC 4, Wind A 0 deg

Vector Structural Engineeri..

STB

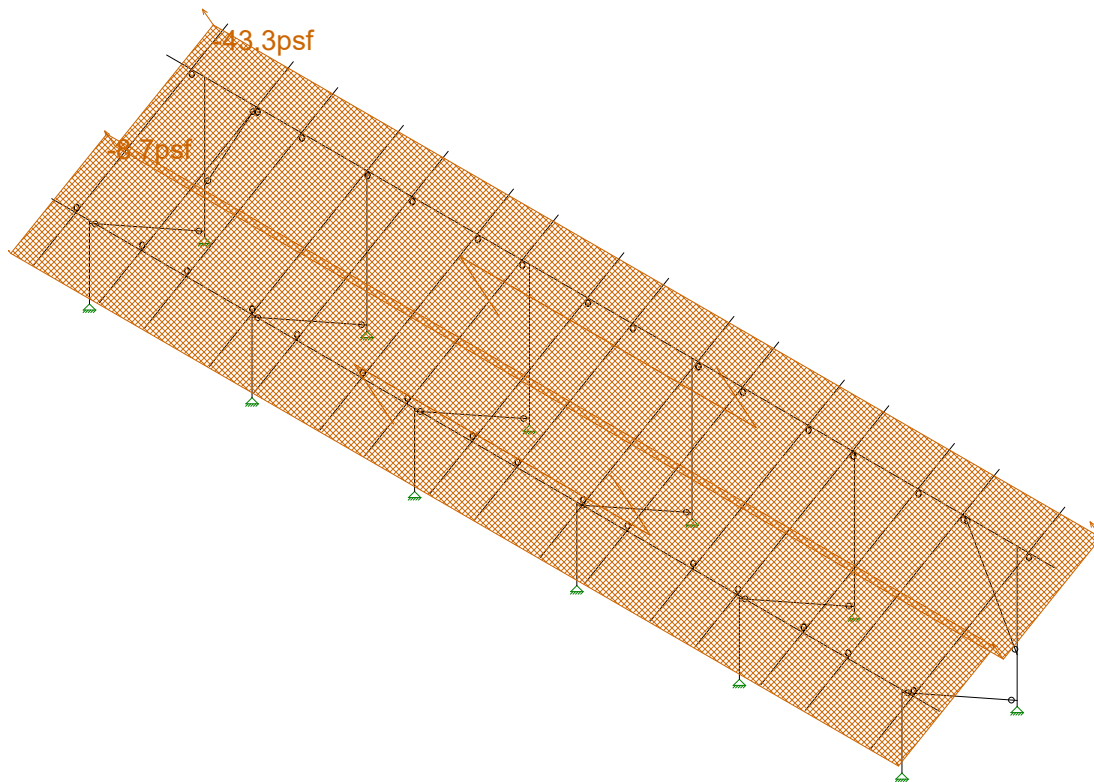
U2716.094.191

Ground Mount

SK - 7

June 7, 2019 at 3:56 PM

USA B1 GM v3.r3d



Loads: BLC 5, Wind B 0 deg

Vector Structural Engineeri..

STB

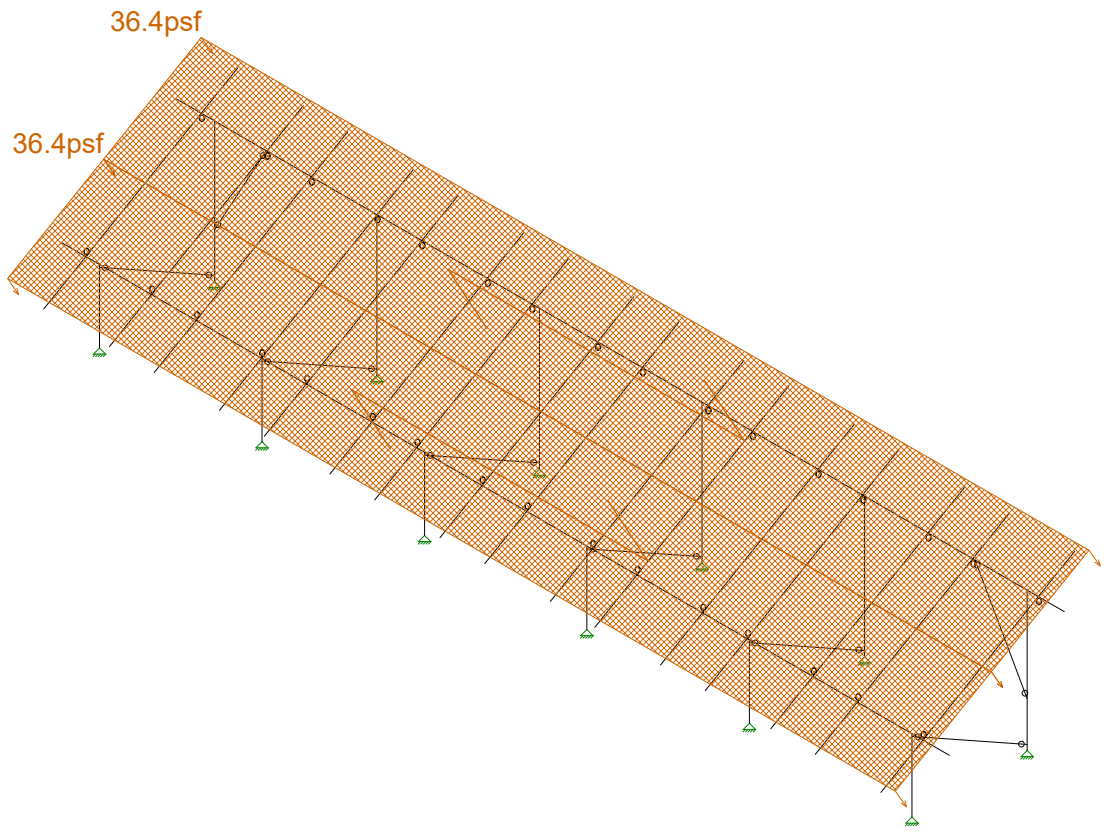
U2716.094.191

Ground Mount

SK - 8

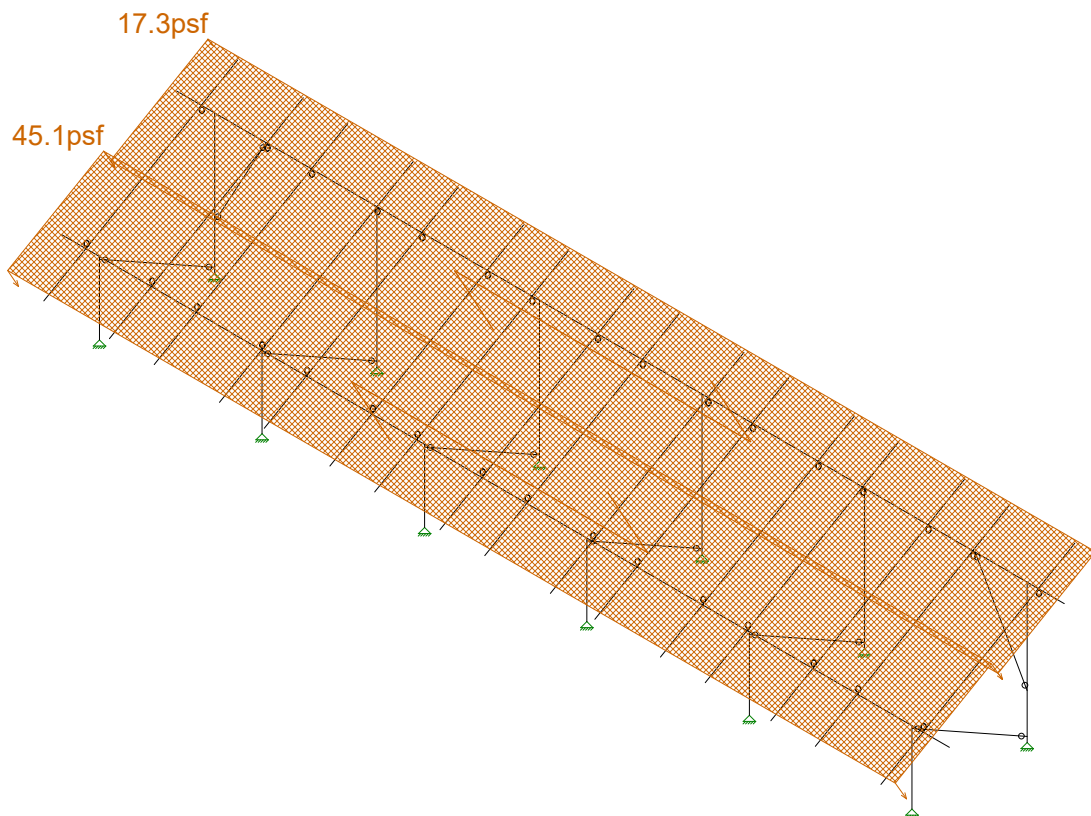
June 7, 2019 at 3:56 PM

USA B1 GM v3.r3d



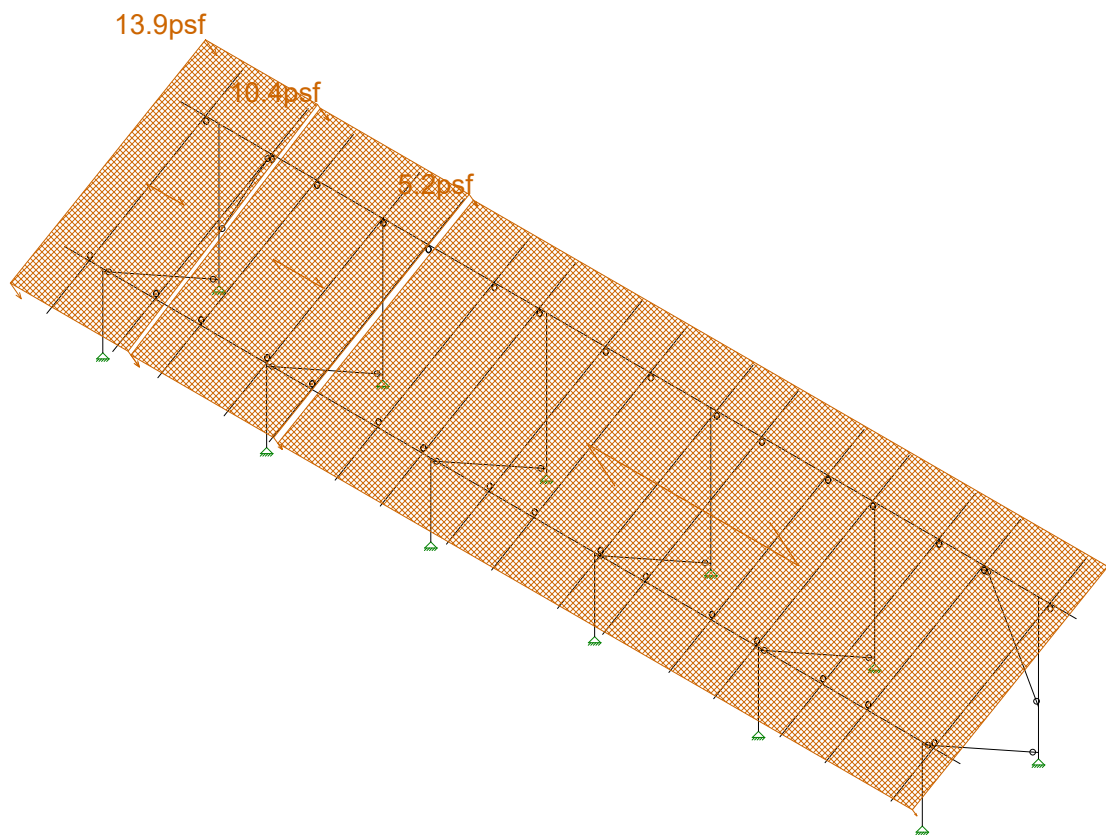
Loads: BLC 6, Wind A 180 deg

Vector Structural Engineeri..	Ground Mount	SK - 9
STB		June 7, 2019 at 3:56 PM
U2716.094.191		USA B1 GM v3.r3d



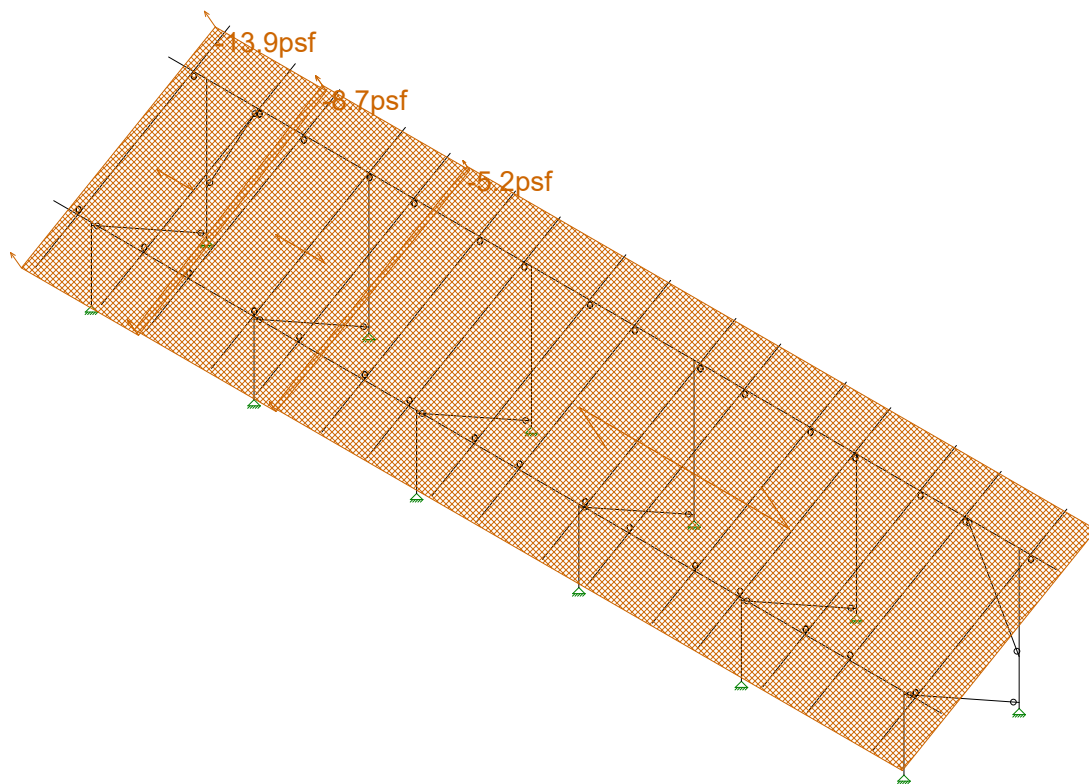
Loads: BLC 7, Wind B 180 deg

Vector Structural Engineeri..	Ground Mount	SK - 10
STB		June 7, 2019 at 3:56 PM
U2716.094.191		USA B1 GM v3.r3d



Loads: BLC 8, Wind A 90

Vector Structural Engineeri..	Ground Mount	SK - 13
STB		June 7, 2019 at 3:56 PM
U2716.094.191		USA B1 GM v3.r3d



Loads: BLC 9, Wind B 90

Vector Structural Engineeri...	Ground Mount	SK - 12
STB		June 7, 2019 at 3:56 PM
U2716.094.191		USA B1 GM v3.r3d







**(Global) Model Settings**

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (in/sec^2)	386.4
Wall Mesh Size (in)	24
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)
RISACONNECTION CODE	AISC 14th(360-10): ASD
Cold Formed Steel Code	AISI S100-16: ASD
Wood Code	AWC NDS-15: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-14
Masonry Code	ACI 530-13: ASD
Aluminum Code	AA ADM1-15: ASD - Building AISC 14th(360-10): ASD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parame Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR SET ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

**(Global) Model Settings, Continued**

Seismic Code	ASCE 7-10
Seismic Base Elevation (in)	15600
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	1
SDS	1
S1	1
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	1
Om X	1
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

**Hot Rolled Steel Properties**

	Label	E [ksi]	G [ksi]	Nu	Therm (1E5 F)	Density[lb/ft^3]	Yield[psi]	Ry	Fu[psi]	Rt
1	A992	29000	11154	.3	.65	490	50000	1.1	65000	1.1
2	A36 Gr.36	29000	11154	.3	.65	490	36000	1.5	58000	1.2
3	A572 Gr.50	29000	11154	.3	.65	490	50000	1.1	65000	1.1
4	A500 Gr.B R...	29000	11154	.3	.65	527	42000	1.4	58000	1.3
5	A500 Gr.B Re...	29000	11154	.3	.65	527	46000	1.4	58000	1.3
6	A53 Gr.B	29000	11154	.3	.65	490	35000	1.6	60000	1.2
7	A1085	29000	11154	.3	.65	490	50000	1.4	65000	1.3

**Aluminum Properties**

	Label	E [ksi]	G [ksi]	Nu	Therm (...Density[... Table B.4	kt	Ftu[psi]	Fty[psi]	Fcy[psi]	Fsu[psi]	Ct
1	3003-H14	10100	3787.5	.33	1.3 172.8 Table B.4-1	1	19000	16000	13000	12000	141
2	6061-T6	10100	3787.5	.33	1.3 172.8 Table B.4-2	1	38000	35000	35000	24000	141
3	6063-T5	10100	3787.5	.33	1.3 172.8 Table B.4-2	1	22000	16000	16000	13000	141
4	6063-T6	10100	3787.5	.33	1.3 172.8 Table B.4-2	1	30000	25000	25000	19000	141
5	5052-H34	10200	3787.5	.33	1.3 172.8 Table B.4-1	1	34000	26000	24000	20000	141
6	6061-T6 W	10100	3787.5	.33	1.3 172.8 Table B.4-1	1	24000	15000	15000	15000	141
7	6005-T5	10100	3787.5	.33	1.3 172.8 Table B.4-1	1	38000	35000	35000	24000	141

**Hot Rolled Steel Section Sets**

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	Post	Pipe 2.0 A21165	Column	Pipe	A572 Gr.50	Typical	.776	.499	.499	.998
2	Cross Beam	Pipe 2.5 A21168	Beam	Wide Flange	A572 Gr.50	Typical	.947	.907	.907	1.814
3	Diagonal Brace	1.5x1.5x0.083	Beam	Wide Flange	A36 Gr.36	Typical	.47	.158	.158	.236



Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.094.191  
 Model Name : Ground Mount

July 25, 2019  
 4:27 PM  
 Checked By: \_\_\_\_\_

### Aluminum Section Sets

	Label	Shape	Type	Design List	Material	Design R...	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	AL Posts	2.375ODX0.188	Column	Pipe	6005-T5	Typical	1.29	.778	.778	1.54
2	AL Brace	RT1.5x2x0.15625	VBrace	Rectangular Tubes	6005-T5	Typical	.996	.327	.524	.602
3	AL Rails	HR250 ALA	Beam	Rectangular Tubes	6005-T5	Typical	.723	.095	.486	.261
4	AL Cross Beam	Cross Rail	Beam	Rectangular Tubes	6005-T5	Typical	1.909	1.97	4.366	4.017

### Member Area Loads (BLC 2 : Solar Panel Weight)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N199	N196	Y	A-B	-3

### Member Area Loads (BLC 3 : Roof Live/Snow)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N199	N196	PY	A-B	-13

### Member Area Loads (BLC 4 : Wind A 0 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	-31.2
2	N198	N201	N199	N196	Perp	A-B	-31.2

### Member Area Loads (BLC 5 : Wind B 0 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	-43.3
2	N198	N201	N199	N196	Perp	A-B	-8.7

### Member Area Loads (BLC 6 : Wind A 180 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	36.4
2	N198	N201	N199	N196	Perp	A-B	36.4

### Member Area Loads (BLC 7 : Wind B 180 deg)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N200	N201	N198	Perp	A-B	17.3
2	N198	N201	N199	N196	Perp	A-B	45.1

### Member Area Loads (BLC 8 : Wind A 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N203	N202	N196	Perp	A-B	13.9
2	N203	N209	N208	N202	Perp	A-B	10.4
3	N209	N200	N199	N208	Perp	A-B	5.2

### Member Area Loads (BLC 9 : Wind B 90)

	Joint A	Joint B	Joint C	Joint D	Direction	Distribution	Magnitude[psf]
1	N197	N203	N202	N196	Perp	A-B	-13.9
2	N203	N209	N208	N202	Perp	A-B	-8.7
3	N209	N200	N199	N208	Perp	A-B	-5.2

### Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area(M...Surface...
1	Self Weight	DL		-1.05					
2	Solar Panel Weight	DL							1







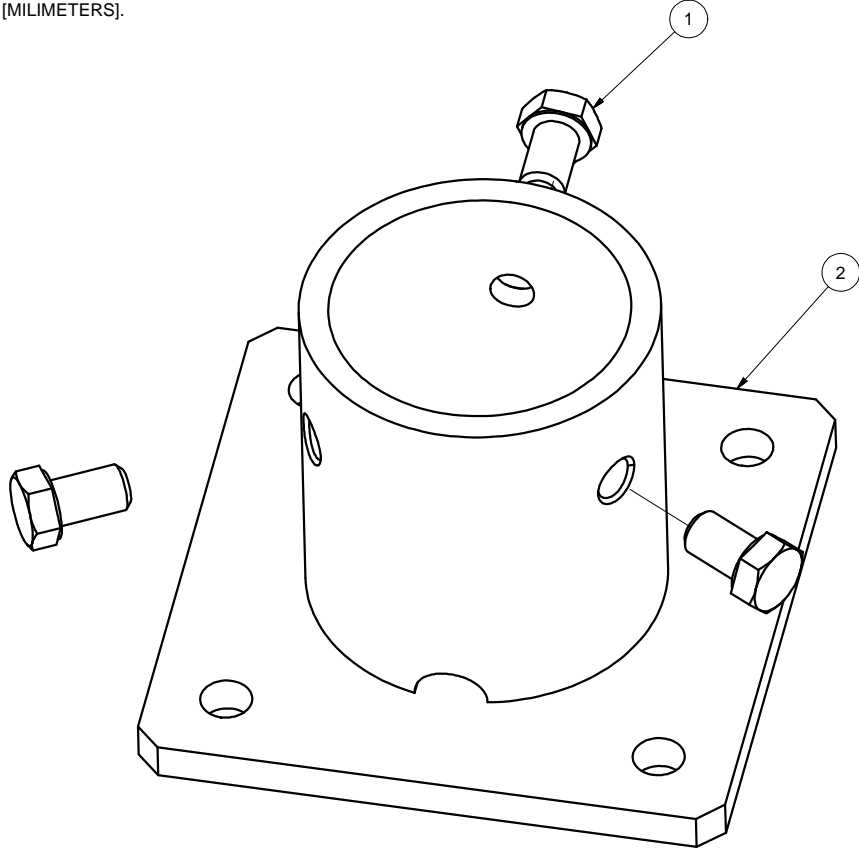
Company : Vector Structural Engineering  
 Designer : STB  
 Job Number : U2716.094.191  
 Model Name : Ground Mount

July 25, 2019  
 4:27 PM  
 Checked By: \_\_\_\_\_

**Envelope AA ADM1-15: ASD - Building Aluminum Code Checks (Continued)**

Member	Shape	Code C...	Loc[in]	LC Shear ...	Loc[in]	Dir	LC Pnc/O...	Pnt/Om...	Mny/O...	Mnz/O...	Vny/O...	Vnz/O...	Cb	Eqn			
12	M62	HR250_A..	.763	36.144	12	.081	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1
13	M65	HR250_A..	.763	36.144	12	.082	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1
14	M68B	HR250_A..	.974	89.499	16	.082	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1
15	M71A	HR250_A..	.763	36.144	12	.090	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1
16	M69C	RT1.5x2x...	.287	47.196	11	.011	0	z	12	2657.816	19411....	770.742	927.083	6090.199	4101.563	1....	H.1-1
17	M71B	HR250_A..	.833	87.778	11	.097	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1
18	M74	HR250_A..	.837	36.144	12	.088	37.865	y	12	2221.164	14089....	309.506	613.954	5108.727	1672.364	1	H.1-1

NOTES: UNLESS OTHERWISE SPECIFIED  
 1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].



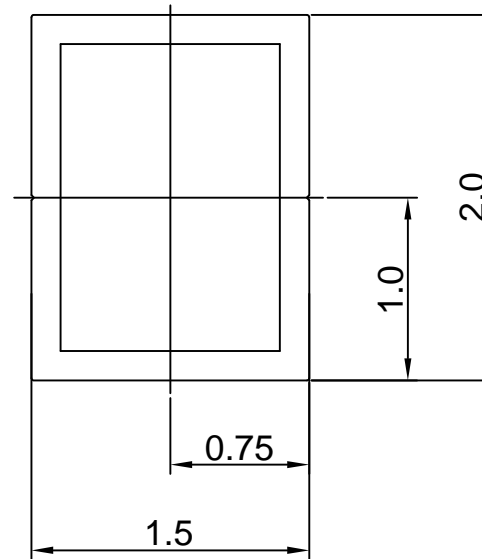
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	10/20/2016

2	A21120-001	2" PIPE BASE	1
1	B15018-011	HEX CAP SCREW 3/8-16 X 5/8	3
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>Sunmodo Corp.</b> 1905 E 5TH STREET, STE A, VANCOUVER, WA 98661	
Tolerances		TITLE	
X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd		2" PIPE BASE KIT	
DRAWN BY		DATE	
LWF		10/20/2016	
CHECKED BY		DRAWING NUMBER	
		B K10268-001	
APPROVALS		SCALE: NONE SHEET 1 of 1	

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NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERAIL: ALUMINUM 6005-T5.  
FINISH: CLEAR ANODIZED 10  $\mu$ m THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



## Section properties:

Weight: 1.156 lbs/ft

Area: 0.992 in<sup>2</sup>

Perimeter: 12.601 in

Bounding Box: X: -1.000,1.000

Y: -0.750, 0.750

Centroid:(0.000,0.000)

Moments of Inertia(in<sup>4</sup>): I<sub>x</sub>=0.506,I<sub>y</sub>=0.322

Section modulus in bending(in<sup>3</sup>): W<sub>x</sub>=0.675,W<sub>y</sub>=0.322

Radii of Gyration: X: 0.714, Y: 0.570

MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS			
All Dimensions in inches [millimeters]			
Tolerances			
X.XXX ± 0.01 [0.25mm]		Break all sharp edges	
X.XX ± 0.02 [0.50mm]		.010-.020 unless	
X.X ± 0.039 [1.0mm]		otherwise specified.	
Unless otherwise specd			
DRAWN BY	DATE	TITLE	
zcg	03/12/2014	1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661	
CHECKED BY		B	DRAWING NUMBER
			A20164
APPROVALS		SCALE:	NONE
			SHEET 1 of 1

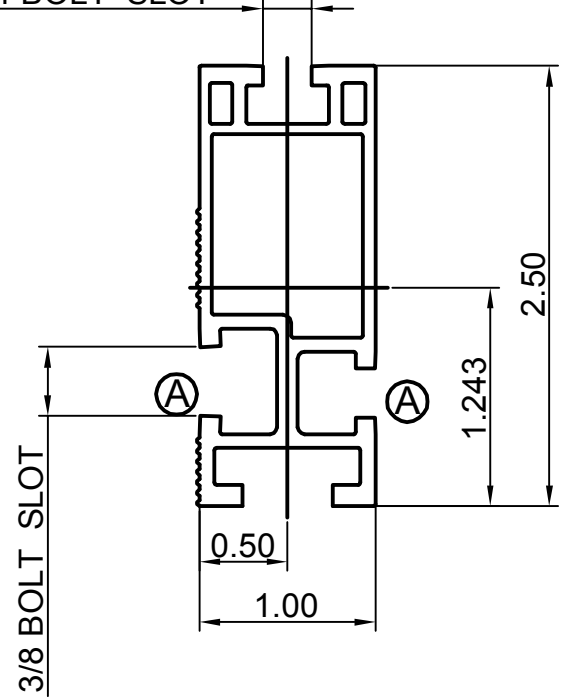


REVISIONS			
REV	DESCRIPTION	BY	DATE
A	ADDED BOTTOM CHANNEL & CHANGED ONE 3/8 CHANNEL TO 1/4	zcg	02/21/2013

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERIAL: ALUMINUM 6005-T5.  
FINISH: CLEAR ANODIZED 15 μm THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.

2X 1/4 BOLT SLOT



### Section properties:

Weight: 0.850 lbs/ft  
 Area: 0.723 in<sup>2</sup>  
 Perimeter: 17.325 in  
 Bounding Box: X: -0.500,0.500  
                   Y: -1.243,1.257

Centroid:(0.000,0.000)  
 Moments of Inertia(in<sup>4</sup>): Ix=0.486,Iy=0.095  
 Section modulus in bending(in<sup>3</sup>): Wx=0.387,Wy=0.190  
 Radii of Gyration: X: 0.820, Y: 0.363

MATERIAL <b>SEE NOTES</b>		<b>Sunmodo Corp.</b>	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters]		1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661	
Tolerances: X.XXX ± 0.01 [0.25mm] X.XX ± 0.02 [0.50mm] X.X ± 0.03 [1.0mm] Unless otherwise spec'd		TITLE HELIO STANDARD RAIL	
DRAWN BY zcg	DATE 02/21/2013	DRAWING NUMBER A20144	
CHECKED BY		SCALE: NONE SHEET 1 of 1	
APPROVALS			

4

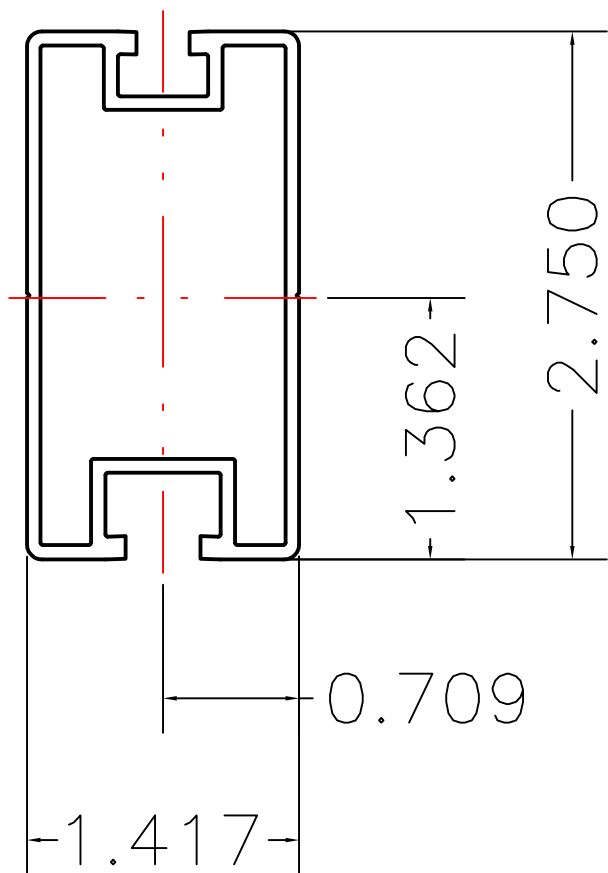
3

2

1

NOTES: UNLESS OTHERWISE SPECIFIED

- 1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
- 2. MATERIAL: 6005-T5.  
FINISH: CLEAR ANODIZED 10um THICK.
- 3. THE UNSPECIFIED RADII ARE .02" MAX.
- 4. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.



### Section properties:

Weight: 0.862 lbs/ft  
 Area: 0.736 in<sup>2</sup>  
 Perimeter: 19.824 in  
 Bounding Box: X: -0.709,0.709  
                   Y: -1.362,1.388  
 Centroid:(0.000,0.000)  
 Moments of Inertia(in<sup>4</sup>): I<sub>x</sub>=0.727,I<sub>y</sub>=0.214  
 Section modulus in bending(in<sup>3</sup>): W<sub>x</sub>=0.524,W<sub>y</sub>=0.302  
 Radii of Gyration: X: 0.994, Y: 0.539

MATERIAL SEE NOTES	
Third Angle Projection:	
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters]	
Tolerances	
X.XXX ±0.01 [0.25mm]	Break all sharp edges .010-.020 unless otherwise specified.
X.XX ±0.02 [0.50mm]	
X.X ±0.039 [1.0mm]	
Unless otherwise spec'd	
DRAWN BY KYY	DATE 01/18/2018
CHECKED BY	
APPROVALS	

<b>SunModo Corp.</b>	
14800 NE 65TH STREET, VANCOUVER WA 98682	
TITLE RAIL, HR300 (SUNRAY), EXTRUSION	
B	DRAWING NUMBER A20288
SCALE: NONE	SHEET 1 of 1

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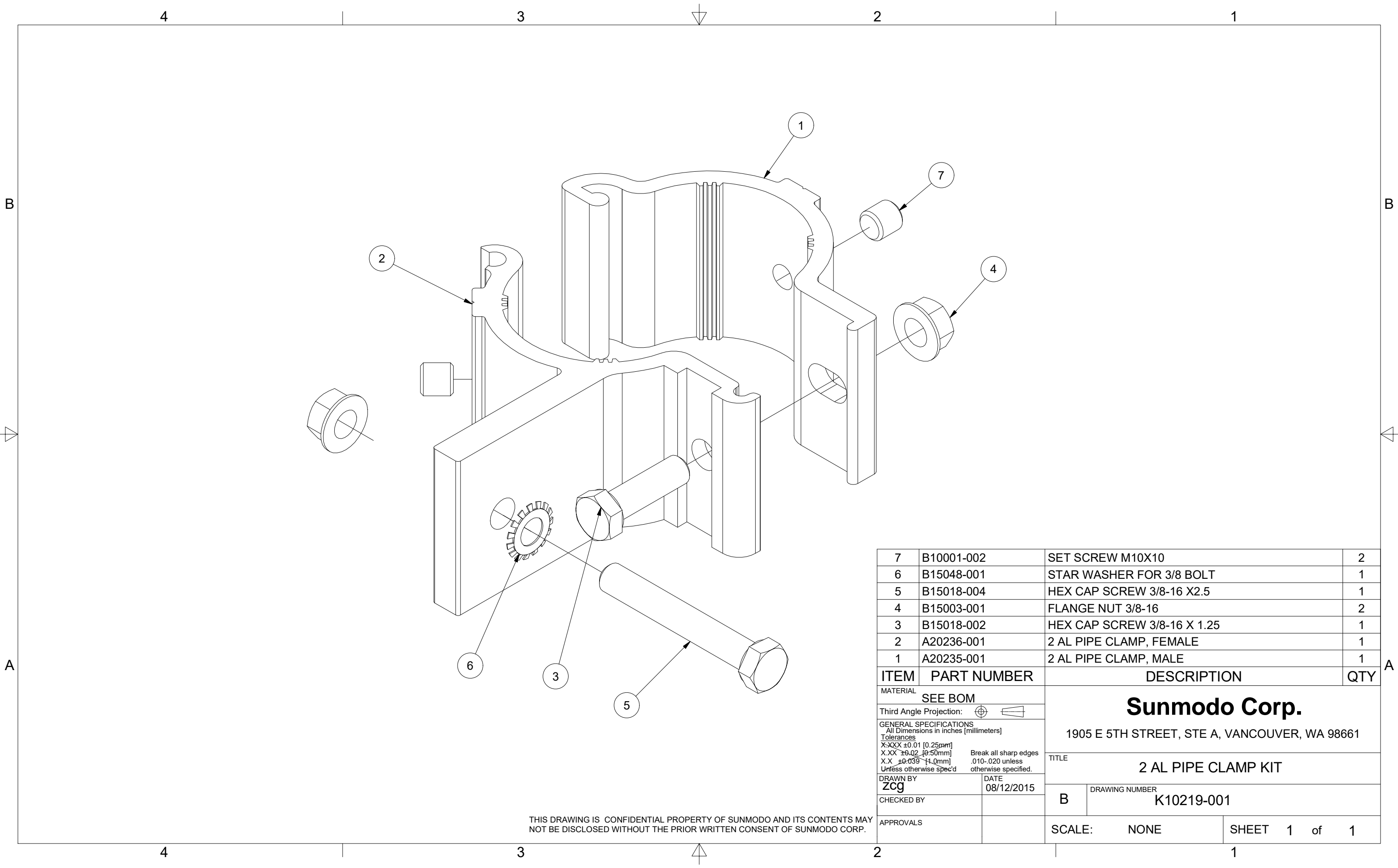
4

3

2

1





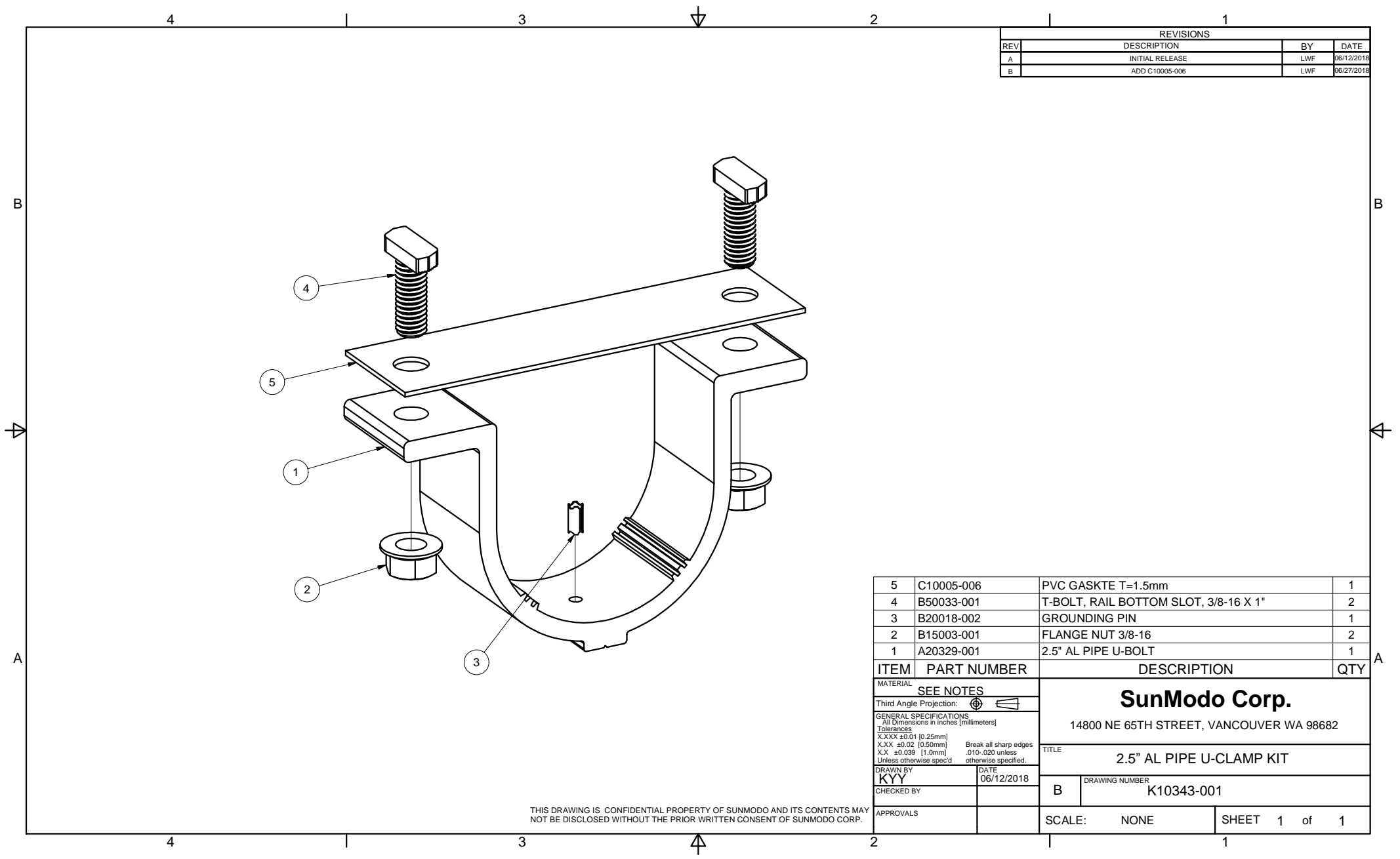
7	B10001-002	SET SCREW M10X10	2
6	B15048-001	STAR WASHER FOR 3/8 BOLT	1
5	B15018-004	HEX CAP SCREW 3/8-16 X2.5	1
4	B15003-001	FLANGE NUT 3/8-16	2
3	B15018-002	HEX CAP SCREW 3/8-16 X 1.25	1
2	A20236-001	2 AL PIPE CLAMP, FEMALE	1
1	A20235-001	2 AL PIPE CLAMP, MALE	1

ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE BOM	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches (millimeters)			
Tolerances			
X.XXX ±0.01 [0.25mm]		Break all sharp edges	
X.XX ±0.02 [0.50mm]		.010-.020 unless	
X.X ±0.039 [1.0mm]		otherwise specified.	
DRAWN BY		DATE	
zcg		08/12/2015	
CHECKED BY		B	
APPROVALS		DRAWING NUMBER	
		K10219-001	
SCALE:		NONE	SHEET 1 of 1

**Sunmodo Corp.**  
1905 E 5TH STREET, STE A, VANCOUVER, WA 98661

TITLE  
**2 AL PIPE CLAMP KIT**

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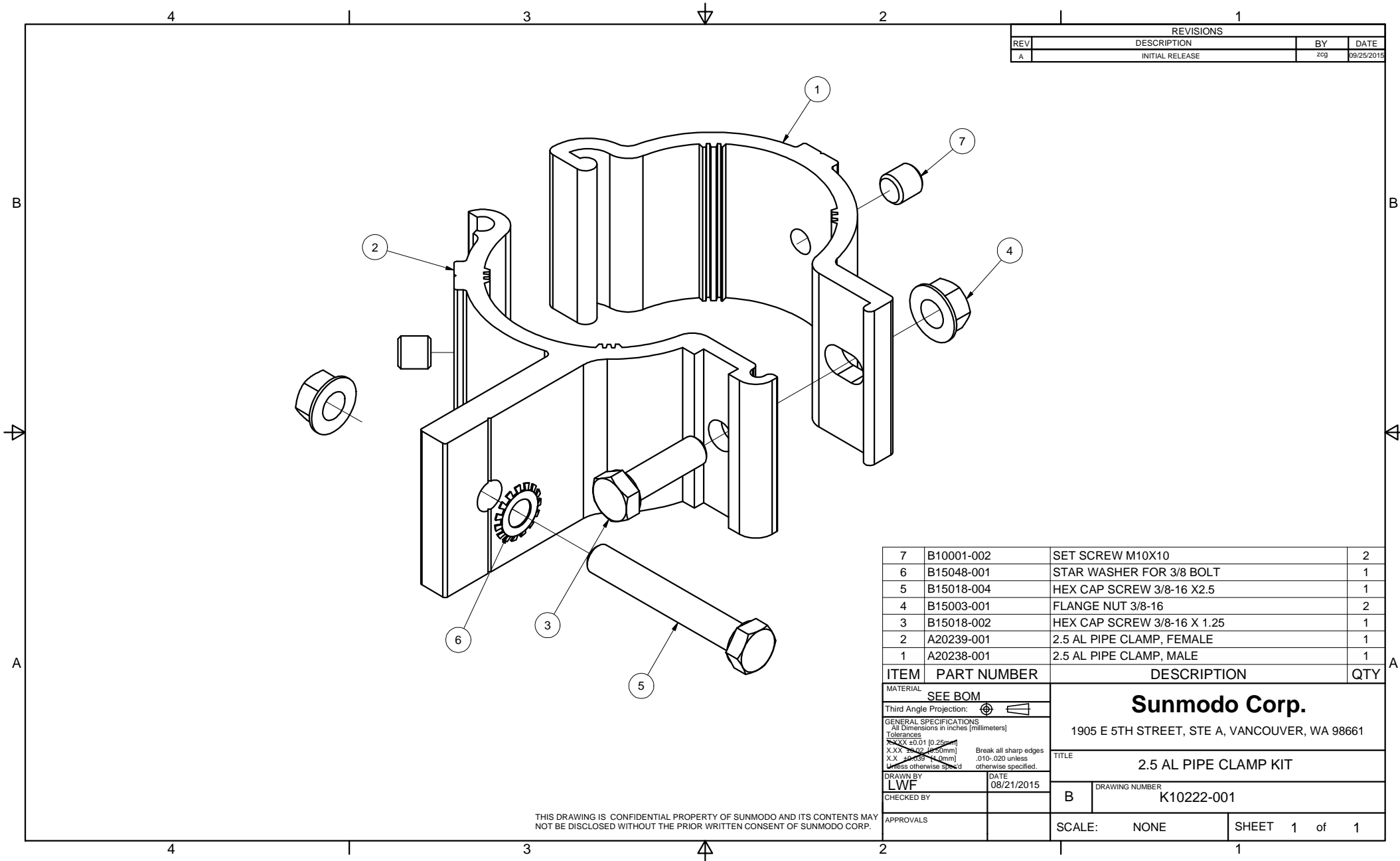


REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018
B	ADD C10005-006	LWF	06/27/2018

ITEM	PART NUMBER	DESCRIPTION	QTY
5	C10005-006	PVC GASKTE T=1.5mm	1
4	B50033-001	T-BOLT, RAIL BOTTOM SLOT, 3/8-16 X 1"	2
3	B20018-002	GROUNDING PIN	1
2	B15003-001	FLANGE NUT 3/8-16	2
1	A20329-001	2.5" AL PIPE U-BOLT	1

MATERIAL		<b>SEE NOTES</b>	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<p><b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682</p>	
<small>All Dimensions in inches [millimeters]</small> <small>Tolerances</small> X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd			
TITLE		2.5" AL PIPE U-CLAMP KIT	
DRAWN BY	DATE	DRAWING NUMBER	
KYY	06/12/2018	B K10343-001	
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

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REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	zcg	09/25/2015

7	B10001-002	SET SCREW M10X10	2
6	B15048-001	STAR WASHER FOR 3/8 BOLT	1
5	B15018-004	HEX CAP SCREW 3/8-16 X2.5	1
4	B15003-001	FLANGE NUT 3/8-16	2
3	B15018-002	HEX CAP SCREW 3/8-16 X 1.25	1
2	A20239-001	2.5 AL PIPE CLAMP, FEMALE	1
1	A20238-001	2.5 AL PIPE CLAMP, MALE	1

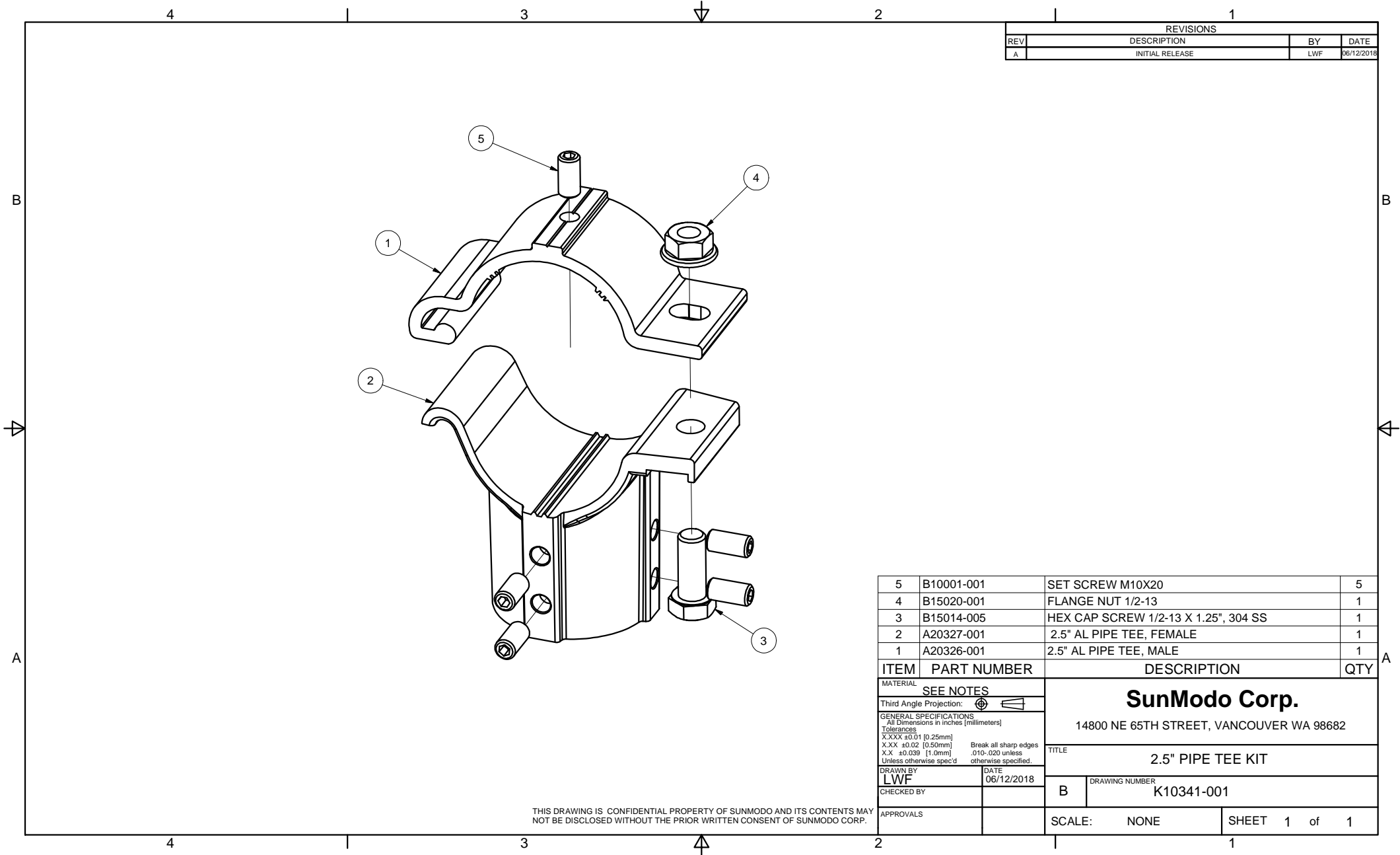
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE BOM	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters]			
Tolerances			
X.XX ±0.01 (0.25mm)		Break all sharp edges	
X.XX ±0.02 (0.51mm)		.010-.020 unless	
X.X ±0.03 (0.76mm)		otherwise specified.	
DRAWN BY LWF		DATE 08/21/2015	
CHECKED BY		B	
APPROVALS		SCALE: NONE	
		SHEET 1 of 1	

**Sunmodo Corp.**  
1905 E 5TH STREET, STE A, VANCOUVER, WA 98661

TITLE  
**2.5 AL PIPE CLAMP KIT**

DRAWING NUMBER  
K10222-001

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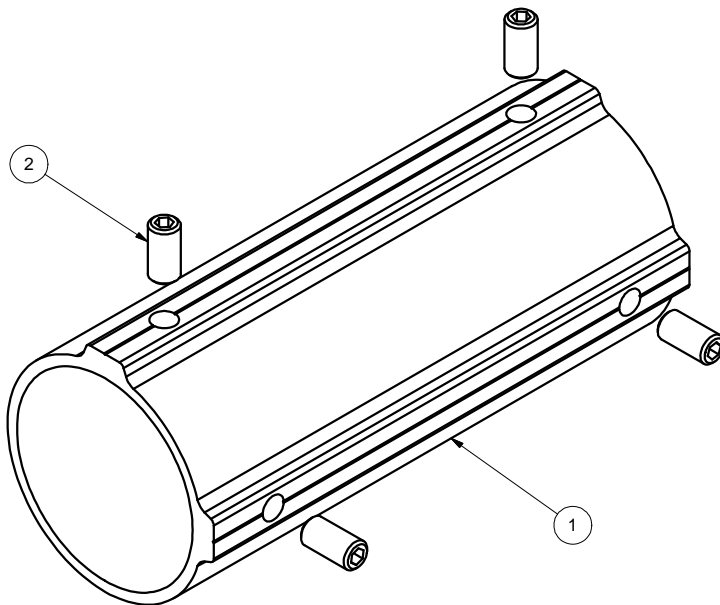
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018

ITEM	PART NUMBER	DESCRIPTION	QTY
5	B10001-001	SET SCREW M10X20	5
4	B15020-001	FLANGE NUT 1/2-13	1
3	B15014-005	HEX CAP SCREW 1/2-13 X 1.25", 304 SS	1
2	A20327-001	2.5" AL PIPE TEE, FEMALE	1
1	A20326-001	2.5" AL PIPE TEE, MALE	1

MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682	
Tolerances		TITLE	
X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd		2.5" PIPE TEE KIT	
DRAWN BY		DATE	
LWF		06/12/2018	
CHECKED BY		DRAWING NUMBER	
		B K10341-001	
APPROVALS		SCALE: NONE	
		SHEET 1 of 1	

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REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018



2	B10001-001	SET SCREW M10X20	4
1	A20328-001	2.5" PIPE SPLICE	1
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		<b>SunModo Corp.</b> 14800 NE 65TH STREET, VANCOUVER WA 98682	
All Dimensions in inches [millimeters] Tolerances X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd		TITLE <b>2.5" PIPE SPLICE KIT</b>	
DRAWN BY	DATE	DRAWING NUMBER	
LWF	06/12/2018	B K10342-001	
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

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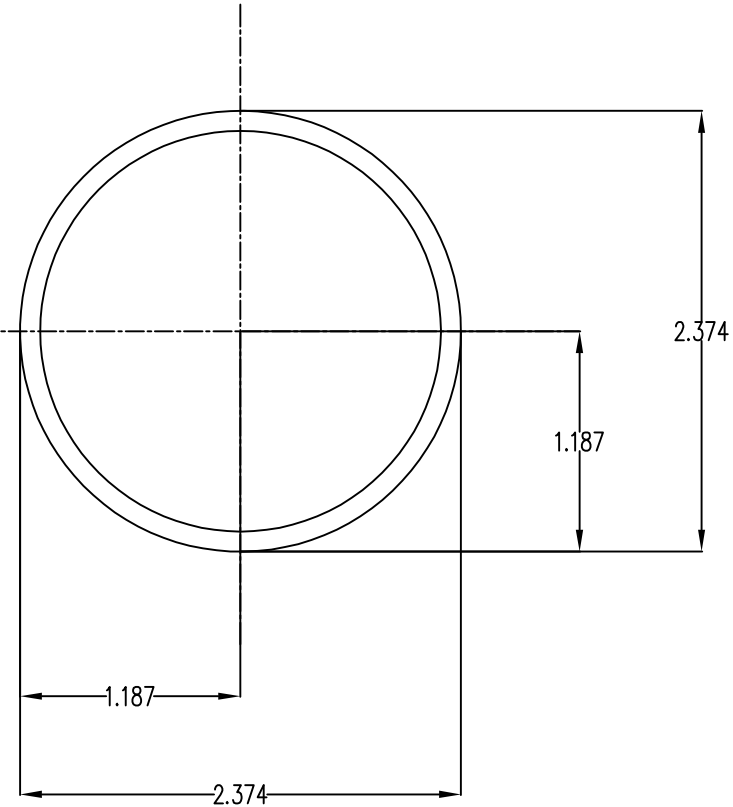
NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERIAL: HIGH STRENGTH STEEL PIPE OR TUBE.
3. FINISH: HOT DIP GALVANIZE PER ASTM A123 / A123M - 02.

MINIMUM 50 KSI YIELD STRESS.

4. BREAK ALL BURRS AND SHARP EDGES.

5. ALL WELDING MUST BE IN COMPLIANCE WITH AWS CODE D1;1.



## Section properties:

Weight: 2.641 lbs/ft

Area: 0.776 in<sup>2</sup>

Perimeter: 14.238 in

Bounding Box: X: -1.187, 1.187

Y: -1.187, 1.187

Centroid: (0.000, 0.000)

Moments of Inertia (in<sup>4</sup>): I<sub>x</sub>=0.499, I<sub>y</sub>=0.499

Section modulus in bending (in<sup>3</sup>): W<sub>x</sub>=0.420, W<sub>y</sub>=0.420

Radii of Gyration: X: 0.802, Y: 0.802

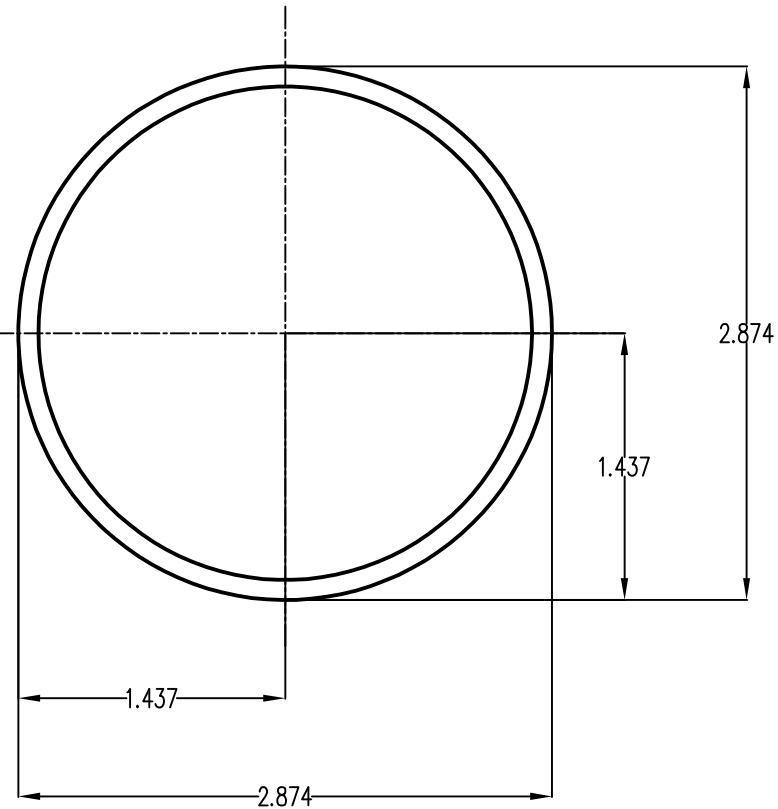
MATERIAL		SEE NOTES		<b>Sunmodo Corp.</b> 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS				TITLE	
All Dimensions in Inches (millimeters)				PIPE, HSS, 2.375" OD X 12 GAUGE, L=XXX	
Tolerances				Break all sharp edges .010-.020 unless otherwise specified.	
XXX ±0.01 (0.25mm)					
XX ±0.02 (0.50mm)					
X ±0.050 (1.27mm)					
Unless otherwise specified					
DRAWN BY	DATE	B		DRAWING NUMBER	
LWF	04/03/2019			A21165	
CHECKED BY					
APPROVALS				SCALE: NONE SHEET 1 of 1	

NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS SHOWN ARE INCHES [MILIMETERS].
2. MATERAIL:HIGH STRENGTH STEEL PIPE OR TUBE.
3. FINISH: HOT DIP GALVANIZE PER ASTM A123 / A123M - 02.

MINIMUM 50 KSI YIELD STRESS.

4. BREAK ALL BURRS AND SHARP EDGES.
5. ALL WELDING MUST BE IN COMPLIANCE WITH AWS CODE D1;1.



### Section properties:

Weight: 3.201 lbs/ft

Area: 0.941 in<sup>2</sup>

Perimeter: 17.378 in

Bounding Box: X: -1.437,1.437

Y: -1.437,1.437

Centroid:(0.000,0.000)

Moments of Inertia(in<sup>4</sup>): Ix=0.901,Iy=0.901

Section modulus in bending(in<sup>3</sup>): Wx=0.627,Wy=0.627

Radii of Gyration: X: 0.979, Y: 0.979

MATERIAL		SEE NOTES		<b>Sunmodo Corp.</b> 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS All Dimensions in Inches (millimeters)				TITLE	
Tolerances XXX ±0.01 (0.25mm) XX ±0.02 (0.50mm) X ±0.030 (1.0mm) Unless otherwise specified				PIPE, HSS, 2.875" OD X 12 GAUGE,L=XXX	
DRAWN BY LWF		DATE 04/03/2019		DRAWING NUMBER A21168	
CHECKED BY				B	
APPROVALS				SCALE: NONE SHEET 1 of 1	