



Project Number: U2716.114.191

February 16, 2024

Sunmodo
14800 NE 65th Street
Vancouver, WA 98682

**REFERENCE: Sunmodo Sunturf Ground Mount A5 - Standard Panels
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 International Building Code, 2015 Edition. 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. This document does not address site-specific installations. 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: 140 mph
- Wind exposure: B
- Ground snow load: 70 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	2320	1.5	3480
LATERAL	1690	2	3380

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
CO Firm License Number: 20181009799

Kelly Springer, P.E.
CO License: 56677 - Expires: 10/31/2025
Project Engineer

Enclosures

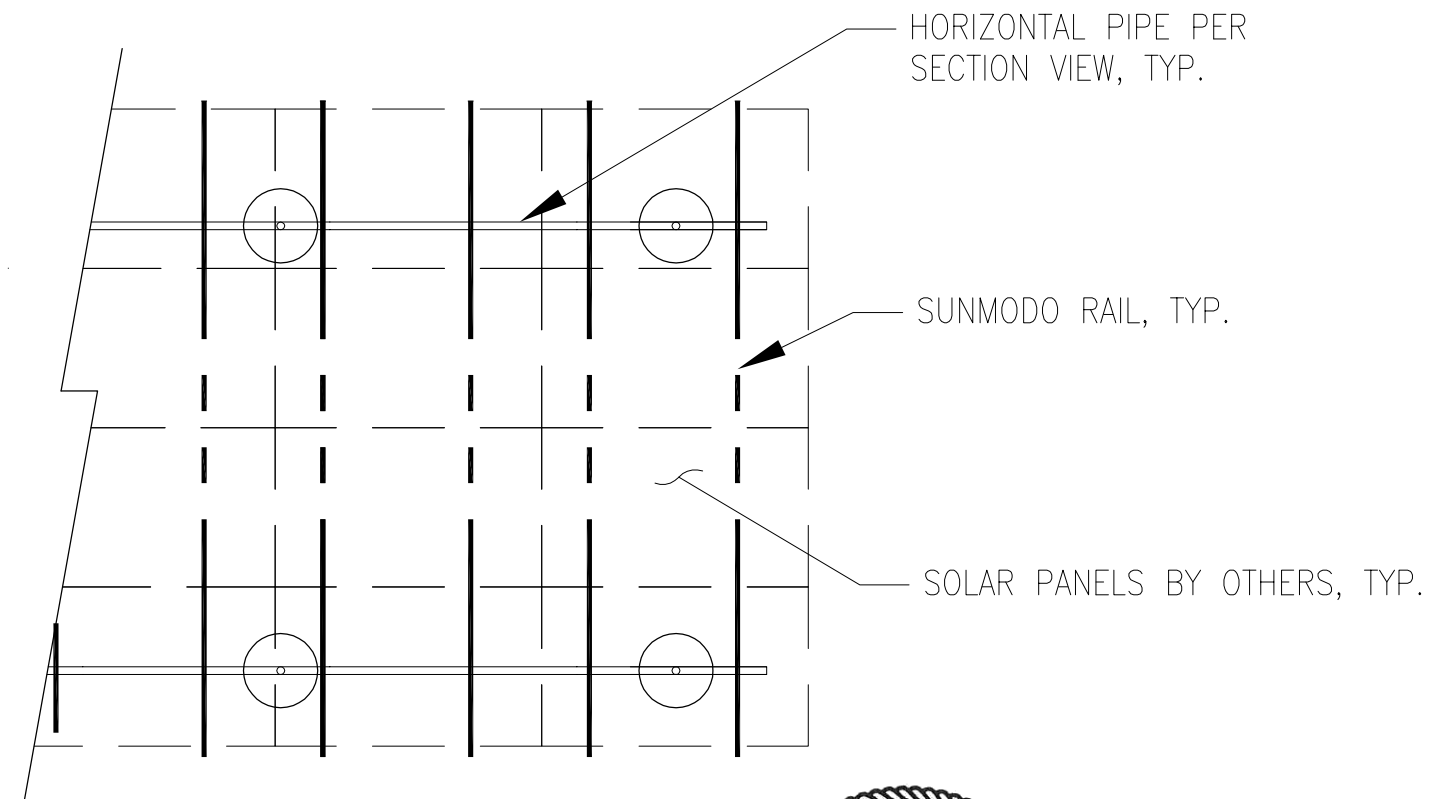
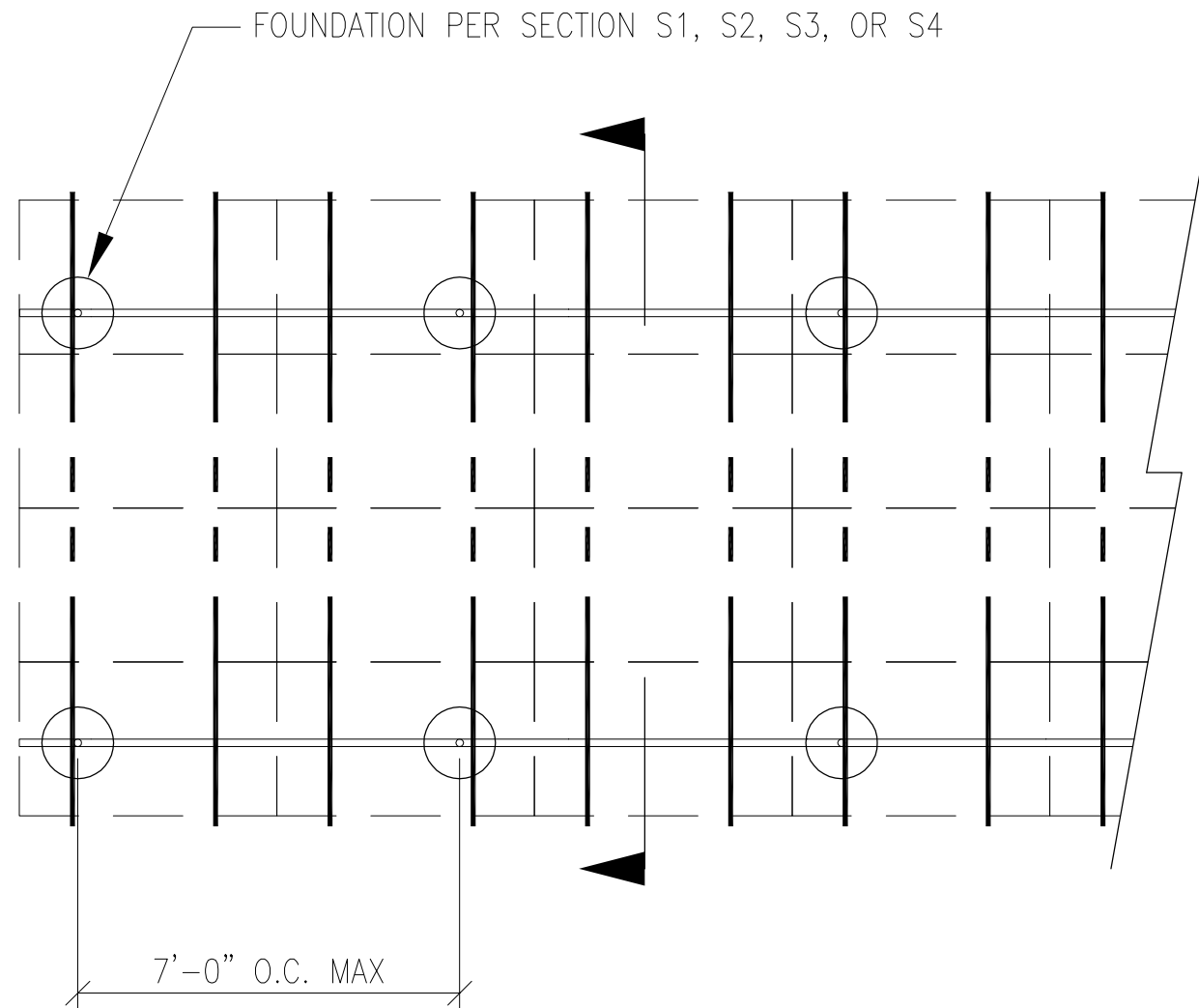
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JOB NO. U2716-114-191
 PROJECT SUNMODO SUNTURF GROUND MOUNTS A5
 SUBJECT ALL OPTIONS

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



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PV ARRAY PLAN

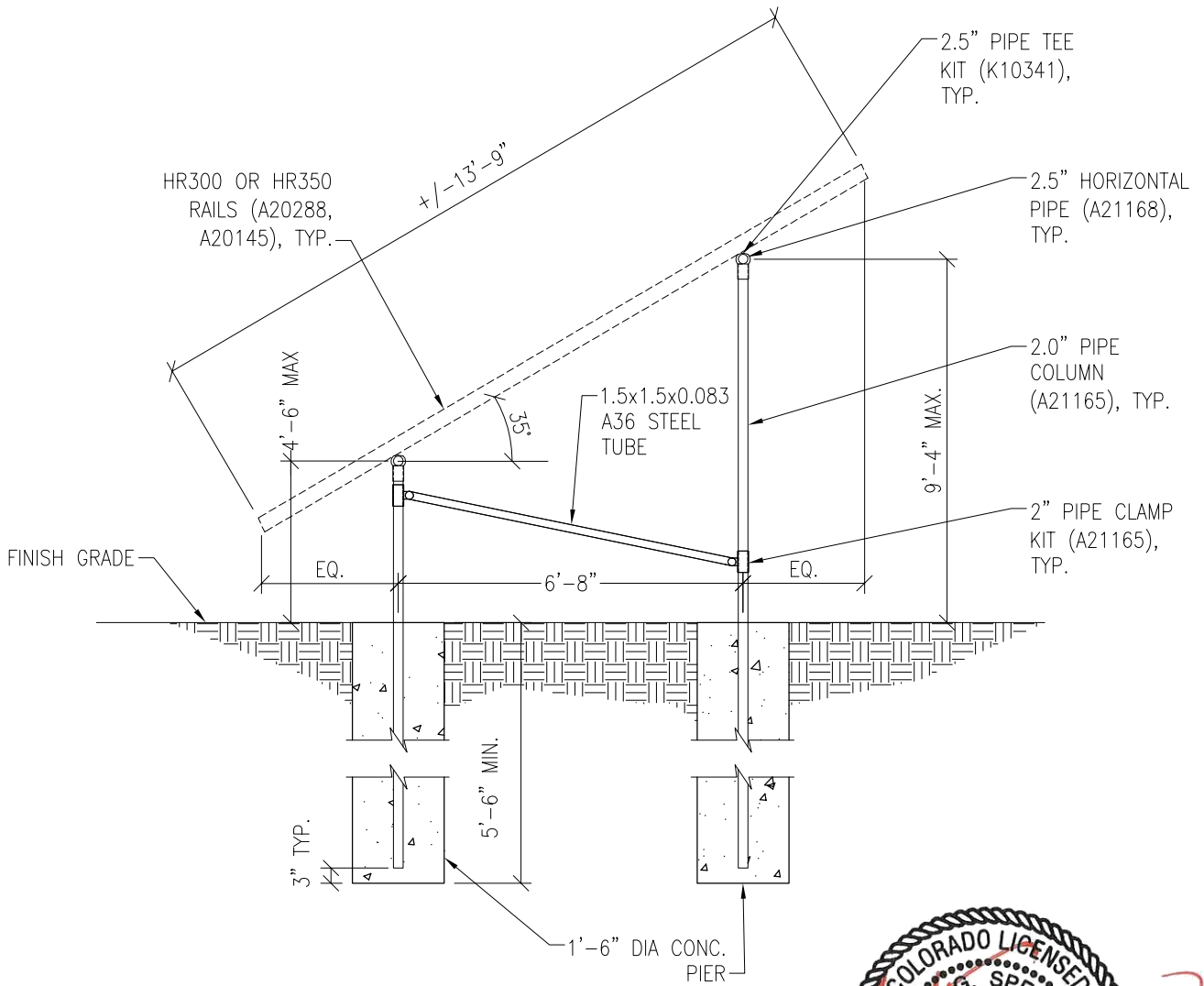
N.T.S.



P1

PROJECT SUNMODO SUNTURF GROUND MOUNTS A5

SUBJECT DRILLED PIER OPTION



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PV ARRAY SECTION

N.T.S.

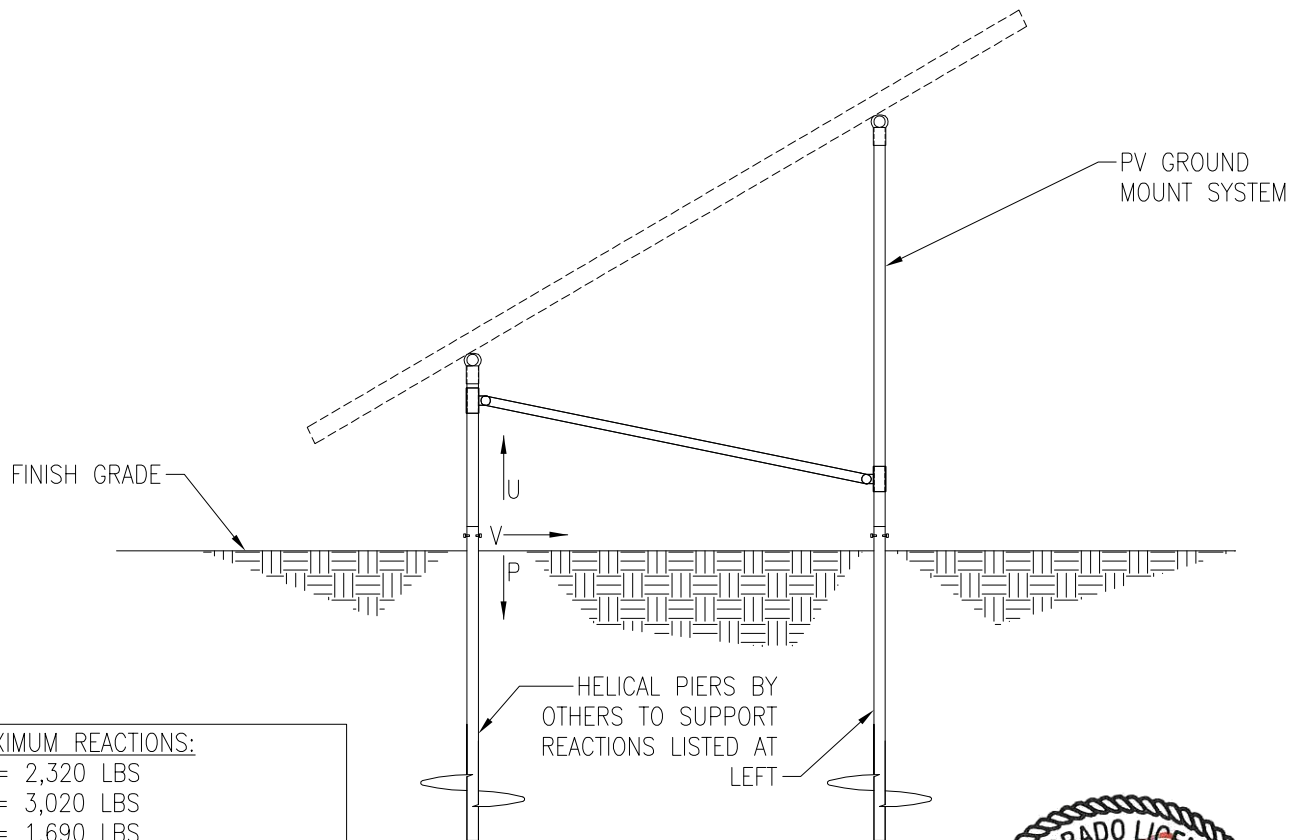
S1

PROJECT SUNMODO SUNTURF GROUND MOUNTS A5

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.



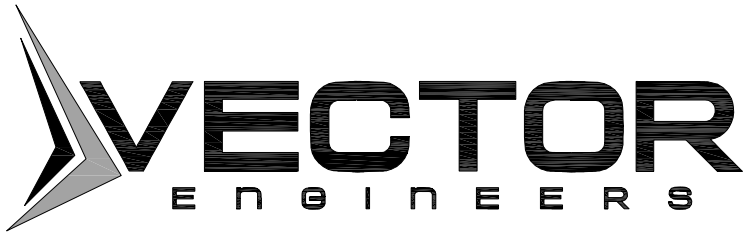
MAXIMUM REACTIONS:
 U = 2,320 LBS
 P = 3,020 LBS
 V = 1,690 LBS



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PV ARRAY SECTION

N.T.S.



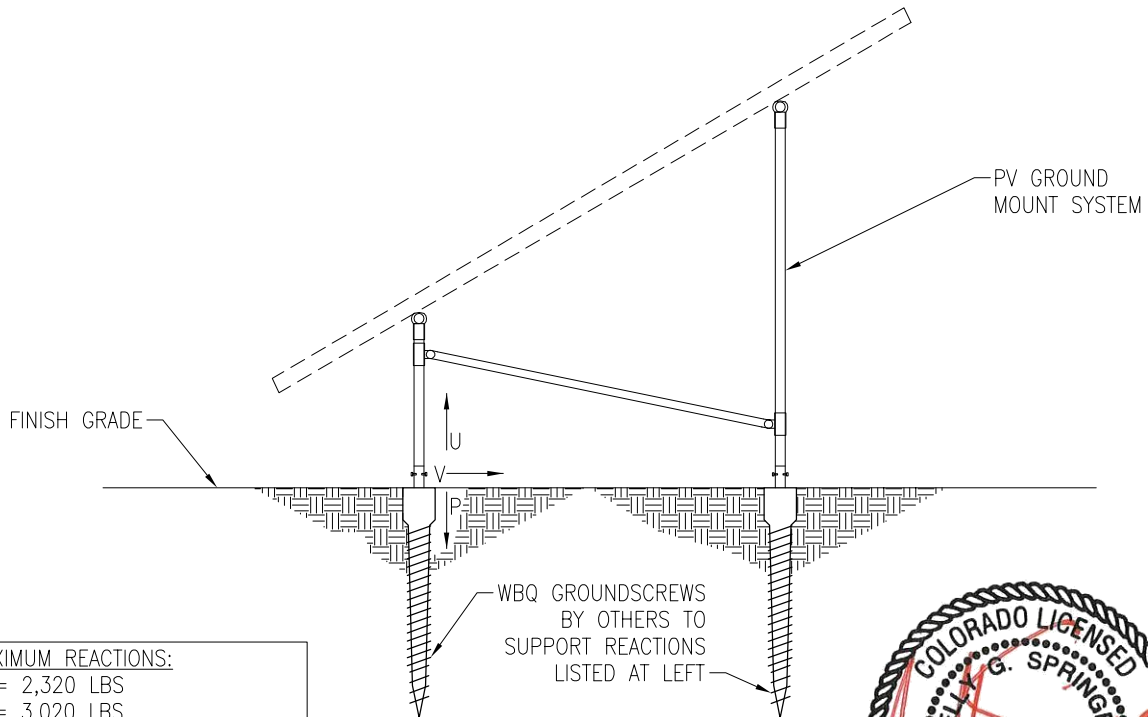
JOB NO. U2716-114-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A5

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 = 2,320 LBS
 P = 3,020 LBS
 V = 1,690 LBS

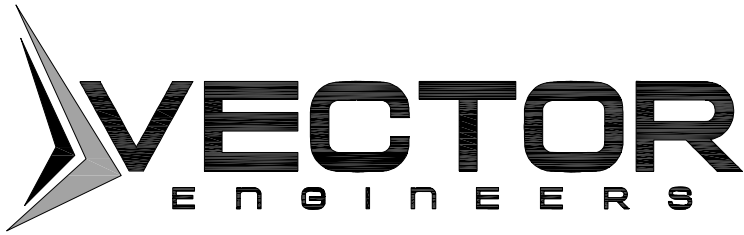


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PV ARRAY SECTION

N.T.S.

S3



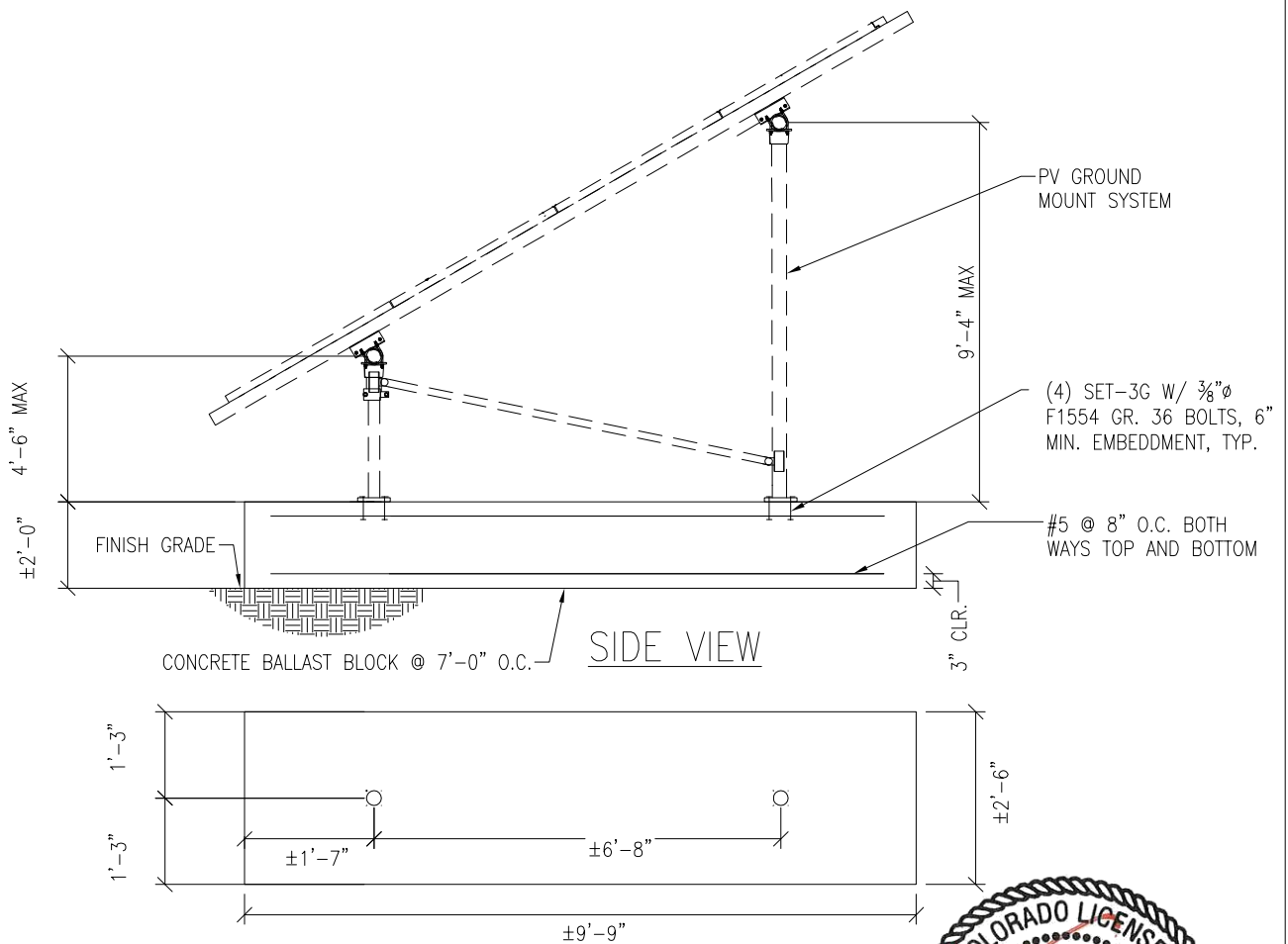
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PROJECT SUNMODO SUNTURF GROUND MOUNTS A5

SUBJECT BALLASTED BLOCK OPTION

NOTES:

1. For ground mount components see Section S1.



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PV ARRAY SECTION

N.T.S.

S4

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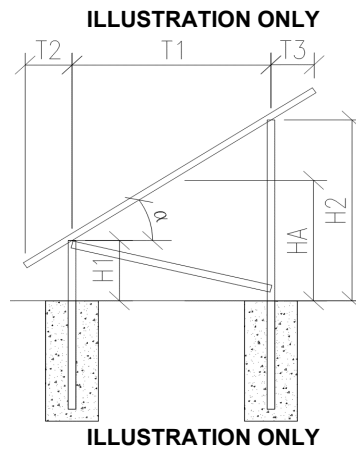
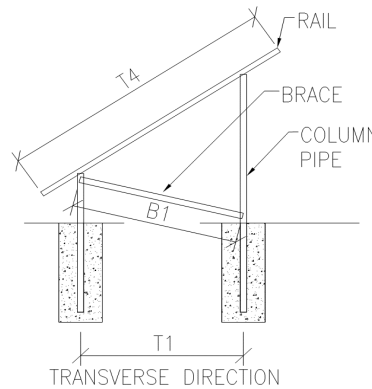
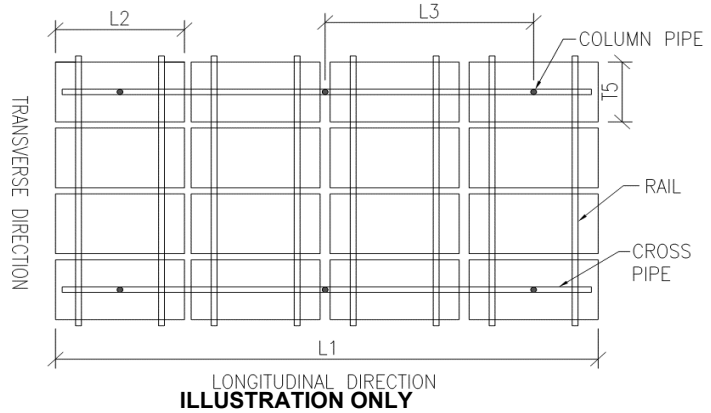
WWW.VECTORSE.COM

PROJECT: A5 – 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 ²]:	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]:	6.7
Longitudinal Column Spacing (L3) [ft]:	7.0
# of Columns in Longitudinal Direction:	12
# of Columns in Transverse Direction:	2
Total Number of Columns:	24
Panel Slope from Horizontal (a) [°]:	35.0
Short Column Height (H1) [ft]:	4.5
Approximate Tall Column Height (H2) [ft]:	9.2
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]:	7.0
Tributary Area per Column [ft ²]:	48.1
Rail Weight [plf]:	1.0
Transverse Rail Weight per Column [lb]:	27.5
Longitudinal Rail Weight per Column [lb]:	25.6
Tall Column Weight [lb]:	33.6
Panel Weight per Column [lb]:	104.6
Rail Weight per Column [lb]:	27.5
Cross Pipe Weight per Column [lb]:	25.6
Brace Weight per Column [lb]:	16.4
Total Weight per Column (1.0 D) [lb]:	207.7



Assumptions:

- T2 = T3



JOB NO.: U2716-114-191

DESIGNED: STB

DATE: 08/01/19

PROJECT: A5 – Sunmodo Sunturf GM

SUBJECT: Snow Load

SNOW LOAD (S):

ASCE 7 Standard:	10	
Panel Slope from Horizontal [°]:	35.0	
Snow Ground Load, p_g [psf]:	70.0	(Section 7.2)
Terrain Category:	B	(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]:	42	(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 :	0.636	(Figure 7-2)
Sloped Roof Snow Load, p_s [psf]:	27	(Equation 7.4-1)
Design Snow Load, S [psf]:	27	
Tributary Transverse Length [ft]:	5.6	
Tributary Longitudinal Length [ft]:	7	
Tributary Area per Column [ft ²]:	39.4	
Snow Load per Column (1.0 S) [lb]:	1060.8	



PROJECT: A5 – Sunmodo Sunturf GM

SUBJECT: Wind Pressure

Design Wind Load:

ASCE 7 Standard:	10	
Basic Wind Speed, V [mph]:	140	
Risk Category:	I	
Exposure Category	B	(Section 26.7.3)
Velocity Pressure Exposure Coefficient, K_h :	0.57	(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]:	24.3	(Equation 27.3-1)
Gust Effect Factor, G:	0.85	(Section 26.9.1)
Panel Slope [degrees]:	35.0	

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)	-2.43	-0.57
Case 3 ($\gamma = 180^\circ$, Load Case A)	2.10	2.17
Case 4 ($\gamma = 180^\circ$, Load Case B)	2.67	1.07

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)	-37.2	-37.2
Case 2 ($\gamma = 0^\circ$, Load Case B)	-50.3	-11.7
Case 3 ($\gamma = 180^\circ$, Load Case A)	43.4	44.8
Case 4 ($\gamma = 180^\circ$, Load Case B)	55.1	22.0

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)	-37.2	-37.2
Case 2 ($\gamma = 0^\circ$, Load Case B)	-11.7	-50.3
Case 3 ($\gamma = 180^\circ$, Load Case A)	43.4	44.8
Case 4 ($\gamma = 180^\circ$, Load Case B)	55.1	22.0



JOB NO.: U2716-114-191

PROJECT: A5 – 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 :	0.57	(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]:	140	

Velocity Pressure, q_h [psf]:	24.3	(Equation 27.3-1)
Gust Effect Factor, G :	0.85	(Section 26.9.1)

$\gamma = 90^\circ$ or 270°

Force Coefficient, C_N :

Horizontal Distance from Winward Edge	Roof angle		
	Load Case	Obstructed Wind Flow	
		CN	
$\leq h$	35	A	-0.8
		B	0.8
$> h, \leq 2h$	35	A	-0.6
		B	0.5
$> 2h$	35	A	-0.3
		B	0.3

Design Wind Pressure, p [psf]:

	Roof angle		
	Load Case	Obstructed Wind Flow	
$\leq h$	35	A	-16.5
		B	16.5
$> h, \leq 2h$	35	A	-12.4
		B	10.3
$> 2h$	35	A	-6.2
		B	6.2



JOB NO.: U2716-114-191

DESIGNED: STB

Foundation Option 1: Drilled Concrete Pier



JOB NO.: U2716-114-191
DATE: 08/01/19

DESIGNED: STB

PROJECT: A5 – Sunmodo Sunturf GM

Drilled Pier Design

Design Loads:

Max. Shear, V [k]:	1.7	Max. Down, P _d [k]:	3.0
Max. Moment, M [k-ft]:	0.0	Max. Uplift, P _u [k]:	2.3

Pier Properties:

Pier Diameter, b [ft]:	1.5	Volume of Concrete [ft ³]:	10
Min. Pier Diameter, b _{min} (opt'l) [ft]:		Volume of Concrete [yd ³]:	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 _{min} (opt'l) [ft]:			
Max. Pier Depth, d _{max} (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]:	1,690	
Point of Application, h [ft]:	0.0	
S _{1_max} [psf]:		
S ₁ [psf]:	550	
A = 2.34*P/(S ₁ b):	4.79	
Required Pier Depth, d _{reqd} [ft]:	4.8	Lateral bearing capacity OK.

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.

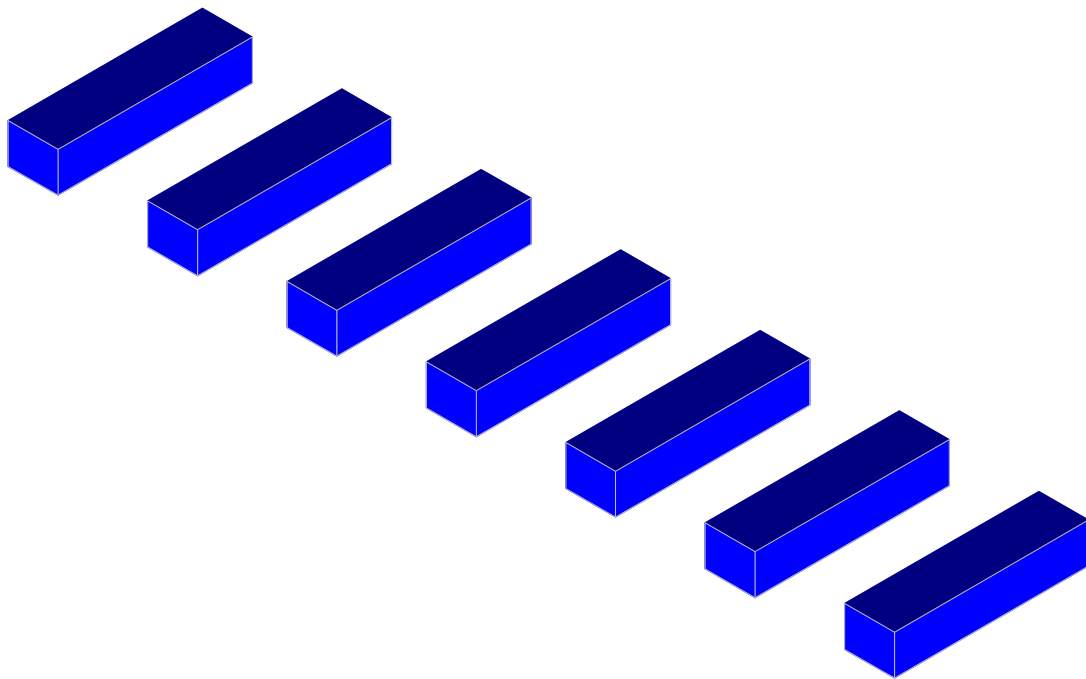
Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	2320	1.5	3480
LATERAL	1690	2	3380

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.

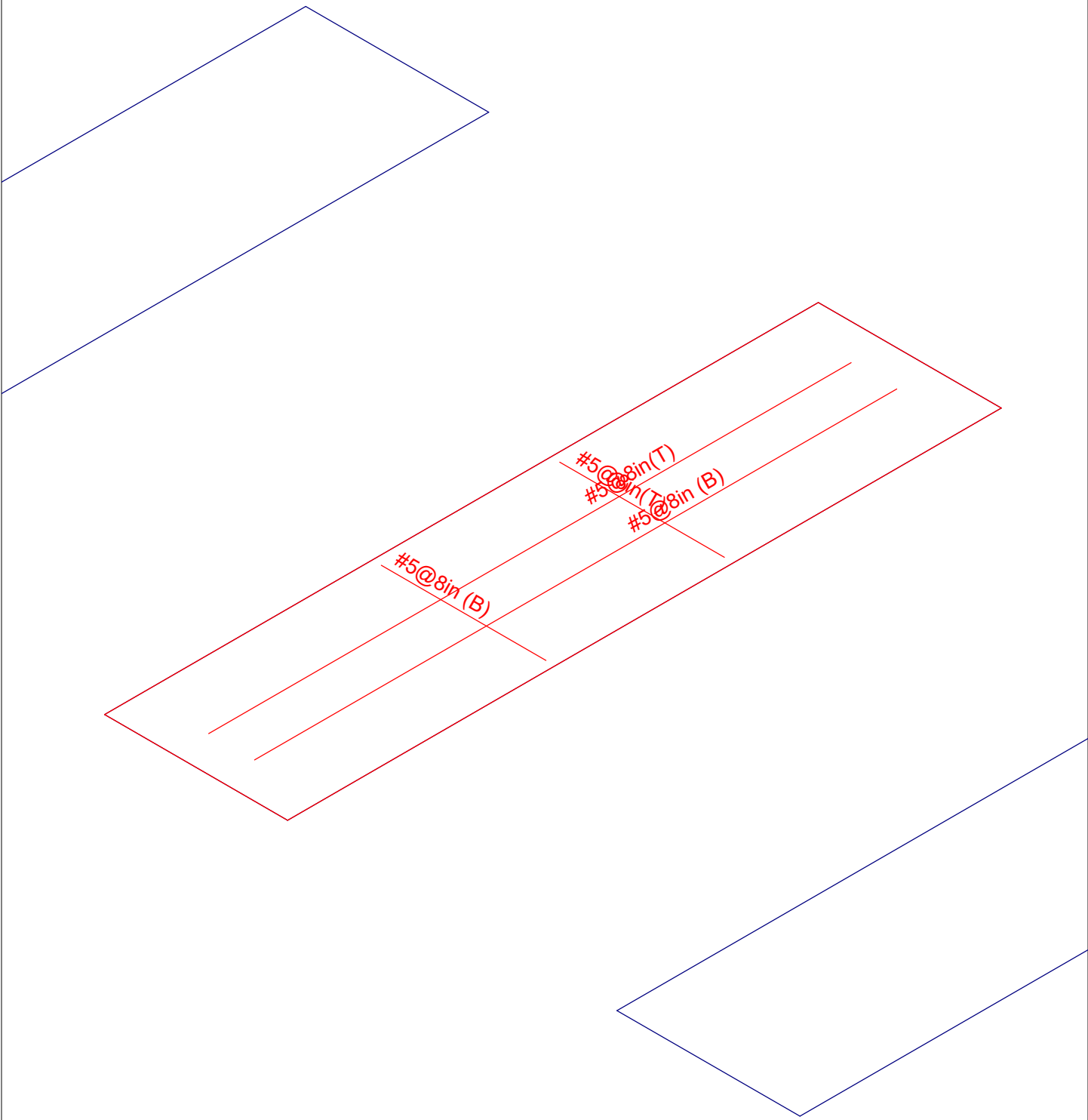
Load (ASD)	Value (lbs)	Factor of Safety	Test Value (lbs)
UPLIFT	2320	1.5	3480
LATERAL	1690	2	3380

Foundation Option 4: Ballasted Block



Results for LC 1, 1.0 D

Vector Structural Engineeri..	Ground Mount	SK - 2
STB		Aug 1, 2019 at 12:09 PM
U2716.114.181		New England A5.r3d



Results for LC 1, 1.0 D

Vector Structural Engineeri...	Ground Mount	SK - 1
STB		Aug 1, 2019 at 12:08 PM
U2716.114.181		New England A5.r3d

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	100
Mesh Size (in)	12
Max Iterations	10
Merge Tolerance (in)	.12
Solver	Sparse Accelerated
Coefficient of Friction	.3
No. of Shear Regions	4
Shear Region Spacing Increment (in)	4
Min 1 Bar Dia Spacing for Beams?	No
Optimize footings for OTM / Sliding?	Yes
Parame Beta Factor	.65
Pile Safety Factor	3
Concrete Stress Block	Rectangular
Concrete Rebar Set	ASTM A615
Concrete Code	ACI 318-14
HR Steel Pile Code	AISC 14th(360-10): ASD
Wood Pile Code	AWC NDS-15: ASD

Concrete Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\...	Density[lb/ft^3]	fc[psi]	Lambda	Flex Stee...	Shear St...
1	Conc3000NW	3156	1372	.15	.6	145	3000	1	60000	60000
2	Conc3500NW	3409	1482	.15	.6	145	3500	1	60000	60000
3	Conc4000NW	3644	1584	.15	.6	145	4000	1	60000	60000
4	Conc3000LW	2085	907	.15	.6	109.999	3000	.75	60000	60000
5	Conc3500LW	2252	979	.15	.6	109.999	3500	.75	60000	60000
6	Conc4000LW	2408	1047	.15	.6	109.999	4000	.75	60000	60000
7	Conc2500NW	3156	1372	.15	.6	145	2500	1	60000	60000

General Design Parameters

	Label	Max Bending Chk	Max Shear Chk	Top Cover[in]	Bottom Cover[in]
1	Typical	1	1	3	3

Slab Rebar Parameters

	Label	Top Bar	Bottom Bar	Max Top Bar Sp...	Min Top Bar Sp...	Max Bot Bar Sp...	Min Bot Bar Sp...	Spacing Incr...	Rebar Options
1	Typical	#5	#5	8	8	8	8	1	Optimize

Soil Definitions

	Label	Subgrade Modulus[lb/ft^3]	Allowable Bearing[psf]	Depth Properties	Default?
1	Default	1e+5	1500	None	Yes

Point Loads and Moments (Cat 1 : DL)

	Label	Direction	Magnitude[lb,lb-ft]
1	R3D_N1_1	X	-11.981
2	R3D_N1_1	Y	216.315
3	R3D_N2	Y	183.994
4	R3D_N132_2	Y	210.684
5	R3D_N133_1	X	-1.035
6	R3D_N133_1	Y	201.84
7	R3D_N109_1	Y	194.864
8	R3D_N110A_1	Y	206.88
9	R3D_N121_1	Y	213.295



Company : Vector Structural Engineering
 Designer : STB
 Job Number : U2716.114.181
 Model Name : Ground Mount

Aug 1, 2019
 12:09 PM
 Checked By: JSP

Slab Sliding Safety Factors (Continued)

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
40	6	S5	0	6.292	2782.927	1240.954	2782.927	9.999+	2.243
41	6	S6	0	22.484	2811.705	1404.446	2811.705	9.999+	2.002
42	6	S7	0	113.453	2581.843	787.804	2581.843	9.999+	3.277
43	7	S1	0	38.813	2455.423	475.204	2455.423	9.999+	5.167
44	7	S2	0	1.177	2427.732	466.144	2427.732	9.999+	5.208
45	7	S3	0	4.575	2367.968	281.054	2367.968	9.999+	8.425
46	7	S4	0	2.741	2330.158	199.302	2330.158	9.999+	9.999+
47	7	S5	0	1.688	2333.288	201.906	2333.288	9.999+	9.999+
48	7	S6	0	4.115	2333.902	227.226	2333.902	9.999+	9.999+
49	7	S7	0	43.1	2278.468	128.257	2278.468	9.999+	9.999+
50	8	S1	0	13.887	2027.097	473.084	2027.097	9.999+	4.285
51	8	S2	0	3.064	2079.907	407.251	2079.907	9.999+	5.107
52	8	S3	0	1.541	2136.663	249.795	2136.663	9.999+	8.554
53	8	S4	0	.082	2158.361	203.52	2158.361	9.999+	9.999+
54	8	S5	0	.352	2155.885	201.446	2155.885	9.999+	9.999+
55	8	S6	0	1.494	2162.029	227.283	2162.029	9.999+	9.513
56	8	S7	0	3.121	2149.109	128.253	2149.109	9.999+	9.999+
57	9	S1	0	4.486	2312.928	816.507	2312.928	9.999+	2.833
58	9	S2	0	1.862	2327.736	947.452	2327.736	9.999+	2.457
59	9	S3	0	.742	2328.718	919.628	2328.718	9.999+	2.532
60	9	S4	0	4.737	2328.871	927.372	2328.871	9.999+	2.511
61	9	S5	0	5.325	2326.028	906.653	2326.028	9.999+	2.566
62	9	S6	0	8.781	2338.298	1023.227	2338.298	9.999+	2.285
63	9	S7	0	25.453	2266.063	576.661	2266.063	9.999+	3.93
64	10	S1	0	7.453	2359.899	690.853	2359.899	9.999+	3.416
65	10	S2	0	4.932	2400.202	797.015	2400.202	9.999+	3.011
66	10	S3	0	2.474	2388.981	776.273	2388.981	9.999+	3.078
67	10	S4	0	7.174	2391.711	782.01	2391.711	9.999+	3.058
68	10	S5	0	7.487	2385.788	765.853	2385.788	9.999+	3.115
69	10	S6	0	16.636	2412.959	860.883	2412.959	9.999+	2.803
70	10	S7	0	24.377	2298.752	488.404	2298.752	9.999+	4.707
71	11	S1	0	136.678	3137.766	968.334	3137.766	9.999+	3.24
72	11	S2	0	7.129	3145.565	1126.309	3145.565	9.999+	2.793
73	11	S3	0	4.485	3203.031	1087.121	3203.031	9.999+	2.946
74	11	S4	0	10.78	3194.036	1102.056	3194.036	9.999+	2.898
75	11	S5	0	10.369	3188.971	1075.196	3188.971	9.999+	2.966
76	11	S6	0	28.179	3215.462	1213.317	3215.462	9.999+	2.65
77	11	S7	0	200.034	2873.451	683.907	2873.451	9.999+	4.202
78	12	S1	0	108.081	3067.297	837.194	3067.297	9.999+	3.664
79	12	S2	0	2.83	3098.712	977.889	3098.712	9.999+	3.169
80	12	S3	0	5.251	3137.646	941.524	3137.646	9.999+	3.333
81	12	S4	0	12.124	3132.185	955.158	3132.185	9.999+	3.279
82	12	S5	0	11.605	3124.686	930.716	3124.686	9.999+	3.357
83	12	S6	0	32.521	3162.486	1053.334	3162.486	9.999+	3.002
84	12	S7	0	175.325	2819.872	590.853	2819.872	9.999+	4.773
85	13	S1	0	84.732	2851.108	356.403	2851.108	9.999+	8
86	13	S2	0	1.307	2842.048	350.908	2842.048	9.999+	8.099
87	13	S3	0	.957	2820.264	209.22	2820.264	9.999+	9.999+
88	13	S4	0	8.775	2788.439	150.544	2788.439	9.999+	9.999+
89	13	S5	0	8.152	2787.457	151.43	2787.457	9.999+	9.999+
90	13	S6	0	18.744	2804.134	170.419	2804.134	9.999+	9.999+
91	13	S7	0	122.56	2592.34	96.192	2592.34	9.999+	9.999+
92	14	S1	0	45.207	2529.863	354.813	2529.863	9.999+	7.13
93	14	S2	0	4.488	2581.179	304.139	2581.179	9.999+	8.487
94	14	S3	0	3.63	2646.786	188.917	2646.786	9.999+	9.999+
95	14	S4	0	6.657	2659.592	151.573	2659.592	9.999+	9.999+
96	14	S5	0	7.15	2654.405	151.084	2654.405	9.999+	9.999+



Slab Sliding Safety Factors (Continued)

	LC	Slab	Angle[deg]	Va-xx[lb]	Vr-xx[lb]	Va-zz[lb]	Vr-zz[lb]	SR-xx	SR-zz
97	14	S6	0	16.778	2675.229	170.462	2675.229	9.999+	9.999+
98	14	S7	0	87.894	2495.321	96.19	2495.321	9.999+	9.999+
99	15	S1	0	72.974	841.562	1088.675	841.562	9.999+	.773
100	15	S2	0	5.403	845.522	1265.002	845.522	9.999+	.668
101	15	S3	0	2.309	814.237	1224.076	814.237	9.999+	.665
102	15	S4	0	3.077	819.338	1237.919	819.338	9.999+	.662
103	15	S5	0	2.496	820.295	1208.87	820.295	9.999+	.679
104	15	S6	0	10.291	813.546	1364.303	813.546	9.999+	.596
105	15	S7	0	94.302	957.956	768.881	957.956	9.999+	1.246
106	16	S1	0	88.893	904.19	921.137	904.19	9.999+	.982
107	16	S2	0	9.496	942.144	1064.42	942.144	9.999+	.885
108	16	S3	0	0	894.589	1032.936	894.589	9.999+	.866
109	16	S4	0	.172	903.125	1044.103	903.125	9.999+	.865
110	16	S5	0	.387	899.976	1021.137	899.976	9.999+	.881
111	16	S6	0	.182	913.093	1147.844	913.093	9.999+	.795
112	16	S7	0	95.738	1001.541	651.206	1001.541	9.999+	1.538
113	17	S1	0	103.282	1941.346	1291.112	1941.346	9.999+	1.504
114	17	S2	0	6.586	1935.961	1500.011	1935.961	9.999+	1.291
115	17	S3	0	2.682	1979.988	1451.59	1979.988	9.999+	1.364
116	17	S4	0	4.98	1972.891	1467.986	1972.891	9.999+	1.344
117	17	S5	0	4.231	1970.886	1433.595	1970.886	9.999+	1.375
118	17	S6	0	15.572	1983.098	1617.755	1983.098	9.999+	1.226
119	17	S7	0	138.472	1767.807	911.876	1767.807	9.999+	1.939
120	18	S1	0	65.153	1847.387	1116.258	1847.387	9.999+	1.655
121	18	S2	0	.854	1873.49	1302.119	1873.49	9.999+	1.439
122	18	S3	0	3.703	1892.808	1257.46	1892.808	9.999+	1.505
123	18	S4	0	6.772	1890.424	1272.121	1890.424	9.999+	1.486
124	18	S5	0	5.878	1885.173	1240.954	1885.173	9.999+	1.519
125	18	S6	0	21.362	1912.463	1404.446	1912.463	9.999+	1.362
126	18	S7	0	105.527	1696.367	787.804	1696.367	9.999+	2.153
127	19	S1	0	34.021	1559.135	475.204	1559.135	9.999+	3.281
128	19	S2	0	1.177	1531.271	466.144	1531.271	9.999+	3.285
129	19	S3	0	4.575	1469.633	281.054	1469.633	9.999+	5.229
130	19	S4	0	2.306	1432.096	199.302	1432.096	9.999+	7.186
131	19	S5	0	1.273	1435.534	201.906	1435.534	9.999+	7.11
132	19	S6	0	2.993	1434.66	227.226	1434.66	9.999+	6.314
133	19	S7	0	35.173	1392.992	128.257	1392.992	9.999+	9.999+
134	20	S1	0	18.68	1130.808	473.084	1130.808	9.999+	2.39
135	20	S2	0	3.064	1183.446	407.251	1183.446	9.999+	2.906
136	20	S3	0	1.541	1238.328	249.795	1238.328	9.999+	4.957
137	20	S4	0	.517	1260.299	203.52	1260.299	9.999+	6.193
138	20	S5	0	.063	1258.131	201.446	1258.131	9.999+	6.246
139	20	S6	0	.371	1262.787	227.283	1262.787	9.999+	5.556
140	20	S7	0	11.047	1263.633	128.253	1263.633	9.999+	9.853

Envelope Slab Soil Pressures

	Label	UC	LC	Soil Pressure[psf]	Allowable Bearing[psf]	Point
1	S1	.415	5	622.569	1500	N198
2	S2	.42	5	630.448	1500	N205
3	S3	.43	5	644.421	1500	N212
4	S4	.428	5	642.548	1500	N219
5	S5	.426	5	639.715	1500	N226
6	S6	.466	16	698.64	1500	N38
7	S7	.355	5	532.633	1500	N240



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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): 6.000
Code report: ICC-ES ESR-4057
Anchor category: -
Anchor ductility: Yes
 h_{min} (inch): 7.25
 c_{ac} (inch): 10.99
 C_{min} (inch): 1.75
 S_{min} (inch): 3.00

Base Material

Concrete: Normal-weight
Concrete thickness, h (inch): 30.00
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





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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]: 3870

V_{uax} [lb]: 175

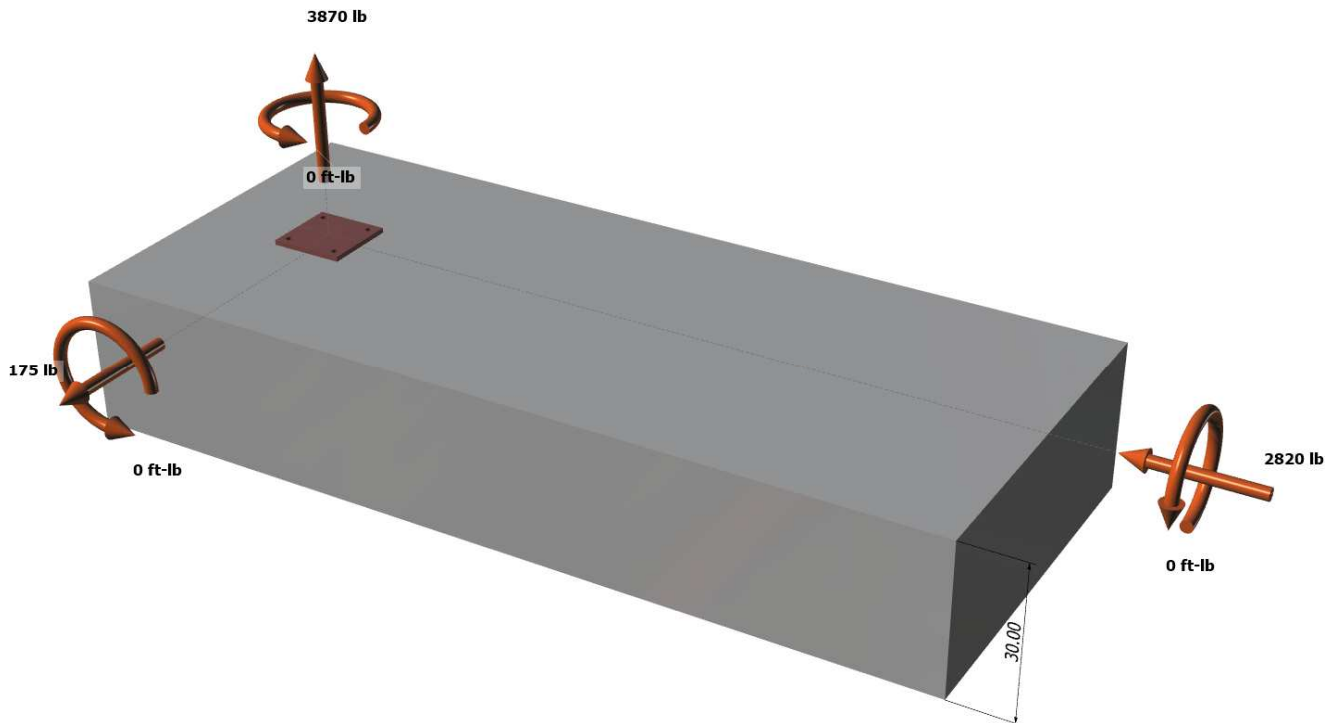
V_{uay} [lb]: -2820

M_{ux} [ft-lb]: 0

M_{uy} [ft-lb]: 0

M_{uz} [ft-lb]: 0

<Figure 1>





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<Figure 2>





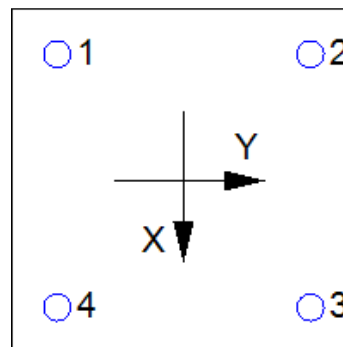
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3. Resulting Anchor Forces

Anchor	Tension load, N _{ua} (lb)	Shear load x, V _{uax} (lb)	Shear load y, V _{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2 + (V_{uay})^2}$ (lb)
1	967.5	43.8	-705.0	706.4
2	967.5	43.8	-705.0	706.4
3	967.5	43.8	-705.0	706.4
4	967.5	43.8	-705.0	706.4
Sum	3870.0	175.0	-2820.0	2825.4

Maximum concrete compression strain (%): 0.00
 Maximum concrete compression stress (psi): 0
 Resultant tension force (lb): 3870
 Resultant compression force (lb): 0
 Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
 Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
 Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
 Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



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

N _{sa} (lb)	φ	φN _{sa} (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 _c	λ _a	f _c (psi)	h _{ef} (in)	N _b (lb)
17.0	1.00	2500	6.000	12492

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

A _{Nc} (in ²)	A _{Nco} (in ²)	C _{a,min} (in)	ψ _{ec,N}	ψ _{ed,N}	ψ _{c,N}	ψ _{cp,N}	N _b (lb)	φ	φN _{cbg} (lb)
424.63	324.00	7.25	1.000	0.942	1.00	1.000	12492	0.65	10021

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 _{k,cr} (psi)	f _{short-term}	K _{sat}	f _c (psi)	n	τ _{k,cr} (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 _a	τ _{cr} (psi)	d _a (in)	h _{ef} (in)	N _{ba} (lb)
1.00	1346	0.38	6.000	9514

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

A _{Na} (in ²)	A _{Na0} (in ²)	C _{Na} (in)	C _{a,min} (in)	ψ _{ec,Na}	ψ _{ed,Na}	ψ _{cp,Na}	N _{ba} (lb)	φ	φN _{ag} (lb)
198.45	112.09	5.29	7.25	1.000	1.000	1.000	9514	0.55	9265



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

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (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)	λ_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 ²)	A_{Vco} (in ²)	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	V_{bx} (lb)	ϕ	ϕV_{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)	λ_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 ²)	A_{Vco} (in ²)	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	V_{by} (lb)	ϕ	ϕV_{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)	λ_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 ²)	A_{Vco} (in ²)	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	V_{by} (lb)	ϕ	ϕV_{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)	λ_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 ²)	A_{Vco} (in ²)	$\psi_{ec,v}$	$\psi_{ed,v}$	$\psi_{c,v}$	$\psi_{h,v}$	V_{bx} (lb)	ϕ	ϕV_{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)

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

k_{cp}	A_{Na} (in ²)	A_{Na0} (in ²)	$\psi_{ed,Na}$	$\psi_{ec,Na}$	$\psi_{cp,Na}$	N_{ba} (lb)	N_a (lb)
2.0	198.45	112.09	1.000	1.000	1.000	9514	16845

A_{Nc} (in ²)	A_{Nco} (in ²)	$\psi_{ec,N}$	$\psi_{ed,N}$	$\psi_{c,N}$	$\psi_{cp,N}$	N_b (lb)	N_{cb} (lb)	ϕ
424.63	324.00	1.000	0.942	1.000	1.000	12492	15417	0.70

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



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ϕV_{cpq} (lb)
21584

11. Results

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

Tension	Factored Load, N_{ua} (lb)	Design Strength, ϕN_n (lb)	Ratio	Status	
Steel	968	3394	0.29	Pass	
Concrete breakout	3870	10021	0.39	Pass	
Adhesive	3870	9265	0.42	Pass (Governs)	
Shear	Factored Load, V_{ua} (lb)	Design Strength, ϕV_n (lb)	Ratio	Status	
Steel	706	1765	0.40	Pass	
T Concrete breakout x+	175	7103	0.02	Pass	
T Concrete breakout y-	2820	5313	0.53	Pass	
Concrete breakout y-	88	9797	0.01	Pass	
Concrete breakout x-	1410	12680	0.11	Pass	
Concrete breakout, combined	-	-	0.53	Pass (Governs)	
Pryout	2825	21584	0.13	Pass	
Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. R17.6	0.23	0.35	58.2%	1.0	Pass

SET-3G w/ 3/8"Ø F1554 Gr. 36 with hef = 6.000 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.

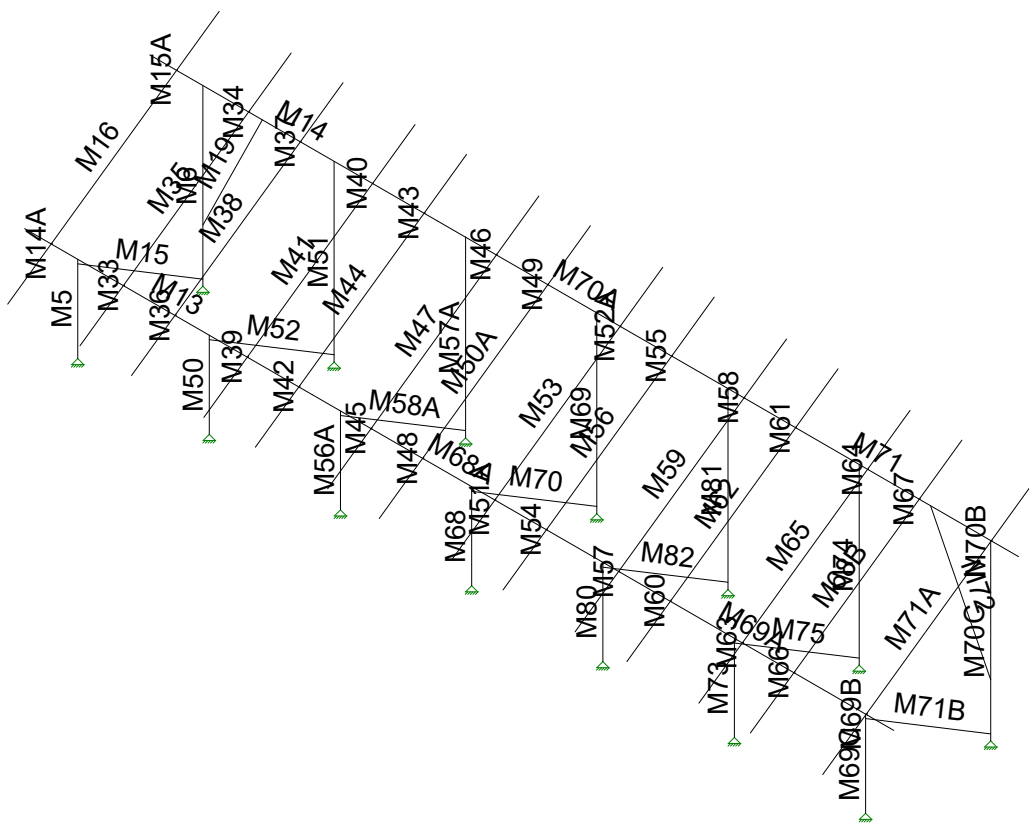


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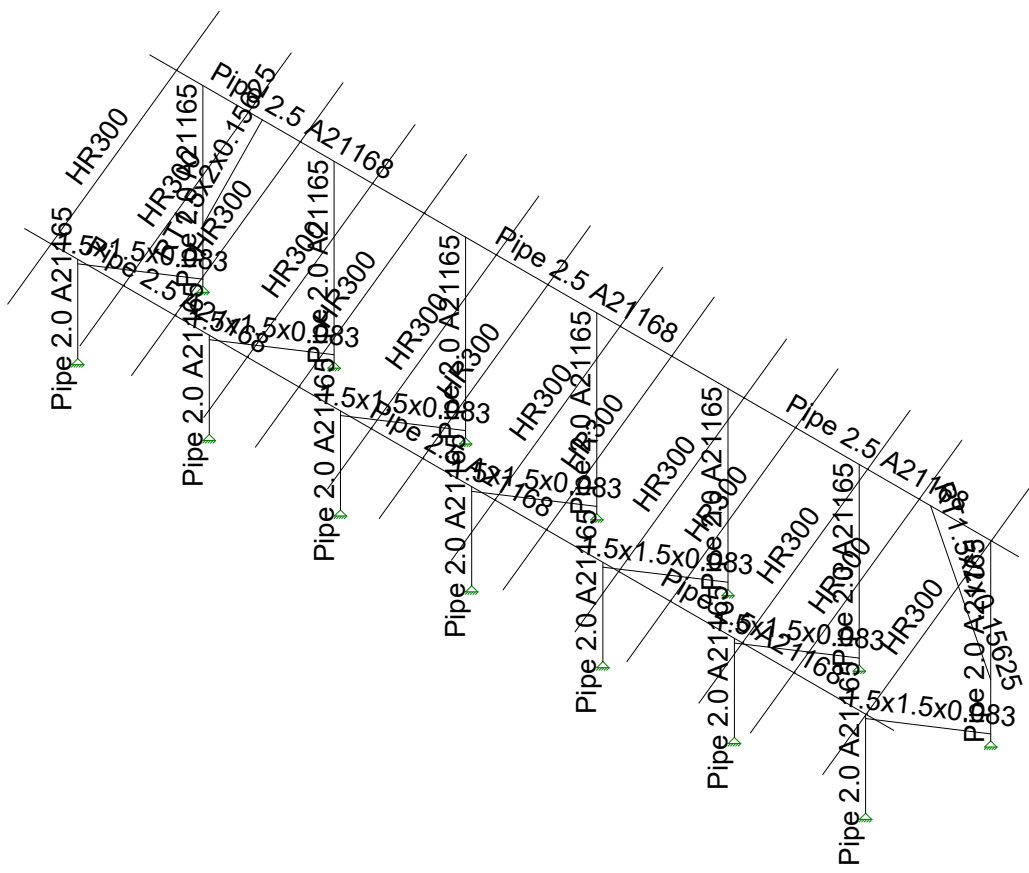
DESIGNED: STB

PROJECT: Ground Mount Package for Ontario Canada

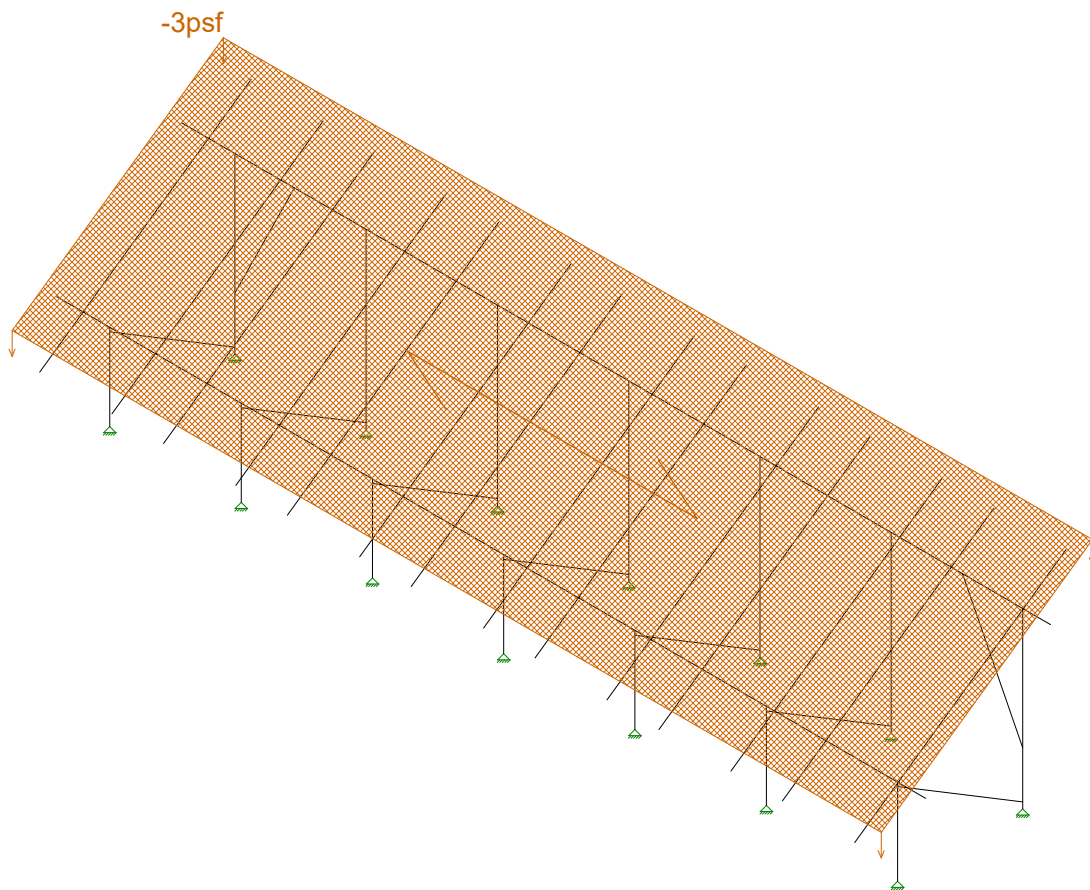
Framing Analysis



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U2716.114.191		New England A5.r3d

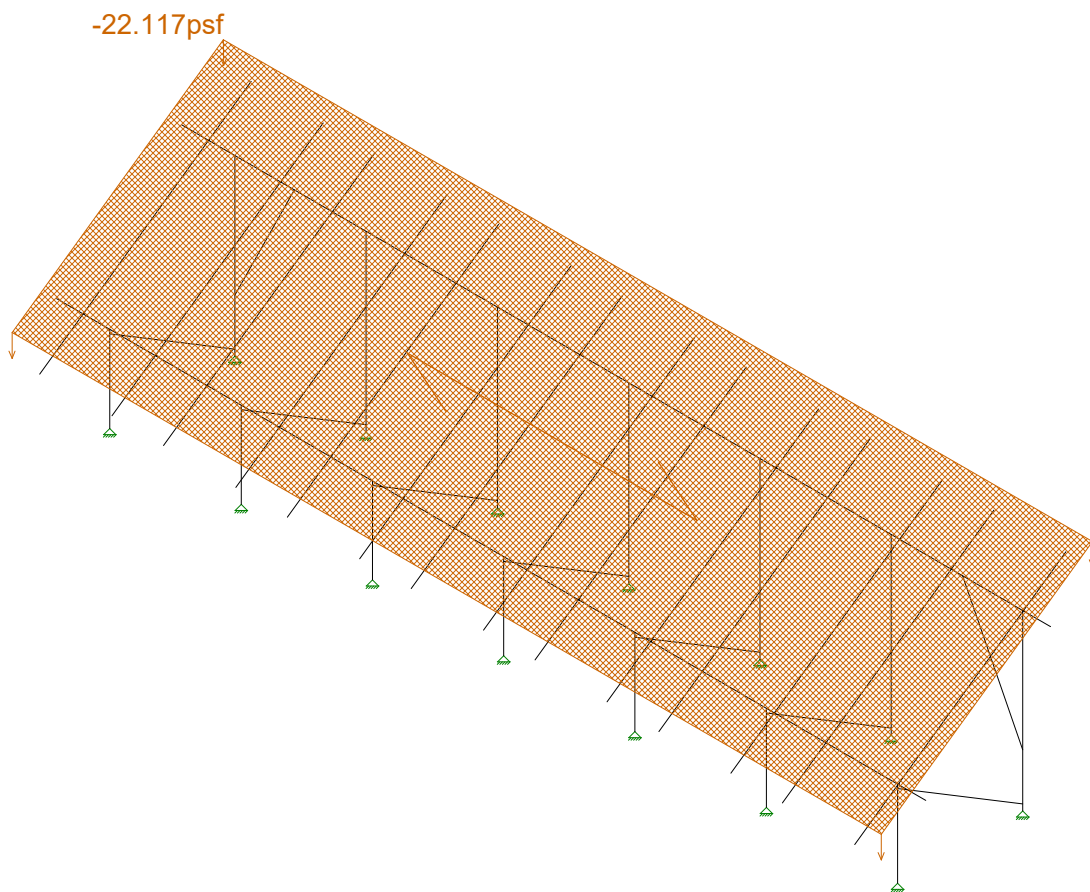


Vector Structural Engineeri...	Ground Mount	SK - 6
STB		Aug 1, 2019 at 12:15 PM
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Loads: BLC 2, Solar Panel Weight

Vector Structural Engineeri..	Ground Mount	SK - 7
STB		Aug 1, 2019 at 12:15 PM
U2716.114.191		New England A5.r3d



Loads: BLC 3, Roof Live/Snow

Vector Structural Engineeri..

STB

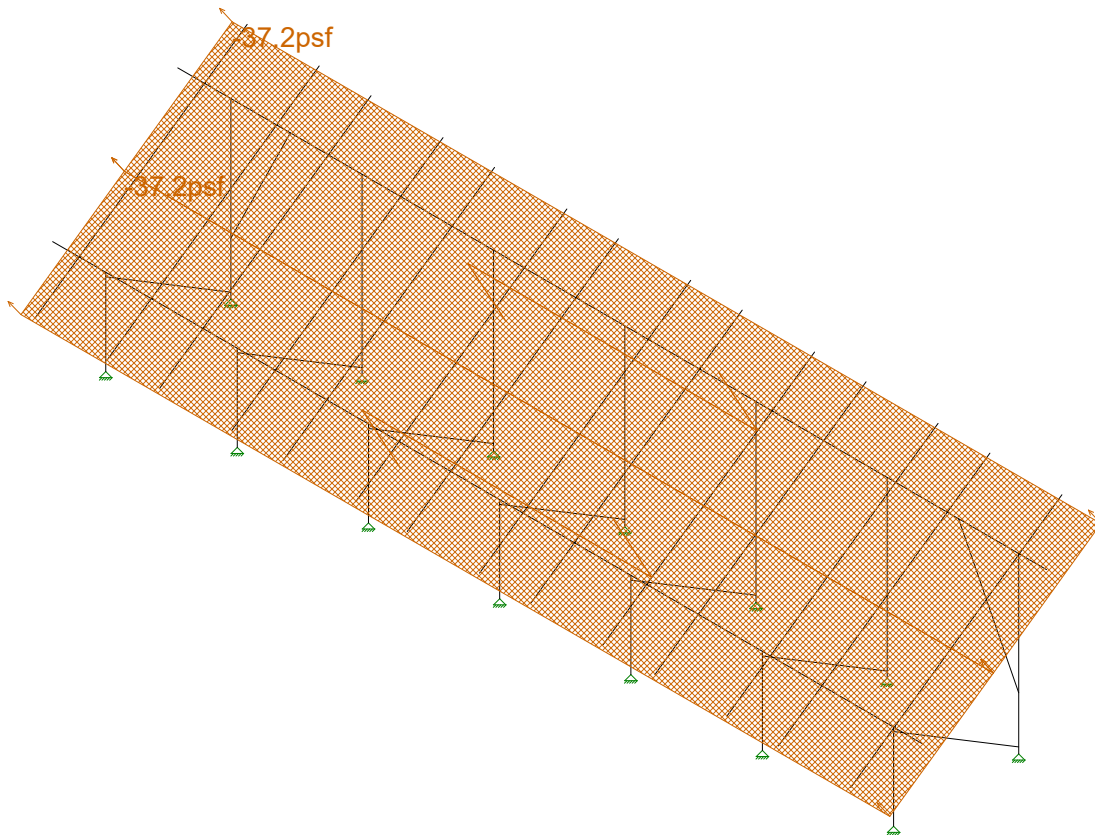
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Ground Mount

SK - 8

Aug 1, 2019 at 12:15 PM

New England A5.r3d



Loads: BLC 4, Wind A 0 deg

Vector Structural Engineeri..

STB

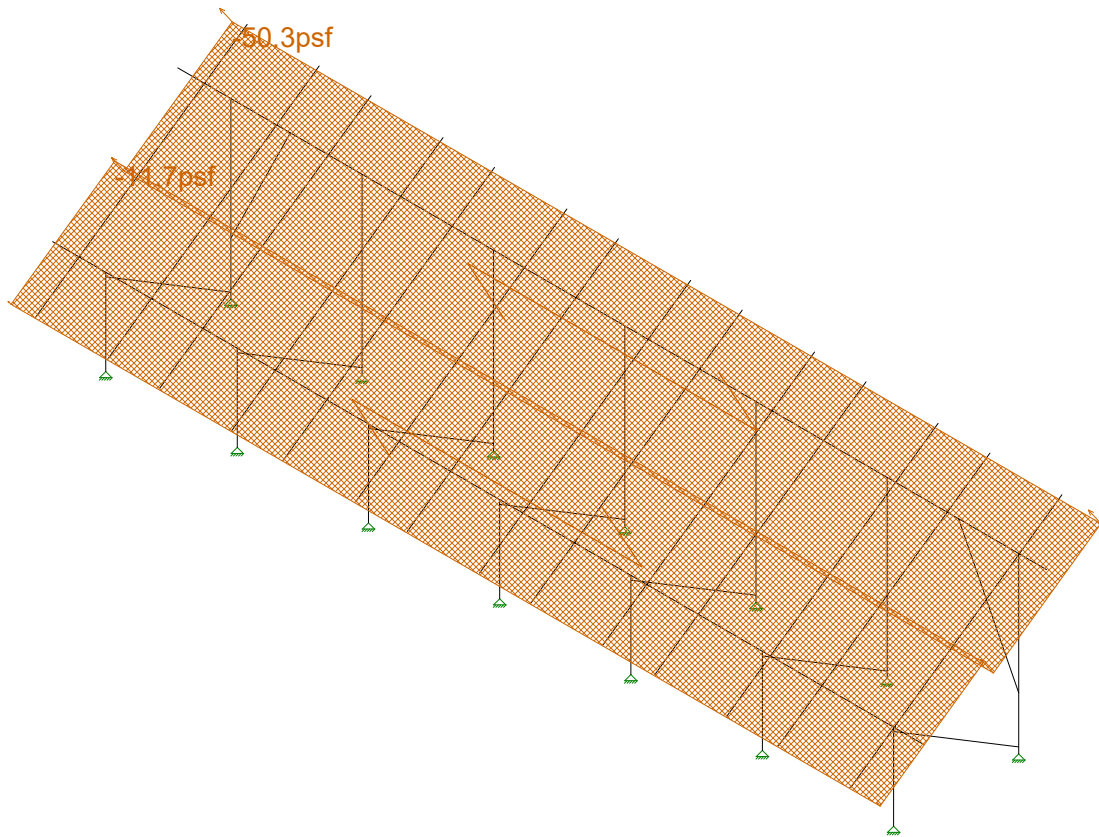
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Ground Mount

SK - 9

Aug 1, 2019 at 12:15 PM

New England A5.r3d



Loads: BLC 5, Wind B 0 deg

Vector Structural Engineeri..

STB

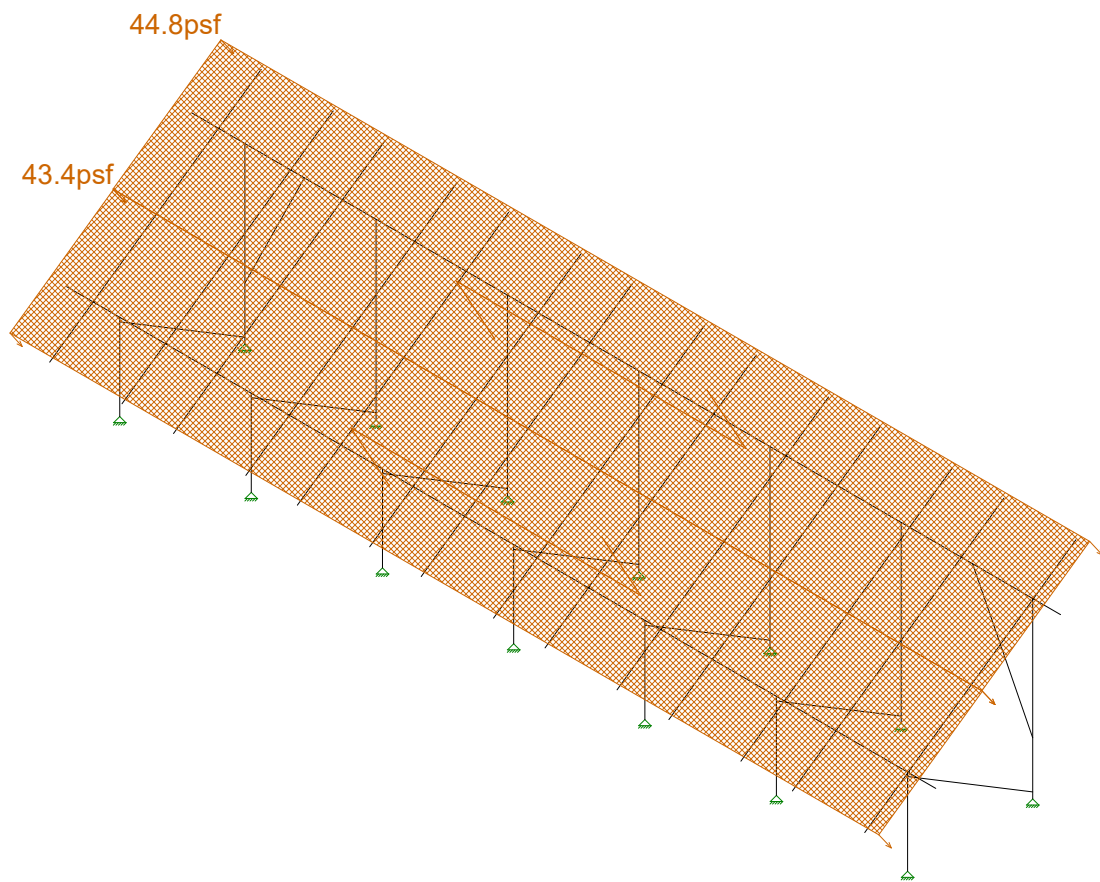
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Ground Mount

SK - 10

Aug 1, 2019 at 12:16 PM

New England A5.r3d



Loads: BLC 6, Wind A 180 deg

Vector Structural Engineeri..

STB

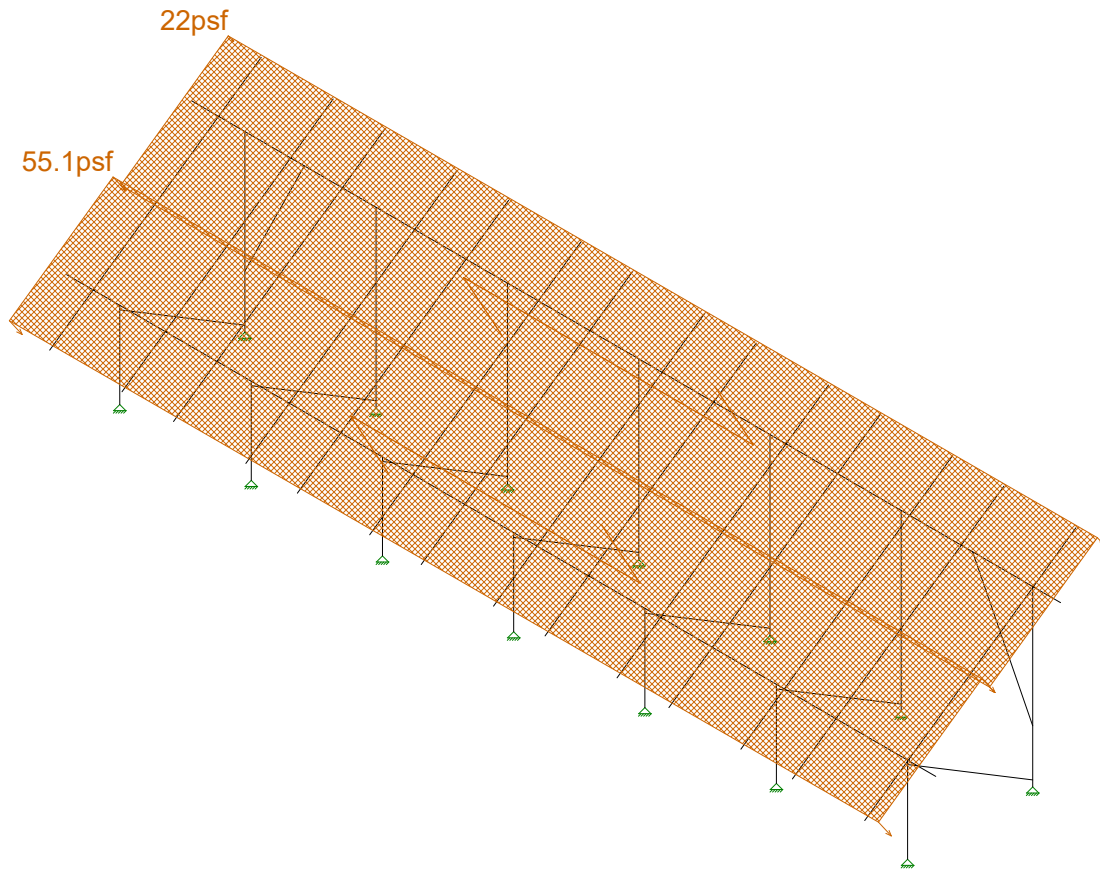
U2716.114.191

Ground Mount

SK - 11

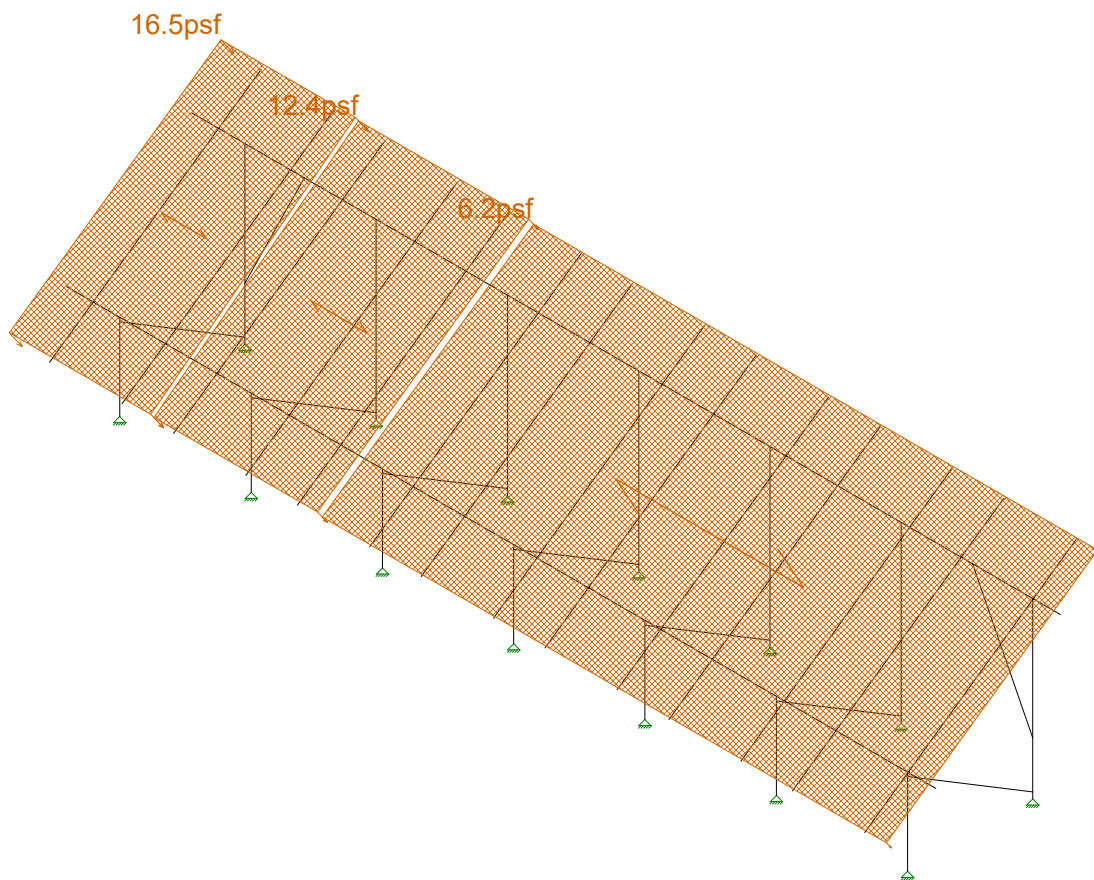
Aug 1, 2019 at 12:16 PM

New England A5.r3d



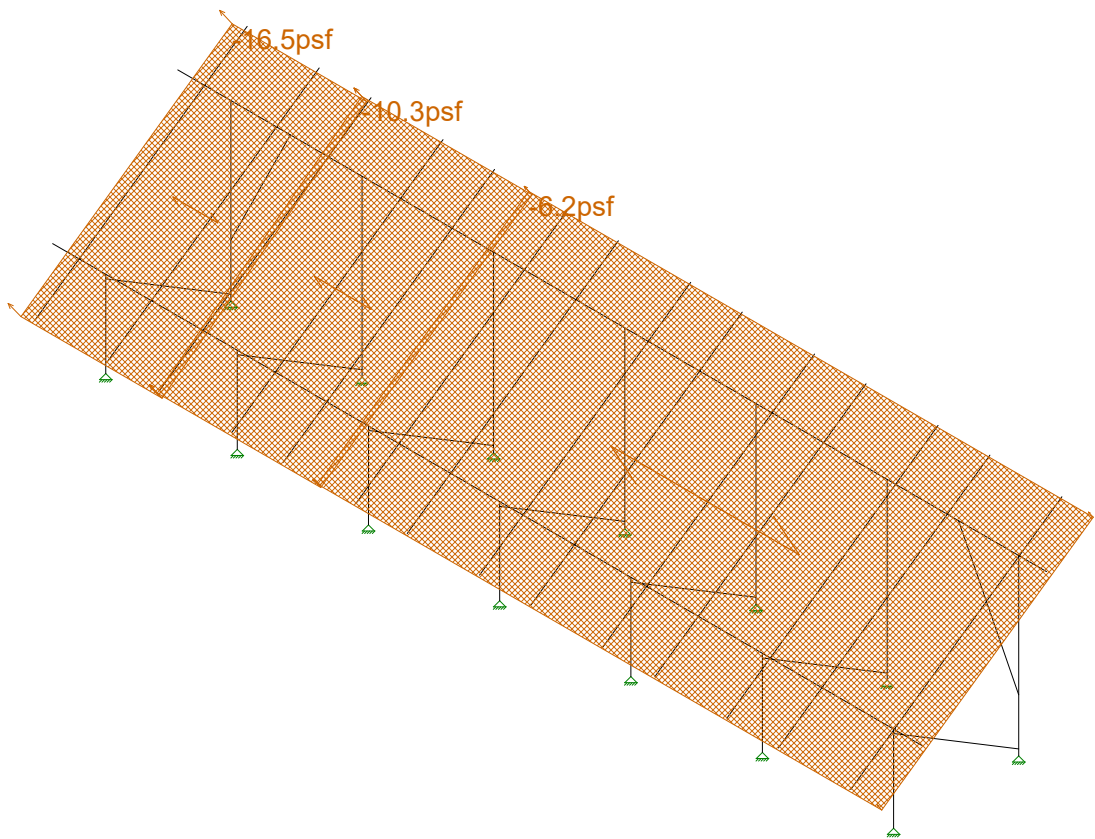
Loads: BLC 7, Wind B 180 deg

Vector Structural Engineeri..	Ground Mount	SK - 12
STB		Aug 1, 2019 at 12:16 PM
U2716.114.191		New England A5.r3d



Loads: BLC 8, Wind A 90

Vector Structural Engineeri..	Ground Mount	SK - 13
STB		Aug 1, 2019 at 12:16 PM
U2716.114.191		New England A5.r3d



Loads: BLC 9, Wind B 90

Vector Structural Engineeri..	Ground Mount	SK - 14
STB		Aug 1, 2019 at 12:16 PM
U2716.114.191		New England A5.r3d



Company : Vector Structural Engineering
 Designer : STB
 Job Number : U2716.114.191
 Model Name : Ground Mount

Aug 1, 2019
 12:16 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	HR300	Beam	Rectangular Tubes	6005-T5	Typical	.736	.214	.727	.614
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	-27

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	-37.2
2	N198	N201	N199	N196	Perp	A-B	-37.2

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	-50.3
2	N198	N201	N199	N196	Perp	A-B	-11.7

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	44.8
2	N198	N201	N199	N196	Perp	A-B	43.4

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	22
2	N198	N201	N199	N196	Perp	A-B	55.1

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	16.5
2	N203	N209	N208	N202	Perp	A-B	12.4
3	N209	N200	N199	N208	Perp	A-B	6.2

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	-16.5
2	N203	N209	N208	N202	Perp	A-B	-10.3
3	N209	N200	N199	N208	Perp	A-B	-6.2

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



Envelope Joint Reactions (Continued)

Joint	X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb-ft]	LC	MZ [lb-ft]	LC
14	min	-1.945	19	-2274.407	16	-1287....	3	0	1	0	1	0
15	N122	max	6.224	12	1691.671	10	63.102	3	0	1	0	1
16		min	-2.134	15	-360.177	17	-73.406	5	0	1	0	1
17	N133B	max	2.83	11	2928.261	11	1541.6...	5	0	1	0	1
18		min	-1.434	16	-2254.273	16	-1301....	3	0	1	0	1
19	N134B	max	10.193	12	1703.544	10	63.326	3	0	1	0	1
20		min	-1.721	15	-368.186	17	-73.542	5	0	1	0	1
21	N151	max	4.182	11	3013.072	11	1688.9...	5	0	1	0	1
22		min	-1.188	16	-2319.265	16	-1426....	3	0	1	0	1
23	N152	max	30.297	12	1845.542	10	62.377	3	0	1	0	1
24		min	-8.747	15	-437.714	17	-71.617	5	0	1	0	1
25	N143A	max	98.799	16	2049.985	11	968.025	5	0	1	0	1
26		min	-130.723	11	-1545.653	16	-816.164	3	0	1	0	1
27	N144A	max	23.184	15	1076.12	10	47.422	3	0	1	0	1
28		min	-64.678	12	-210.858	17	-55.787	5	0	1	0	1
29	Totals:	max	.02	19	23712.94	11	9673.9...	5				
30		min	-.04	14	-9980.616	15	-8157....	15				

Envelope AISC 14th(360-10): ASD Steel Code Checks

Member	Shape	Code Check	Loc[in]	LC	Shear ...	Loc[in]	Dir	LC	Pnc/om [...]	Pnt/om [lb]	Mny/om...	Mnz/om...	Cb	Eqn	
1	M5	Pipe 2.0 A2...	.222	52.073	17	.201	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
2	M6	Pipe 2.0 A2...	.703	3.477	5	.210	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
3	M13	Pipe 2.5 A2...	.656	118....	12	.128	116....	12	11641.036	28358.413	2081.747	2081.747	2...	H1-1b	
4	M14	Pipe 2.5 A2...	.639	118....	11	.127	116....	11	11641.036	28358.413	2081.747	2081.747	2...	H1-1b	
5	M15	1.5x1.5x0.083	.626	48.694	5	.039	0	y	11	2716.455	14085.15	624.421	624.421	1...	H1-1a
6	M80	Pipe 2.0 A2...	.237	52.073	17	.217	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
7	M81	Pipe 2.0 A2...	.752	3.477	5	.230	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
8	M82	1.5x1.5x0.083	.691	48.694	5	.010	93.493	y	10	2716.455	14085.15	624.421	624.421	1...	H1-1a
9	M50	Pipe 2.0 A2...	.239	52.073	17	.227	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
10	M51	Pipe 2.0 A2...	.754	3.477	5	.241	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
11	M52	1.5x1.5x0.083	.722	48.694	5	.007	0	y	14	2716.455	14085.15	624.421	624.421	1...	H1-1a
12	M56A	Pipe 2.0 A2...	.239	52.073	17	.220	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
13	M57A	Pipe 2.0 A2...	.762	3.477	5	.234	0	5	6062.107	23232.186	1397.505	1397.505	2...	H1-1a	
14	M58A	1.5x1.5x0.083	.699	48.694	5	.007	0	y	4	2716.455	14085.15	624.421	624.421	1...	H1-1a
15	M68	Pipe 2.0 A2...	.239	52.073	17	.222	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
16	M69	Pipe 2.0 A2...	.763	3.477	5	.236	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
17	M70	1.5x1.5x0.083	.707	48.694	5	.009	0	y	10	2716.455	14085.15	624.421	624.421	1...	H1-1a
18	M68A	Pipe 2.5 A2...	.635	18.75	12	.138	103....	12	11641.036	28358.413	2081.747	2081.747	2...	H1-1b	
19	M69A	Pipe 2.5 A2...	.652	90	12	.193	90	12	11641.036	28358.413	2081.747	2081.747	1...	H1-1b	
20	M70A	Pipe 2.5 A2...	.707	18.75	11	.161	103....	11	11641.036	28358.413	2081.747	2081.747	2...	H1-1b	
21	M71	Pipe 2.5 A2...	.632	6	11	.196	90	11	11641.036	28358.413	2081.747	2081.747	2...	H1-1b	
22	M73	Pipe 2.0 A2...	.240	52.073	17	.245	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
23	M74	Pipe 2.0 A2...	.811	3.477	5	.258	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
24	M75	1.5x1.5x0.083	.774	48.694	5	.011	93.493	y	10	2716.455	14085.15	624.421	624.421	1...	H1-1a
25	M69C	Pipe 2.0 A2...	.274	52.645	12	.146	52.645	5	16486.797	23232.186	1397.505	1397.505	1...	H1-1b	
26	M70C	Pipe 2.0 A2...	.561	33.608	11	.147	0	5	6062.107	23232.186	1397.505	1397.505	1...	H1-1a	
27	M71B	1.5x1.5x0.083	.448	48.694	5	.063	93.493	y	11	2716.455	14085.15	624.421	624.421	1...	H1-1a

Envelope AA ADM1-15: ASD - Building Aluminum Code Checks

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	
1	M19	RT1.5x2x...	.222	52.977	11	.022	0	z	5	2260.001	19411....	770.742	927.083	6090.199	4101.563	1...	H.1-1
2	M16	HR300	.615	82.515	11	.082	36.1	y	11	3887.213	14342....	494.953	934.619	6236.364	2843.273	1	H.1-1
3	M35	HR300	.635	80.796	11	.092	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1	H.1-1
4	M38	HR300	.615	84.234	11	.086	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1	H.1-1



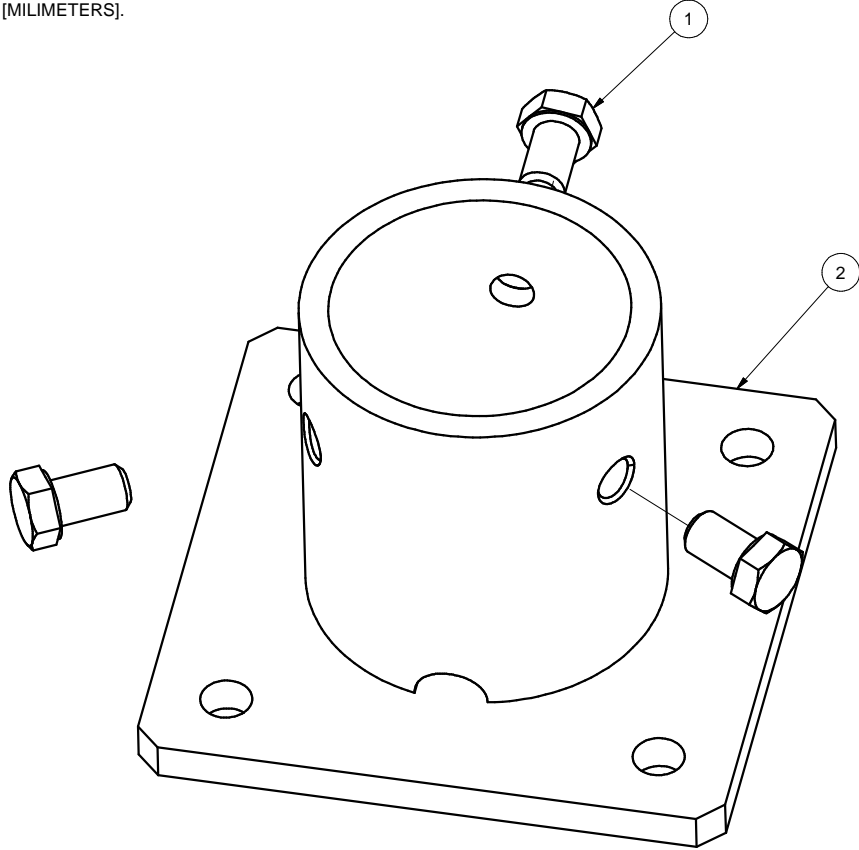
Company : Vector Structural Engineering
 Designer : STB
 Job Number : U2716.114.191
 Model Name : Ground Mount

Aug 1, 2019
 12:16 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
5	M41	HR300	.604	84.234	11	.082	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
6	M44	HR300	.606	84.234	11	.081	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
7	M47	HR300	.619	84.234	11	.082	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
8	M50A	HR300	.597	34.381	12	.082	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
9	M53	HR300	.630	84.234	11	.082	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
10	M56	HR300	.597	34.381	12	.081	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
11	M59	HR300	.638	84.234	11	.081	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
12	M62	HR300	.597	34.381	12	.081	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
13	M65	HR300	.646	84.234	11	.086	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
14	M68B	HR300	.611	80.796	11	.091	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
15	M71A	HR300	.607	84.234	11	.080	36.1	y	12	3887.213	14342....	494.953	934.619	6236.364	2843.273	1 H.1-1
16	M72	RT1.5x2x...	.208	53.045	11	.012	0	z	5	2254.199	19411....	770.742	927.083	6090.199	4101.563	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

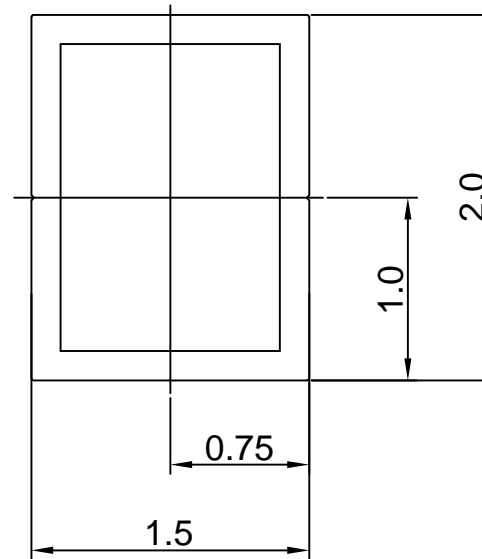
2	A21120-001	2" PIPE BASE	1
1	B15018-011	HEX CAP SCREW 3/8-16 X 5/8	3
ITEM	PART NUMBER	DESCRIPTION	QTY
MATERIAL SEE NOTES			
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters] Tolerances X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] X.X ±0.039 [1.0mm] Unless otherwise spec'd			
DRAWN BY LWF		DATE 10/20/2016	
CHECKED BY		B	DRAWING NUMBER K10268-001
APPROVALS		SCALE: NONE	SHEET 1 of 1

Sunmodo Corp.
 1905 E 5TH STREET, STE A, VANCOUVER, WA 98661
 TITLE
 2" PIPE BASE KIT

THIS DRAWING IS CONFIDENTIAL PROPERTY OF SUNMODO AND ITS CONTENTS MAY NOT BE DISCLOSED WITHOUT THE PRIOR WRITTEN CONSENT OF SUNMODO CORP.

NOTES: UNLESS OTHERWISE SPECIFIED

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



Section properties:

Weight: 1.156 lbs/ft

Area: 0.992 in²

Perimeter: 12.601 in

Bounding Box: X: -1.000,1.000

Y: -0.750, 0.750

Centroid:(0.000,0.000)

Moments of Inertia(in⁴): I_x=0.506,I_y=0.322

Section modulus in bending(in³): W_x=0.675,W_y=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 specified			
DRAWN BY	DATE		
zcg	03/12/2014		
CHECKED BY			
		B	DRAWING NUMBER
			A20164
APPROVALS			
		SCALE:	NONE
		SHEET	1 of 1

Sunmodo Corp.

1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661

TITLE
1.5X2 AL TUBE BRACE EXTRUSION

DRAWING NUMBER
A20164

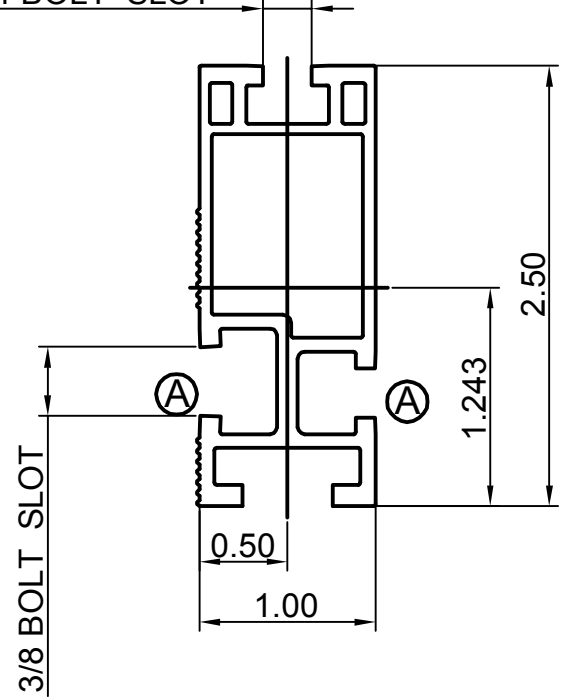
SCALE: NONE SHEET 1 of 1

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. MATERAIL: ALUMINUM 6005-T5.
FINISH: CLEAR ANODIZED 15 μ m THICK.
3. THE UNSPECIFIED DIMENSIONS ARE SPECIFIED BY 2D CAD FILE.

2X 1/4 BOLT SLOT



Section properties:

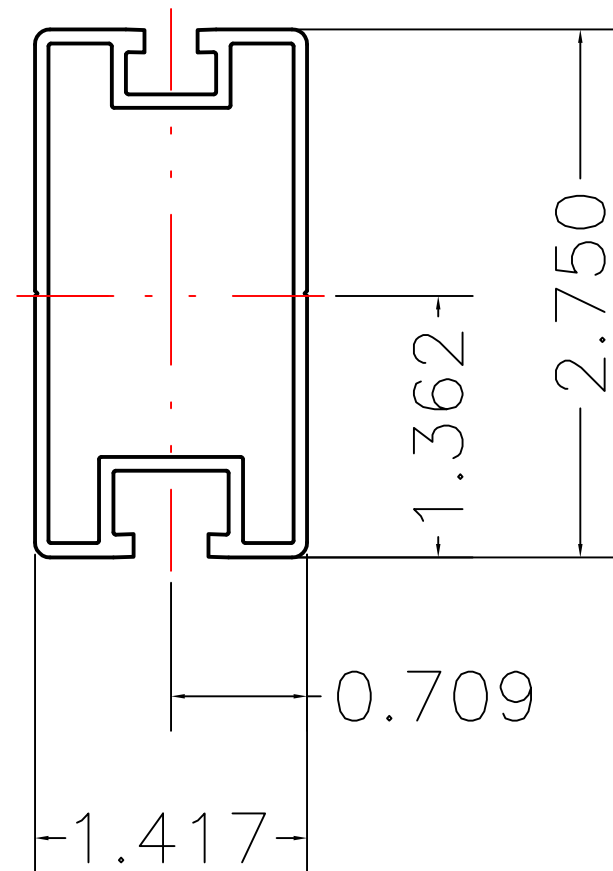
Weight: 0.850 lbs/ft
 Area: 0.723 in²
 Perimeter: 17.325 in
 Bounding Box: X: -0.500,0.500
 Y: -1.243,1.257

Centroid:(0.000,0.000)
 Moments of Incertia(in⁴): Ix=0.486,Iy=0.095
 Section modulus in bending(in³): Wx=0.387,Wy=0.190
 Radii of Gyration: X: 0.820, Y: 0.363

MATERIAL SEE NOTES		Sunmodo Corp.	
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 ± 0.039 [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			

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 in²
 Perimeter: 19.824 in
 Bounding Box: X: -0.709,0.709
 Y: -1.362,1.388
 Centroid:(0.000,0.000)
 Moments of Inertia(in⁴): Ix=0.727,Iy=0.214
 Section modulus in bending(in³): Wx=0.524,Wy=0.302
 Radii of Gyration: X: 994, Y: 0.539

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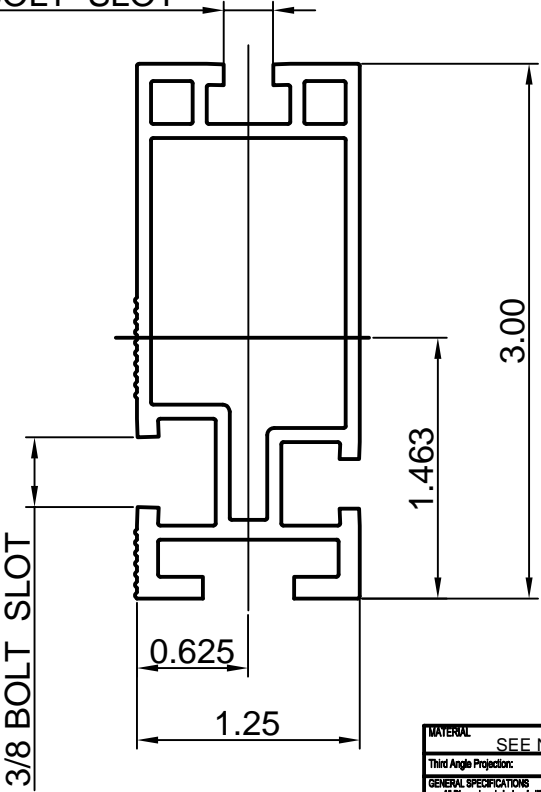
MATERIAL SEE NOTES		SunModo Corp. 14800 NE 65TH STREET, VANCOUVER WA 98682	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters]		TITLE RAIL, HR300 (SUNRAY), EXTRUSION	
Tolerances X.XXX ±0.01 [0.25mm] X.XX ±0.02 [0.50mm] Break all sharp edges X.X ±0.039 [1.0mm] .010-.020 unless otherwise specified. Unless otherwise spec'd			
DRAWN BY KYY	DATE 01/18/2018	B	DRAWING NUMBER A20288
CHECKED BY			
APPROVALS		SCALE: NONE	SHEET 1 of 1

REV	DESCRIPTON	BY	DATE
A	0.44 WAS 0.41, 0.44 WAS 0.33	LWF	11/30/2015

NOTES: UNLESS OTHERWISE SPECIFIED

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

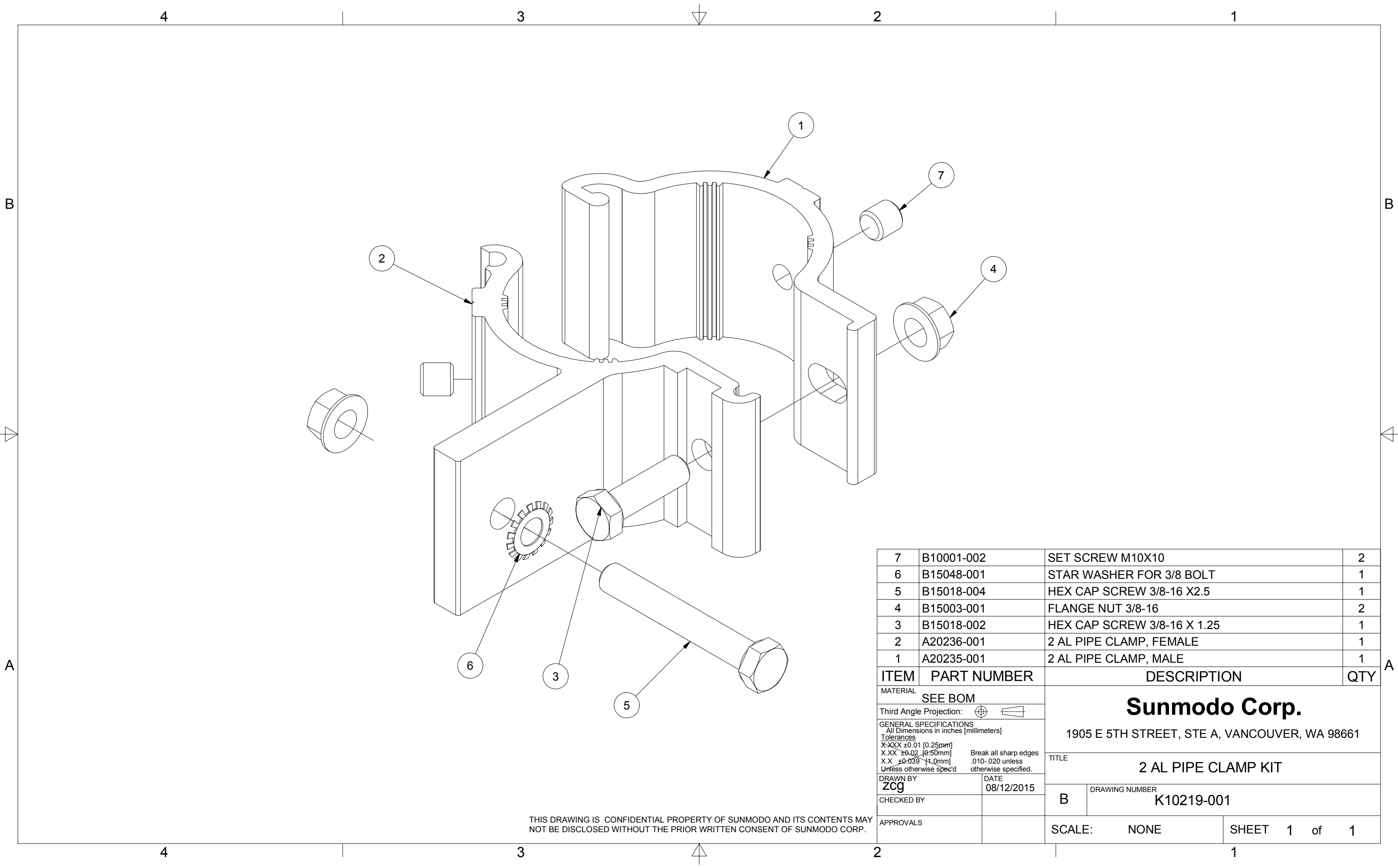
2X 1/4 BOLT SLOT



Section properties:

Weight: 1.151 lbs/ft
 Area: 0.980 in²
 Perimeter: 22.104 in
 Bounding Box: X: -0.625,0.625
 Y: -1.463,1.537
 Centroid:(0.000,0.000)
 Moments of Inertia(in⁴): Ix=1.047,Iy=0.207
 Section modulus in bending(in³): Wx=0.681,Wy=0.331
 Radii of Gyration: X: 1.034, Y: 0.460

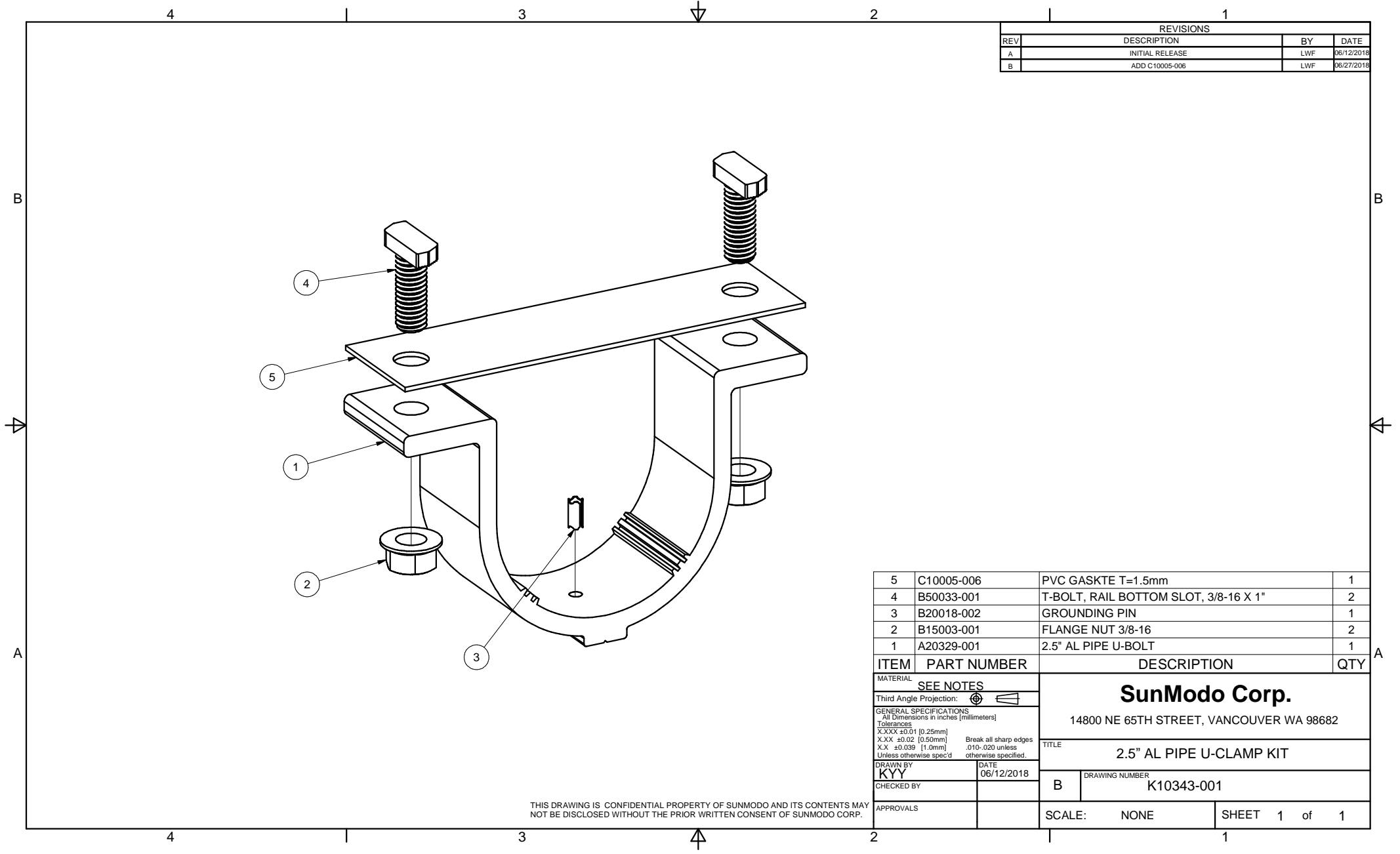
MATERIAL		SEE NOTES	
Third Angle Projection			
GENERAL SPECIFICATIONS			
All Dimensions in Inches (millimeters)			
Tolerances			
XXX ±0.01 (0.25mm)			
XX ±0.02 (0.50mm)			
X ±0.03 (1.0mm)			
Unless otherwise specified.			
DRAWN BY		DATE	
ZCJ		02/21/2013	
CHECKED BY		DATE	
APPROVALS		DATE	
Sunmodo Corp.		1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661	
TITLE		HELIO HEAVY RAIL	
DRAWING NUMBER		A20145	
SCALE:		NONE	
SHEET		1 of 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		TITLE	
		2 AL PIPE CLAMP KIT	
APPROVALS		DRAWING NUMBER	
		B K10219-001	
SCALE:		NONE	SHEET 1 of 1

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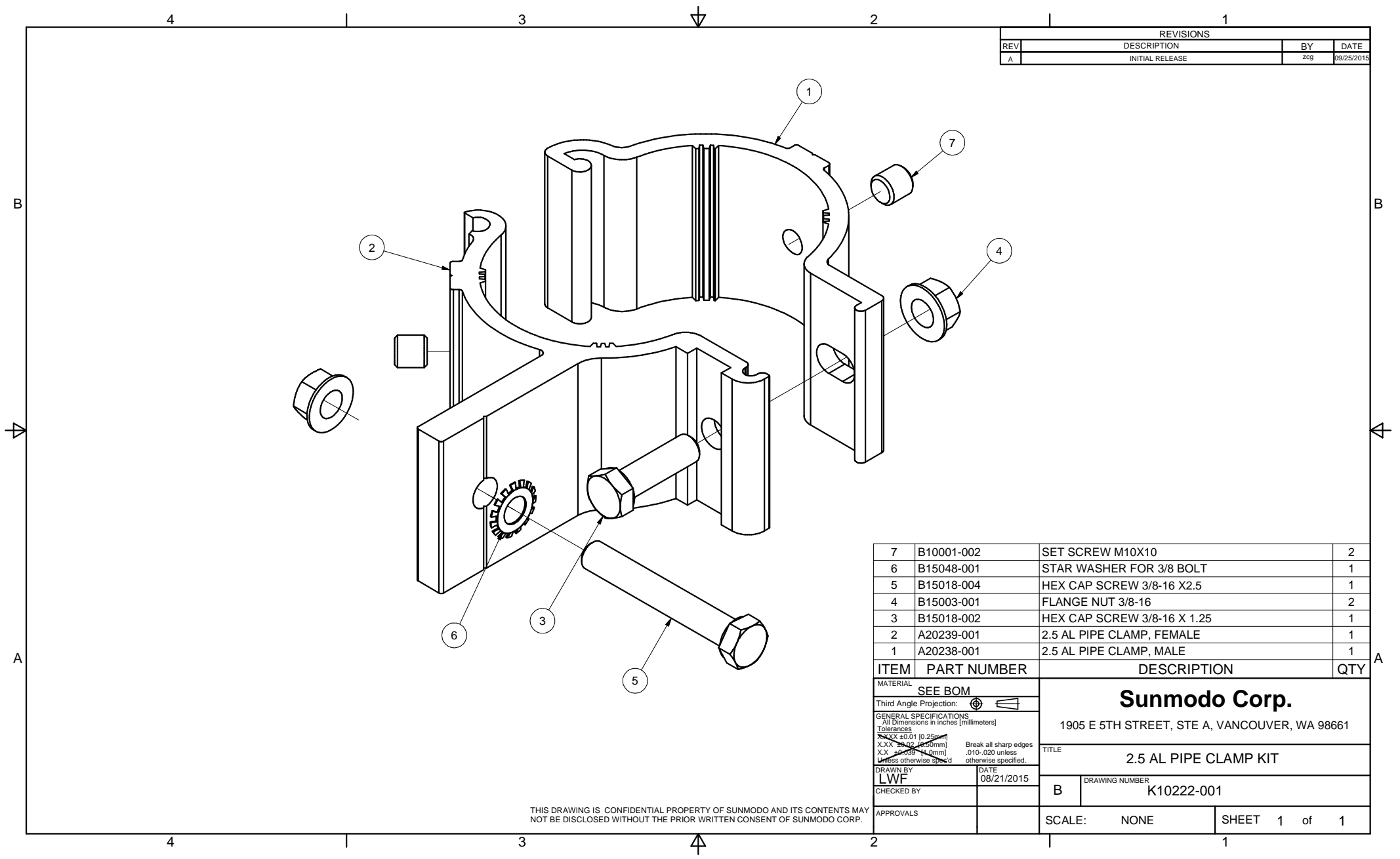


REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018
B	ADD C10005-006	LWF	06/27/2018

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		SEE NOTES	
Third Angle Projection:			
GENERAL SPECIFICATIONS		SunModo Corp. 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" AL PIPE U-CLAMP KIT	
DRAWN BY		DATE	
KYY		06/12/2018	
CHECKED BY		DRAWING NUMBER	
		B K10343-001	
APPROVALS		SCALE: NONE SHEET 1 of 1	

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

ITEM	PART NUMBER	DESCRIPTION	QTY
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

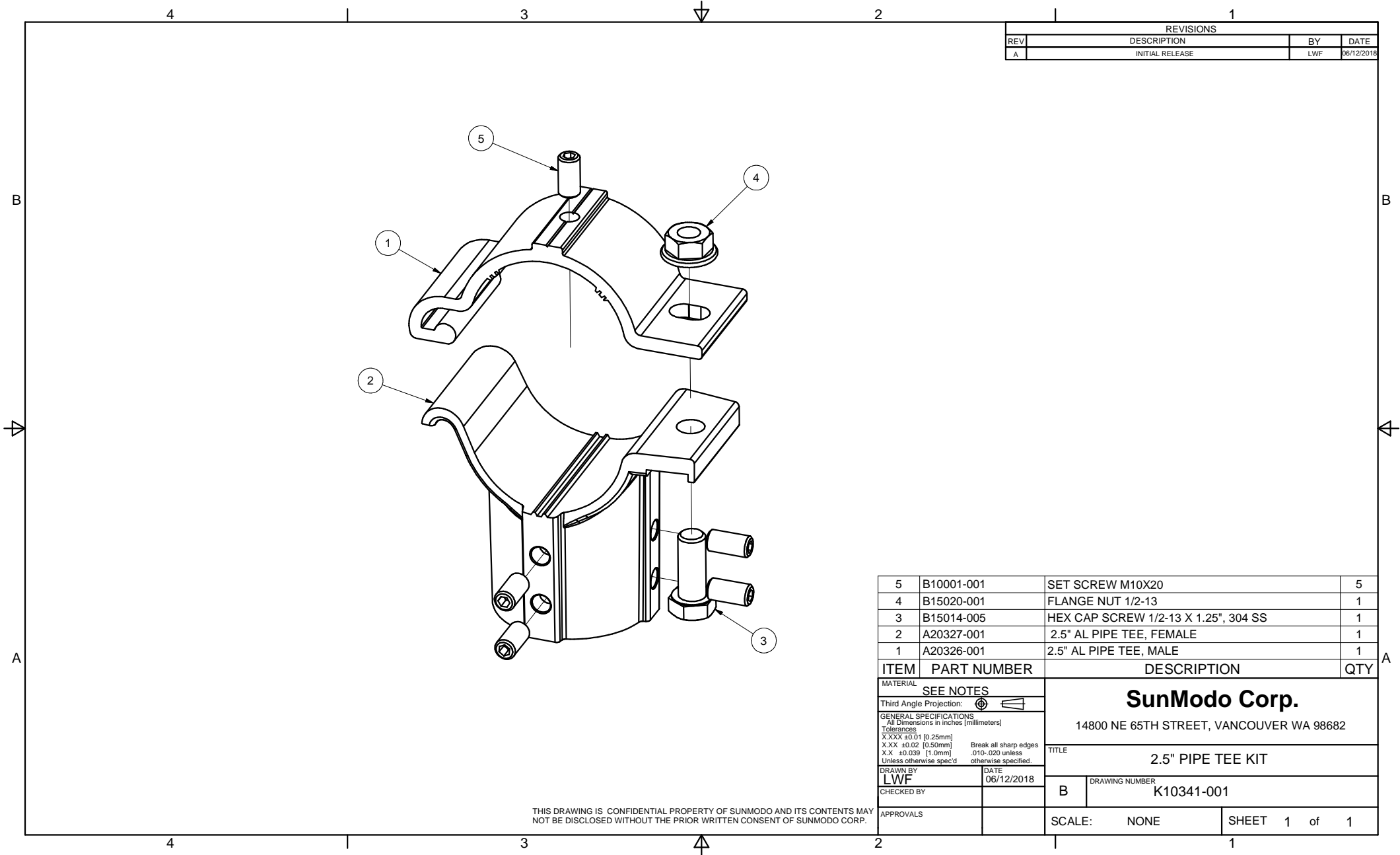
MATERIAL		SEE BOM	
Third Angle Projection:			
GENERAL SPECIFICATIONS All Dimensions in inches [millimeters] Tolerances X.XX ±0.01 (0.25mm) X.X ±0.02 (0.5mm) X.X ±0.03 (0.75mm) Unless otherwise specified, Break all sharp edges .010-.020 unless otherwise specified.			
DRAWN BY		DATE	
LWF		08/21/2015	
CHECKED 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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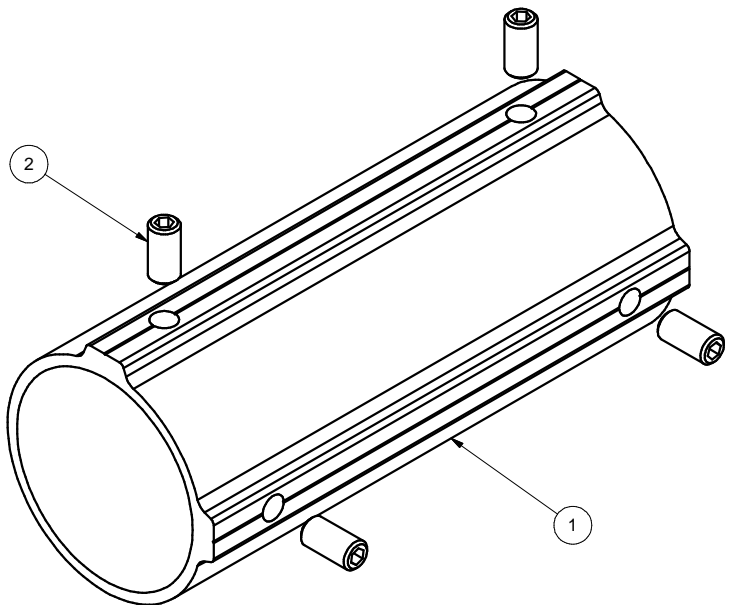
REVISIONS			
REV	DESCRIPTION	BY	DATE
A	INITIAL RELEASE	LWF	06/12/2018

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		SunModo Corp. 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	DRAWING NUMBER	
LWF	06/12/2018	B K10341-001	
CHECKED BY		SCALE: NONE SHEET 1 of 1	
APPROVALS			

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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		SunModo Corp. 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		Break all sharp edges .010-.020 unless otherwise specified.	
DRAWN BY		TITLE	
LWF		2.5" PIPE SPLICE KIT	
DATE		DRAWING NUMBER	
06/12/2018		B K10342-001	
CHECKED BY		SCALE: NONE	
APPROVALS		SHEET 1 of 1	

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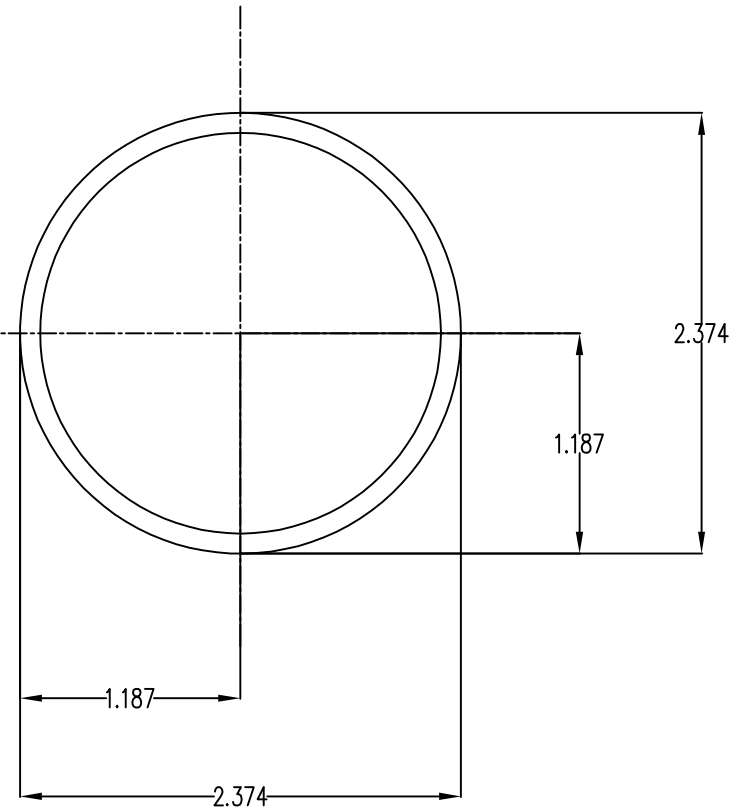
NOTES: UNLESS OTHERWISE SPECIFIED

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 in²

Perimeter: 14.238 in

Bounding Box: X: -1.187,1.187

Y: -1.187,1.187

Centroid:(0.000,0.000)

Moments of Inertia(in⁴): I_x=0.499,I_y=0.499

Section modulus in bending(in³): W_x=0.420,W_y=0.420

Radii of Gyration: X: 0.802, Y: 0.802

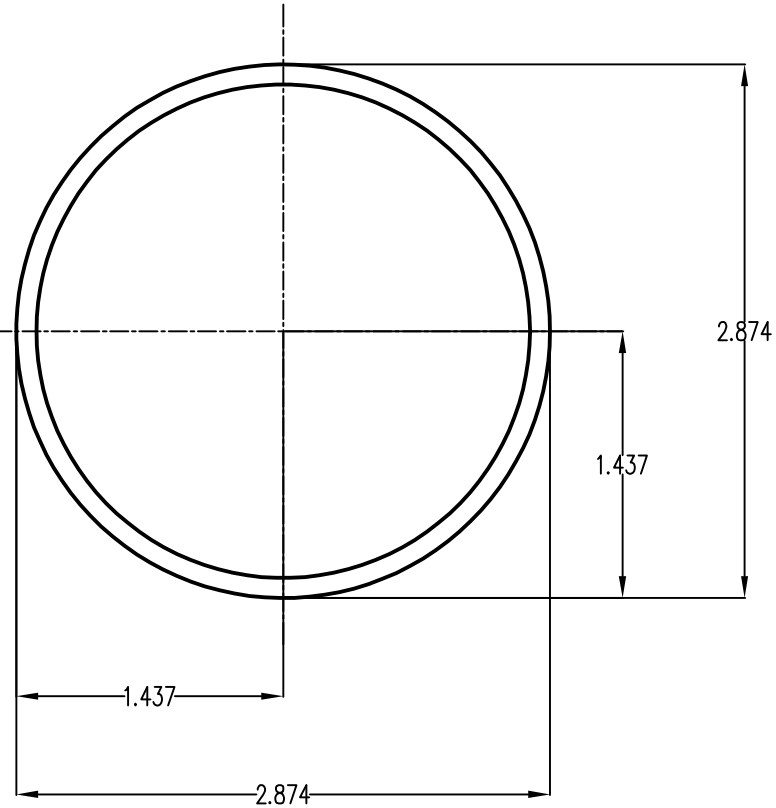
MATERIAL		SEE NOTES		Sunmodo Corp. 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS				TITLE	
All Dimensions in Inches (millimeters)				PIPE, HSS, 2.375" OD X 12 GAUGE,L=XXX	
Tolerances				Break all sharp edges .010-.020 unless otherwise specified.	
XXX ±0.01 (0.25mm)					
XX ±0.02 (0.50mm)					
X ±0.050 (1.2mm)					
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 in²

Perimeter: 17.378 in

Bounding Box: X: -1.437,1.437

Y: -1.437,1.437

Centroid:(0.000,0.000)

Moments of Inertia(in⁴): Ix=0.901,Iy=0.901

Section modulus in bending(in³): Wx=0.627,Wy=0.627

Radii of Gyration: X: 0.979, Y: 0.979

MATERIAL		SEE NOTES		Sunmodo Corp. 14800 NE 85TH STREET, VANCOUVER WA 98682	
Third Angle Projection:					
GENERAL SPECIFICATIONS				TITLE	
All Dimensions in Inches (millimeters)				PIPE, HSS, 2.875" 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 (1.2mm)					
Unless otherwise specified					
DRAWN BY	DATE	B		DRAWING NUMBER	
LWF	04/03/2019			A21168	
CHECKED BY					
APPROVALS				SCALE: NONE SHEET 1 of 1	