



Project Number: U2716-113-191

August 6, 2019

Sunmodo
14800 NE 65th Street
Vancouver, WA 98682

**REFERENCE: Sunmodo Sunturf Ground Mount A4
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 2015 International Building Code. 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: 110 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 | 1560 | 1.5 | 2340 |
| LATERAL | 1130 | 2 | 2260 |

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.

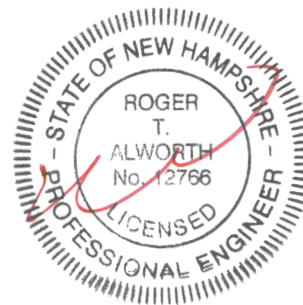
Very truly yours,

VECTOR STRUCTURAL ENGINEERING, LLC
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Roger Alworth, P.E.
License: 12766 - Expires: 01/31/2021
Principal

Enclosures

RTA/stb

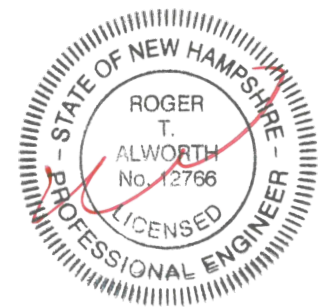
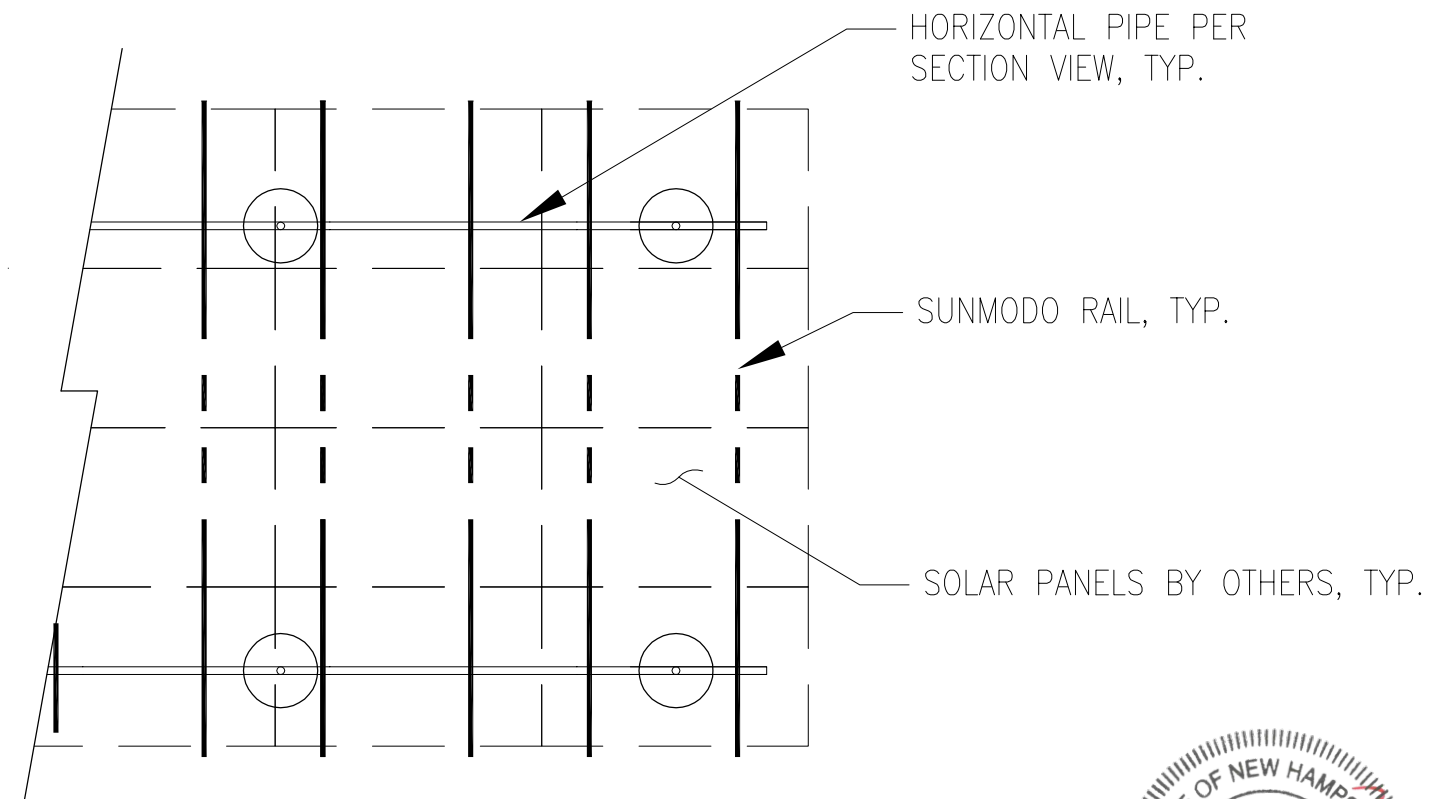
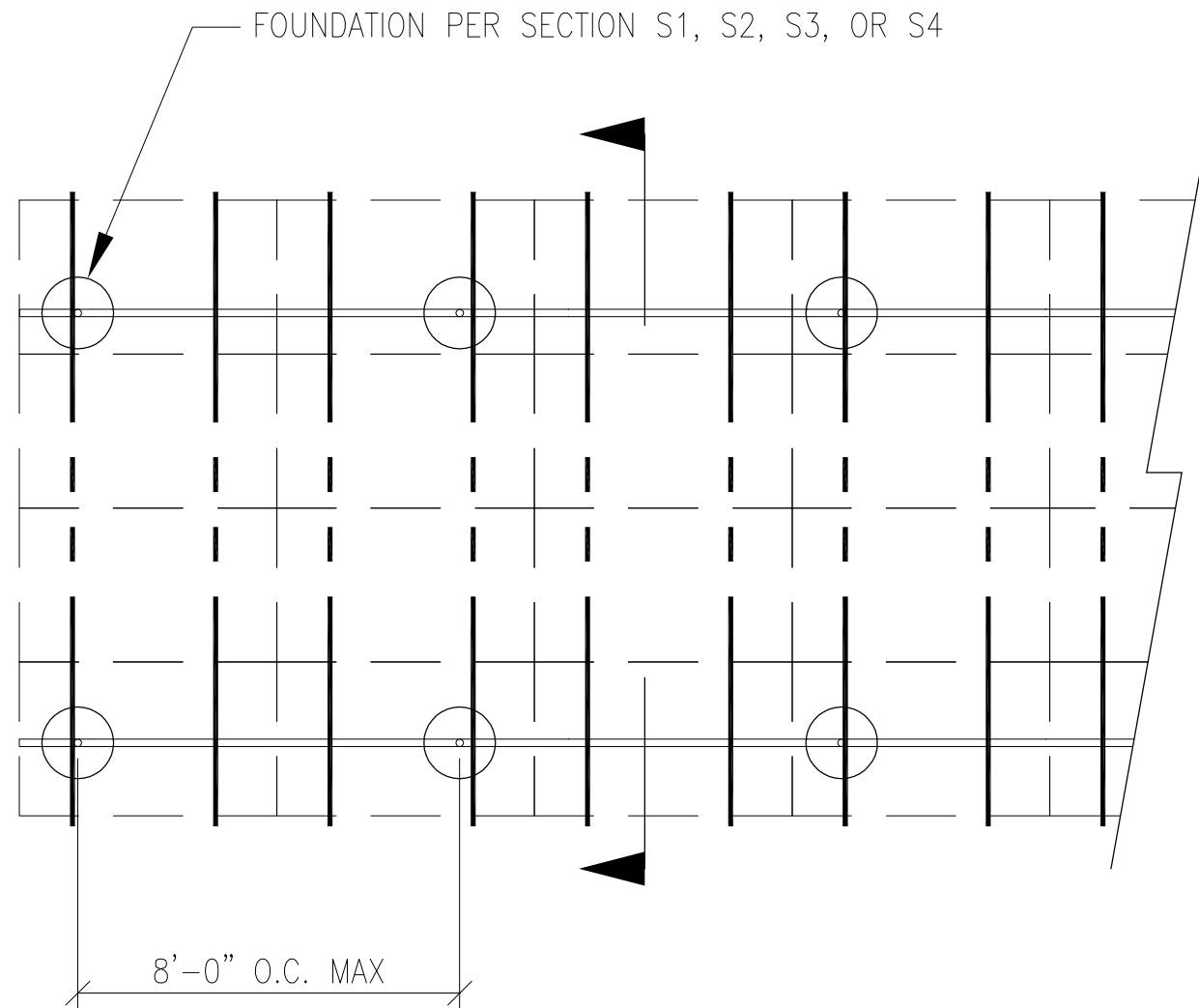


08/06/2019



JOB NO. U2716-113-191
 PROJECT SUNMODO SUNTURF GROUND MOUNTS A4
 SUBJECT ALL OPTIONS

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 DRAPER, UTAH 84020 (801) 990-1776 FAX



08/06/2019

PV ARRAY PLAN

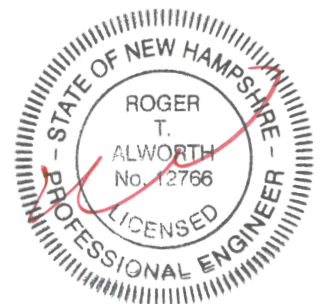
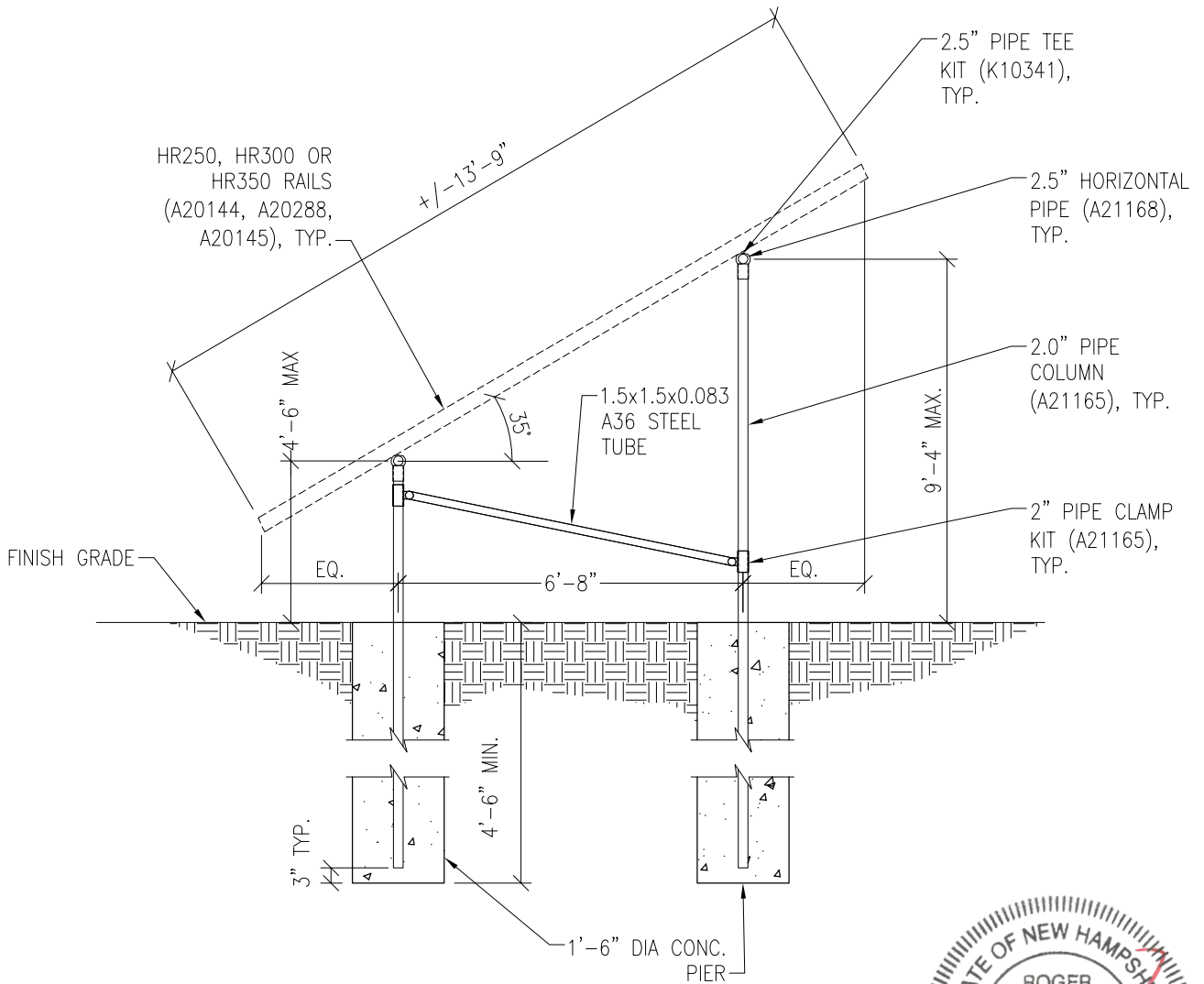
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P1

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 A4

SUBJECT DRILLED PIER OPTION



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PV ARRAY SECTION

08/06/2019

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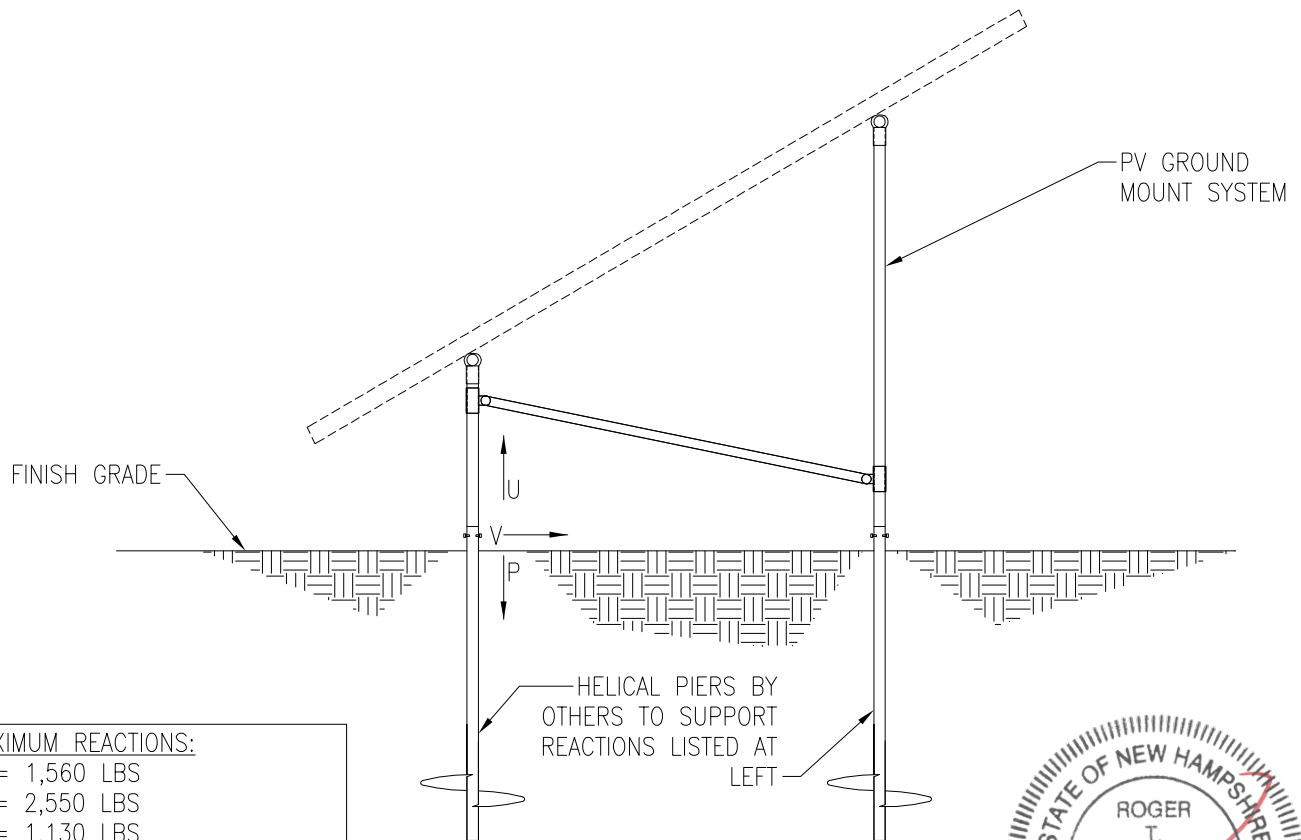
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PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

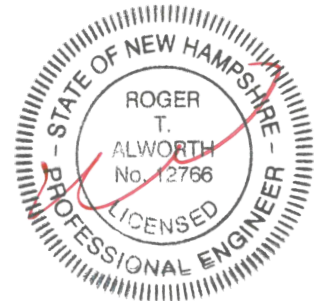
SUBJECT HELICAL PIER OPTION

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 = 1,560 LBS P = 2,550 LBS V = 1,130 LBS |
|--|



03/26/2020

PV ARRAY SECTION

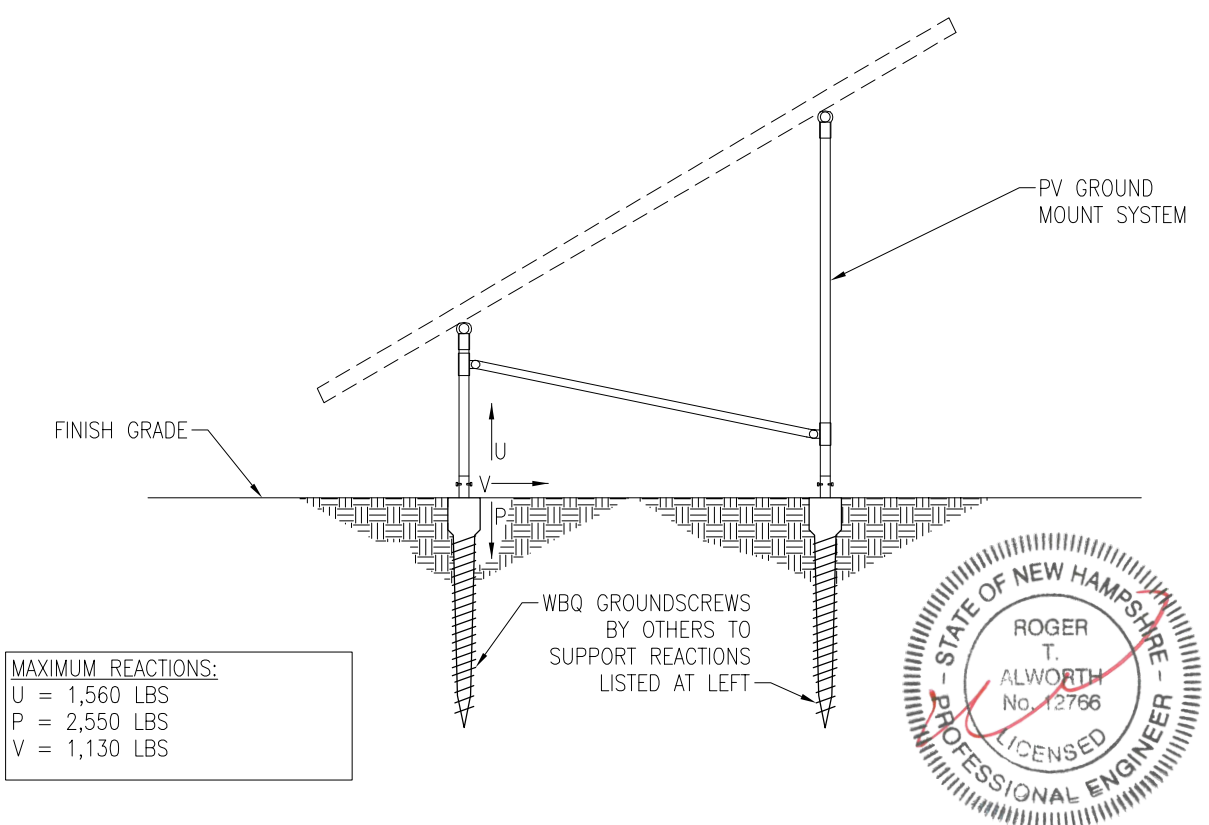
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PROJECT SUNMODO SUNTURF GROUND MOUNTS A41

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.

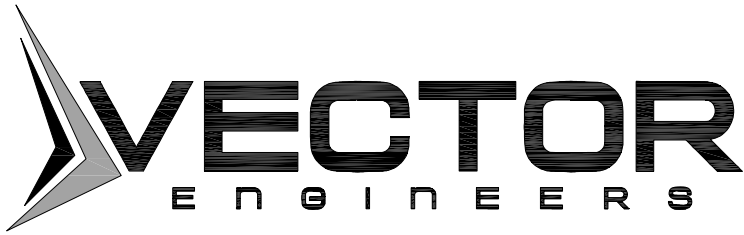


MAXIMUM REACTIONS:
 U = 1,560 LBS
 P = 2,550 LBS
 V = 1,130 LBS

03/26/2020

PV ARRAY SECTION

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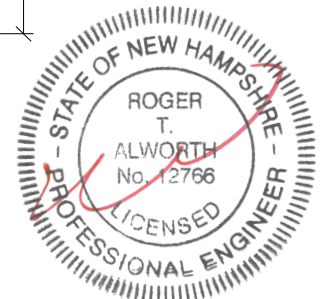
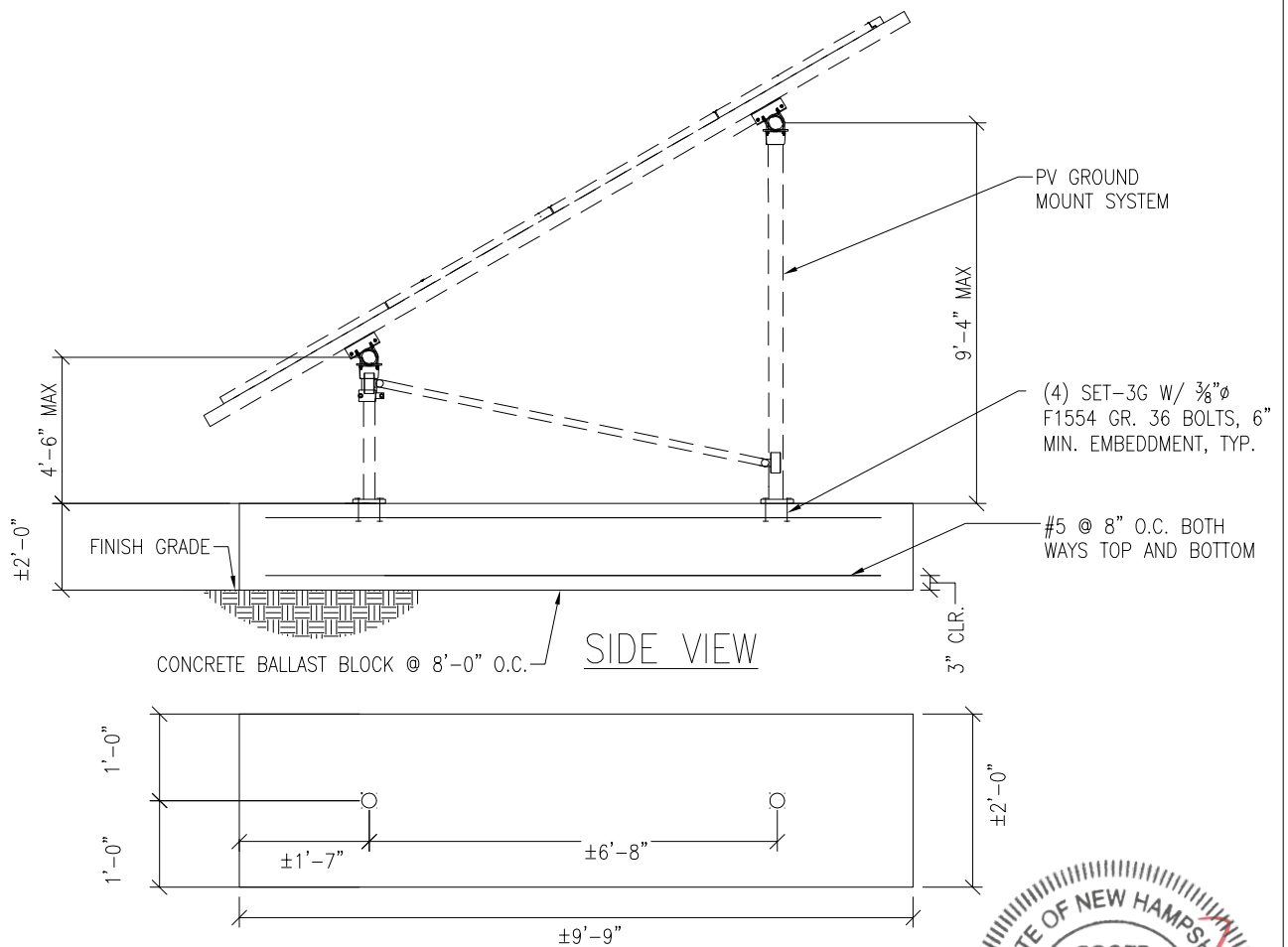
JOB NO. U2716-113-191

PROJECT SUNMODO SUNTURF GROUND MOUNTS A4

SUBJECT BALLASTED BLOCK OPTION

NOTES:

1. For ground mount components see Section S1.



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S4

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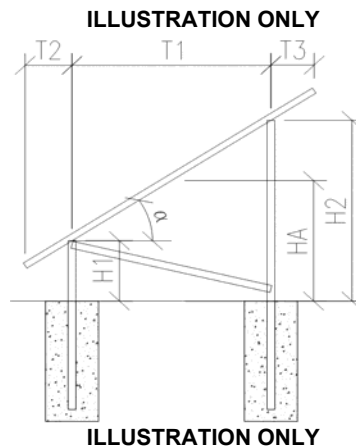
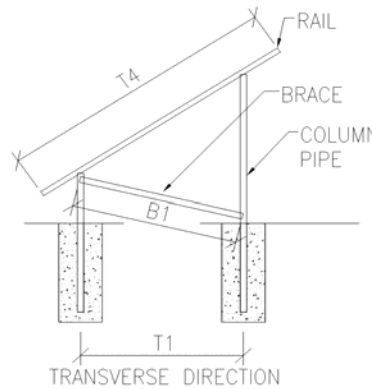
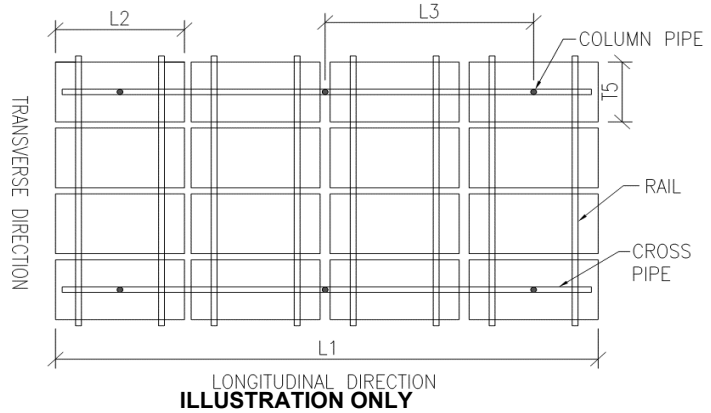
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PROJECT: A4 – Sunmodo Sunturf GM

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]: | 8.0 |
| # of Columns in Longitudinal Direction: | 11 |
| # of Columns in Transverse Direction: | 2 |
| Total Number of Columns: | 22 |
| Panel Slope from Horizontal (a) [°]: | 35.0 |
| Short Column Height (H1) [ft]: | 4.6 |
| Approximate Tall Column Height (H2) [ft]: | 9.3 |
| 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]: | 8.0 |
| Tributary Area per Column [ft ²]: | 54.9 |
| Rail Weight [plf]: | 1.0 |
| Transverse Rail Weight per Column [lb]: | 27.5 |
| Longitudinal Rail Weight per Column [lb]: | 29.2 |
| Tall Column Weight [lb]: | 33.9 |
| Panel Weight per Column [lb]: | 119.6 |
| Rail Weight per Column [lb]: | 27.5 |
| Cross Pipe Weight per Column [lb]: | 29.2 |
| Brace Weight per Column [lb]: | 16.4 |
| Total Weight per Column (1.0 D) [lb]: | 226.7 |



Assumptions:

- T2 = T3



JOB NO.: U2716-113-191

DESIGNED: STB

DATE: 07/31/19

PROJECT: A4 – 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]: | 6 | |
| Tributary Area per Column [ft ²]: | 33.7 | |
| | | |
| Snow Load per Column (1.0 S) [lb]: | 909.2 | |



PROJECT: A4 – Sunmodo Sunturf GM

SUBJECT: Wind Pressure

Design Wind Load:

| | | |
|---|------|-------------------|
| ASCE 7 Standard: | 10 | |
| Basic Wind Speed, V [mph]: | 110 | |
| 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]: | 15.0 | (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) | -23.0 | -23.0 |
| Case 2 ($\gamma = 0^\circ$, Load Case B) | -31.0 | -7.2 |
| Case 3 ($\gamma = 180^\circ$, Load Case A) | 26.8 | 27.6 |
| Case 4 ($\gamma = 180^\circ$, Load Case B) | 34.0 | 13.6 |

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) | -23.0 | -23.0 |
| Case 2 ($\gamma = 0^\circ$, Load Case B) | -7.2 | -31.0 |
| Case 3 ($\gamma = 180^\circ$, Load Case A) | 26.8 | 27.6 |
| Case 4 ($\gamma = 180^\circ$, Load Case B) | 34.0 | 13.6 |



JOB NO.: U2716-113-191

PROJECT: A4 – 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_{zt} : | 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) |
| Ultimate Wind Speed, V [mph]: | 110 | |

| | | |
|---------------------------------|------|-------------------|
| Velocity Pressure, q_h [psf]: | 15.0 | (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]:

| Horizontal Distance from Winward Edge | Roof angle | Load Case | Obstructed Wind Flow |
|---------------------------------------|------------|-----------|----------------------|
| | | | |
| $\leq h$ | 35 | A | -10.2 |
| | | B | 10.2 |
| $> h, \leq 2h$ | 35 | A | -7.7 |
| | | B | 6.4 |
| $> 2h$ | 35 | A | -3.8 |
| | | B | 3.8 |



JOB NO.: U2716-113-191

DESIGNED: STB

Foundation Option 1: Drilled Concrete Pier



JOB NO.: U2716-113-191
DATE: 07/31/19

DESIGNED: STB

PROJECT: A4 – Sunmodo Sunturf GM

Drilled Pier Design

Design Loads:

| | | | |
|------------------------|-----|----------------------------------|-----|
| Max. Shear, V [k]: | 1.1 | Max. Down, P _d [k]: | 2.5 |
| Max. Moment, M [k-ft]: | 0.0 | Max. Uplift, P _u [k]: | 1.6 |

Pier Properties:

| | | | |
|--|------|--|-----|
| Pier Diameter, b [ft]: | 1.5 | Volume of Concrete [ft ³]: | 8 |
| Min. Pier Diameter, b _{min} (opt'l) [ft]: | | Volume of Concrete [yd ³]: | 0.3 |
| Top of Pier Elevation [ft]: | 0.00 | Weight of Concrete [k]: | 1.2 |
| Pier Depth, d [ft]: | 4.5 | | |
| 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]: 5.3 **Bearing capacity OK.**

Check Uplift:

Uplift Capacity [k]: 6.4 **Uplift capacity OK.**

Check Lateral Bearing:

| | | |
|--|-------|-------------------------------------|
| Applied Lateral Force, P [lb]: | 1,130 | |
| Point of Application, h [ft]: | 0.0 | |
| S _{1_max} [psf]: | | |
| S ₁ [psf]: | 450 | |
| A = 2.34*P/(S ₁ b): | 3.92 | |
| Required Pier Depth, d _{reqd} [ft]: | 3.9 | 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 | 1560 | 1.5 | 2340 |
| LATERAL | 1130 | 2 | 2260 |

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.

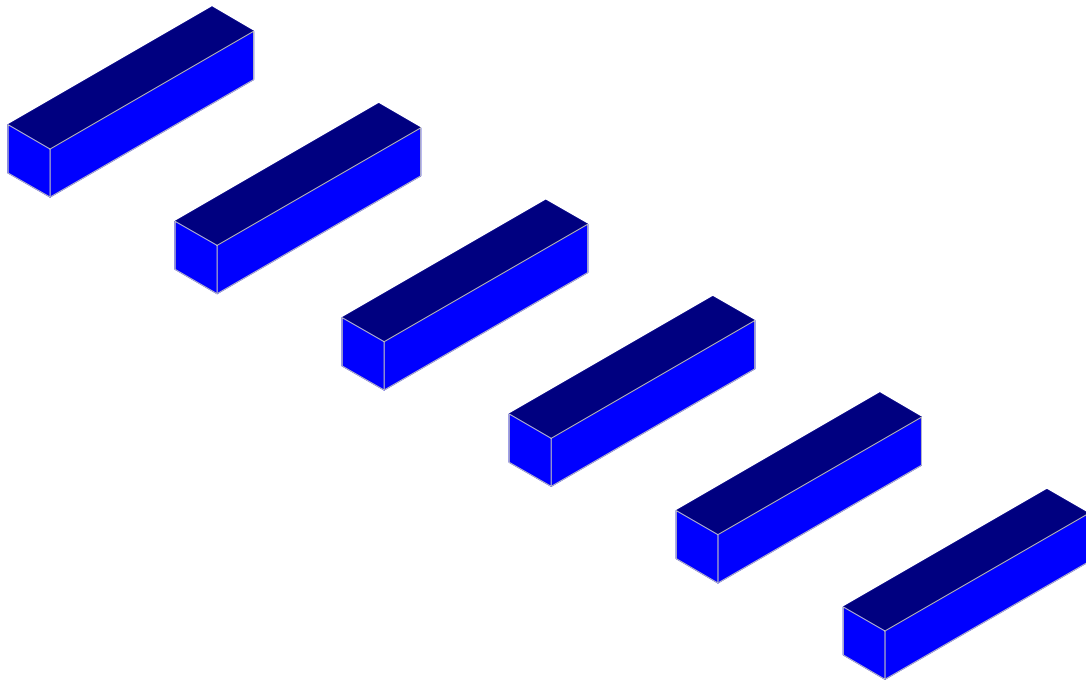
| Load (ASD) | Value (lbs) | Factor of Safety | Test Value (lbs) |
|------------|-------------|------------------|------------------|
| UPLIFT | 1560 | 1.5 | 2340 |
| LATERAL | 1130 | 2 | 2260 |



JOB NO.: U2716-113-191

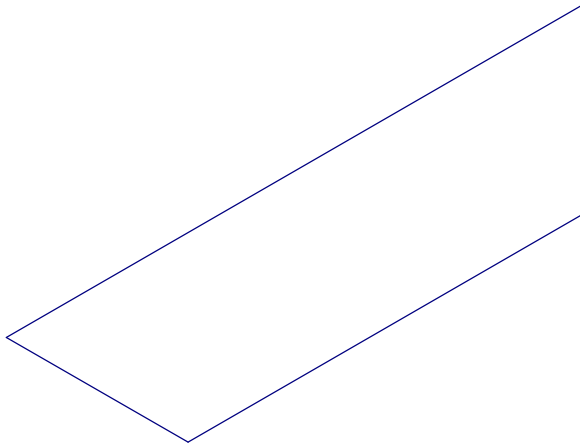
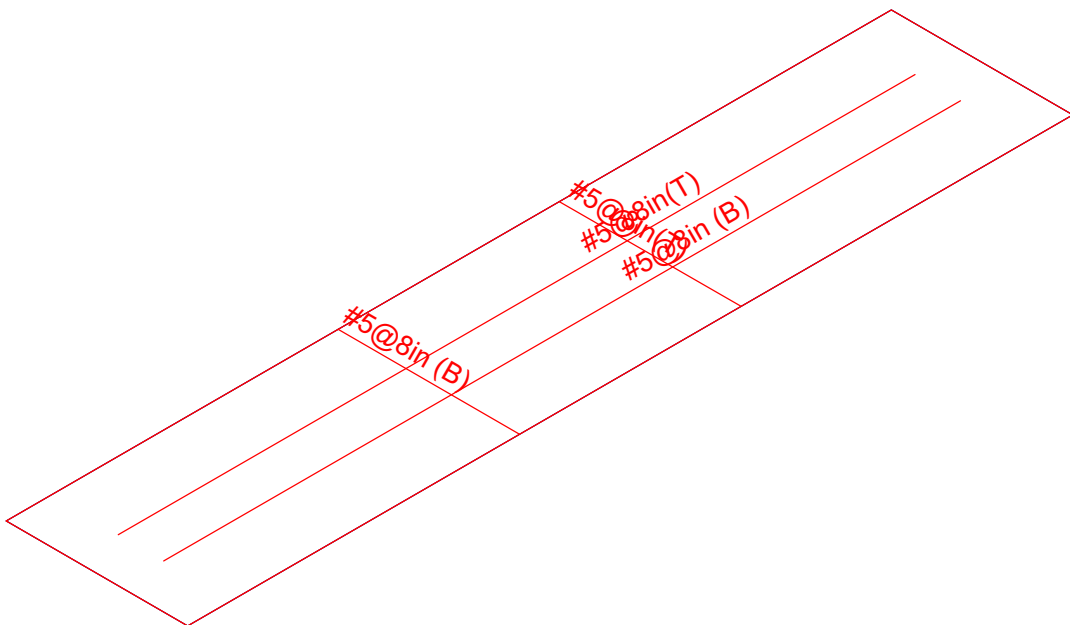
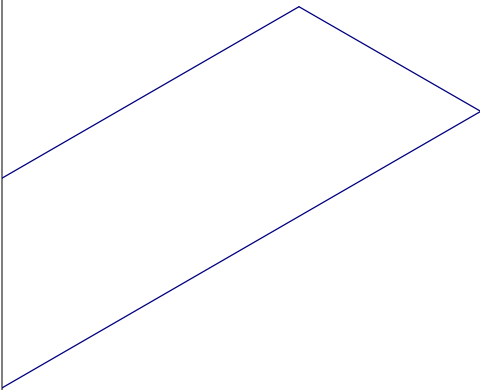
DESIGNED: STB

Foundation Option 4: Ballasted Block



Results for LC 1, 1.0 D

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 1 |
| STB | | July 31, 2019 at 4:14 PM |
| U2716.113.191 | | New England A4.r3d |



Results for LC 1, 1.0 D

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 2 |
| STB | | July 31, 2019 at 4:15 PM |
| U2716.113.191 | | New England A4.r3d |

Point Loads and Moments (Cat 1 : DL) (Continued)

| | Label | Direction | Magnitude[lb.lb-ft] |
|----|------------|-----------|---------------------|
| 10 | R3D_N110A | Y | 236.574 |
| 11 | R3D_N121 | Y | 237.266 |
| 12 | R3D_N122 | Y | 228.968 |
| 13 | R3D_N132_1 | Y | 239.047 |
| 14 | R3D_N134B | Y | 229.84 |
| 15 | R3D_N151 | X | 13.668 |
| 16 | R3D_N151 | Y | 251.294 |
| 17 | R3D_N152 | Y | 216.872 |

Point Loads and Moments (Cat 6 : RLL)

| | Label | Direction | Magnitude[lb.lb-ft] |
|----|------------|-----------|---------------------|
| 1 | R3D_N1_1 | X | -84.411 |
| 2 | R3D_N1_1 | Y | 1091.135 |
| 3 | R3D_N2 | X | -18.066 |
| 4 | R3D_N2 | Y | 1025.849 |
| 5 | R3D_N132 | X | 7.772 |
| 6 | R3D_N132 | Y | 1064.639 |
| 7 | R3D_N133 | X | 12.556 |
| 8 | R3D_N133 | Y | 1241.336 |
| 9 | R3D_N109 | X | -2.726 |
| 10 | R3D_N109 | Y | 1106.755 |
| 11 | R3D_N110A | X | 2.715 |
| 12 | R3D_N110A | Y | 1281.688 |
| 13 | R3D_N121 | X | 1.646 |
| 14 | R3D_N121 | Y | 1201.13 |
| 15 | R3D_N122 | X | 1.233 |
| 16 | R3D_N122 | Y | 1233.798 |
| 17 | R3D_N132_1 | Y | 1211.074 |
| 18 | R3D_N134B | X | 3.816 |
| 19 | R3D_N134B | Y | 1238.485 |
| 20 | R3D_N151 | X | 77.468 |
| 21 | R3D_N151 | Y | 1237.33 |
| 22 | R3D_N152 | X | -2.232 |
| 23 | R3D_N152 | Y | 1159.625 |

Point Loads and Moments (Cat 16 : OL1)

| | Label | Direction | Magnitude[lb.lb-ft] |
|----|-----------|-----------|---------------------|
| 1 | R3D_N1_1 | X | 93.004 |
| 2 | R3D_N1_1 | Y | -2199.727 |
| 3 | R3D_N1_1 | Z | 1247.929 |
| 4 | R3D_N2 | X | 17.333 |
| 5 | R3D_N2 | Y | 371.868 |
| 6 | R3D_N2 | Z | -63.936 |
| 7 | R3D_N132 | X | -9.185 |
| 8 | R3D_N132 | Y | -2412.491 |
| 9 | R3D_N132 | Z | 1540.373 |
| 10 | R3D_N133 | X | -7.915 |
| 11 | R3D_N133 | Y | 477.414 |
| 12 | R3D_N133 | Z | -72.997 |
| 13 | R3D_N109 | X | 4.194 |
| 14 | R3D_N109 | Y | -2484.289 |
| 15 | R3D_N109 | Z | 1583.425 |
| 16 | R3D_N110A | X | -7.539 |
| 17 | R3D_N110A | Y | 480.018 |
| 18 | R3D_N110A | Z | -72.352 |
| 19 | R3D_N121 | X | -2.84 |

Point Loads and Moments (Cat 21 : OL6) (Continued)

| | Label | Direction | Magnitude[lb.-ft] |
|----|------------|-----------|-------------------|
| 1 | R3D N1 1 | X | 30.771 |
| 2 | R3D N1 1 | Y | -929.448 |
| 3 | R3D N1 1 | Z | 535.089 |
| 4 | R3D N2 | X | 7.411 |
| 5 | R3D N2 | Y | 156.356 |
| 6 | R3D N2 | Z | -24.554 |
| 7 | R3D N132 | X | -3.366 |
| 8 | R3D N132 | Y | -387.036 |
| 9 | R3D N132 | Z | 255.284 |
| 10 | R3D N133 | X | -1.272 |
| 11 | R3D N133 | Y | 79.158 |
| 12 | R3D N133 | Z | -12.23 |
| 13 | R3D N109 | X | -1.513 |
| 14 | R3D N109 | Y | -762.573 |
| 15 | R3D N109 | Z | 488.834 |
| 16 | R3D N110A | X | -6.39 |
| 17 | R3D N110A | Y | 149.302 |
| 18 | R3D N110A | Z | -21.771 |
| 19 | R3D N121 | X | -2.431 |
| 20 | R3D N121 | Y | -467.088 |
| 21 | R3D N121 | Z | 280.235 |
| 22 | R3D N122 | Y | 84.667 |
| 23 | R3D N122 | Z | -15.411 |
| 24 | R3D N132 1 | X | -1.095 |
| 25 | R3D N132 1 | Y | -413.105 |
| 26 | R3D N132 1 | Z | 245.841 |
| 27 | R3D N134B | Y | 69.231 |
| 28 | R3D N134B | Z | -12.714 |
| 29 | R3D N151 | X | -22.294 |
| 30 | R3D N151 | Y | -424.007 |
| 31 | R3D N151 | Z | 235.359 |
| 32 | R3D N152 | X | 1.324 |
| 33 | R3D N152 | Y | 70.502 |
| 34 | R3D N152 | Z | -11.554 |

Slabs

| | Label | Thickness [in] | Material | Local Axis Angle [deg] | Analysis Offset [in] |
|---|-------|----------------|------------|------------------------|----------------------|
| 1 | S1 | 24 | Conc2500NW | 0 | 0 |
| 2 | S2 | 24 | Conc2500NW | 0 | 0 |
| 3 | S3 | 24 | Conc2500NW | 0 | 0 |
| 4 | S4 | 24 | Conc2500NW | 0 | 0 |
| 5 | S5 | 24 | Conc2500NW | 0 | 0 |
| 6 | S6 | 24 | Conc2500NW | 0 | 0 |

Load Combinations

| Label | Solve | Service A | SF | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | Cat..Fa... | C... | F... | C... | F... |
|-------|---------------|-----------|-----|------------|------------|------------|------------|------------|------------|------------|------------|------------|------|------|------|------|
| 1 | 1.0 D | Yes | Yes | 1.5 | DL | 1 | | | | | | | | | | |
| 2 | 1.0 D + 1.... | Yes | Yes | 1.5 | DL | 1 | RLL | 1 | | | | | | | | |
| 3 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL1 | .6 | | | | | | |
| 4 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL2 | .6 | | | | | | |
| 5 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL3 | .6 | | | | | | |
| 6 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL4 | .6 | | | | | | |
| 7 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL5 | .6 | | | | | | |
| 8 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | | OL6 | .6 | | | | | | |
| 9 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | .75 | OL1 | .45 | | | | | | |
| 10 | 1.0 D + 0.... | Yes | Yes | 1.5 | DL | 1 | RLL | .75 | OL2 | .45 | | | | | | |

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 |
|-----|----|------|------------|-----------|-----------|-----------|-----------|--------|-------|
| 105 | 18 | S3 | 0 | 1.108 | 1484.391 | 891.483 | 1484.391 | 9.999+ | 1.665 |
| 106 | 18 | S4 | 0 | 4.143 | 1486.958 | 886.647 | 1486.958 | 9.999+ | 1.677 |
| 107 | 18 | S5 | 0 | 12.05 | 1464.927 | 901.185 | 1464.927 | 9.999+ | 1.626 |
| 108 | 18 | S6 | 0 | 42.334 | 1475.806 | 834.058 | 1475.806 | 9.999+ | 1.769 |
| 109 | 19 | S1 | 0 | 34.809 | 1234.13 | 309.108 | 1234.13 | 9.999+ | 3.993 |
| 110 | 19 | S2 | 0 | 4.04 | 1229.14 | 322.683 | 1229.14 | 9.999+ | 3.809 |
| 111 | 19 | S3 | 0 | 3.328 | 1175.032 | 170.493 | 1175.032 | 9.999+ | 6.892 |
| 112 | 19 | S4 | 0 | .674 | 1163.522 | 137.398 | 1163.522 | 9.999+ | 8.468 |
| 113 | 19 | S5 | 0 | 4.989 | 1153.319 | 146.303 | 1153.319 | 9.999+ | 7.883 |
| 114 | 19 | S6 | 0 | 21.271 | 1166.016 | 134.217 | 1166.016 | 9.999+ | 8.688 |
| 115 | 20 | S1 | 0 | 12.225 | 954.369 | 306.321 | 954.369 | 9.999+ | 3.116 |
| 116 | 20 | S2 | 0 | 4.742 | 990.165 | 280.237 | 990.165 | 9.999+ | 3.533 |
| 117 | 20 | S3 | 0 | 1.459 | 1032.988 | 158.894 | 1032.988 | 9.999+ | 6.501 |
| 118 | 20 | S4 | 0 | .657 | 1040.404 | 139.876 | 1040.404 | 9.999+ | 7.438 |
| 119 | 20 | S5 | 0 | .787 | 1042.576 | 145.832 | 1042.576 | 9.999+ | 7.149 |
| 120 | 20 | S6 | 0 | 4.382 | 1038.541 | 134.283 | 1038.541 | 9.999+ | 7.734 |

Envelope Slab Soil Pressures

| | Label | UC | LC | Soil Pressure[psf] | Allowable Bearing[psf] | Point |
|---|-------|------|----|--------------------|------------------------|-------|
| 1 | S1 | .394 | 11 | 591.353 | 1500 | N1 |
| 2 | S2 | .404 | 11 | 606.659 | 1500 | N18 |
| 3 | S3 | .418 | 11 | 627.454 | 1500 | N22 |
| 4 | S4 | .417 | 11 | 625.205 | 1500 | N27 |
| 5 | S5 | .398 | 11 | 596.671 | 1500 | N31 |
| 6 | S6 | .421 | 11 | 631.159 | 1500 | N35 |



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| 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): 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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| 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]: 2600

V_{uax} [lb]: 175

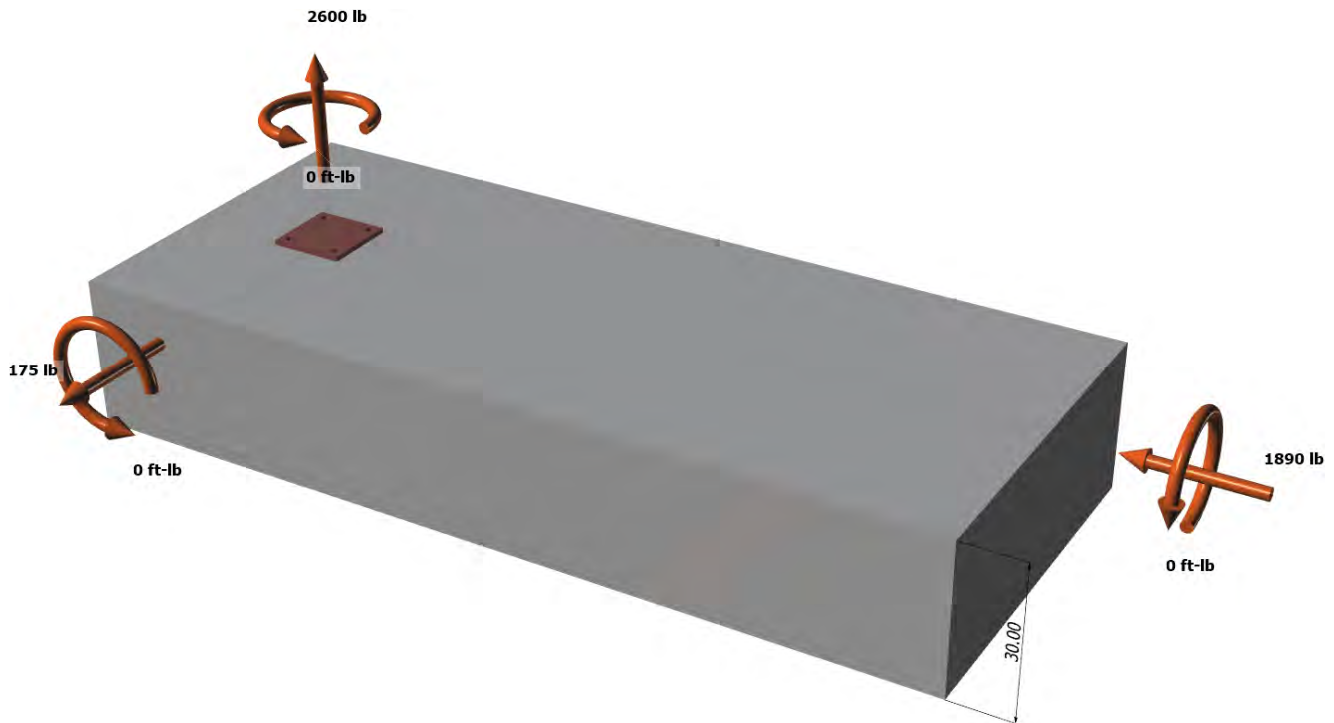
V_{uay} [lb]: -1890

M_{ux} [ft-lb]: 0

M_{uy} [ft-lb]: 0

M_{uz} [ft-lb]: 0

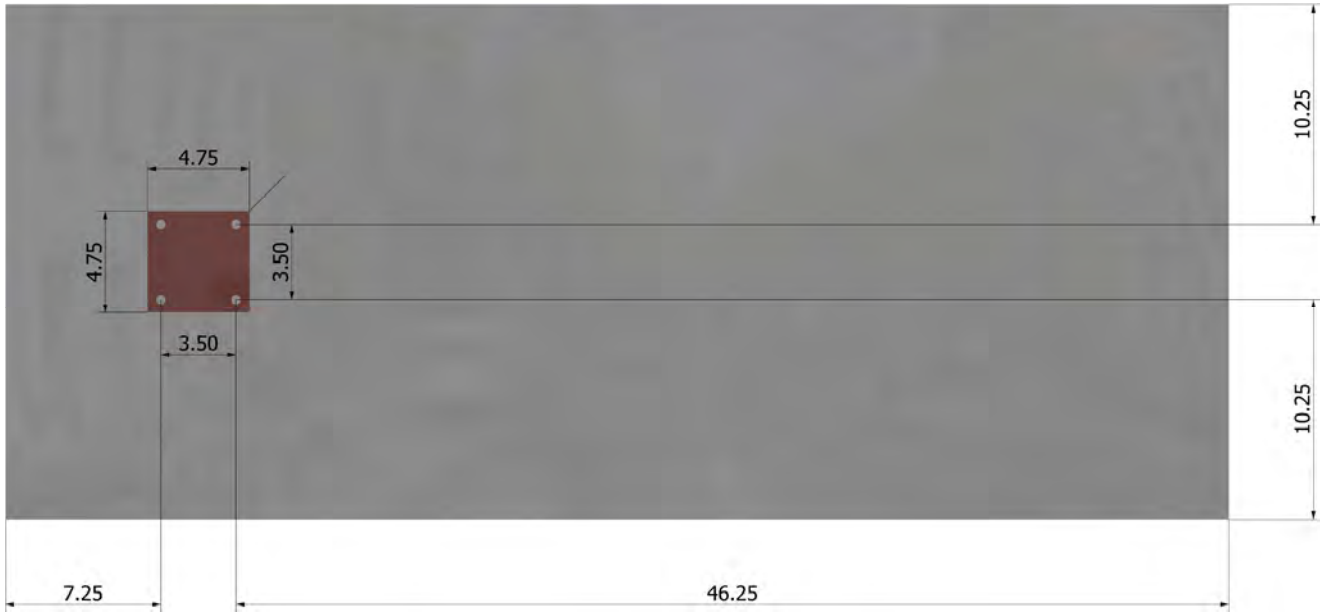
<Figure 1>





| | | | |
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<Figure 2>





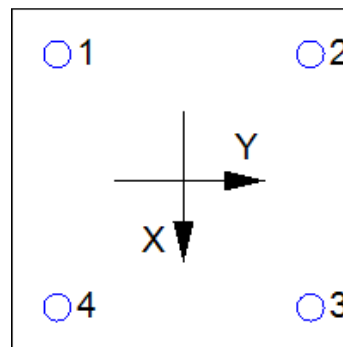
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| E-mail: | | | |

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 | 650.0 | 43.7 | -472.5 | 474.5 |
| 2 | 650.0 | 43.7 | -472.5 | 474.5 |
| 3 | 650.0 | 43.7 | -472.5 | 474.5 |
| 4 | 650.0 | 43.7 | -472.5 | 474.5 |
| Sum | 2600.0 | 175.0 | -1890.0 | 1898.1 |

Maximum concrete compression strain (%): 0.00
 Maximum concrete compression stress (psi): 0
 Resultant tension force (lb): 2600
 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 | 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 _{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) |
|------------------------------------|-------------------------------------|-------------------------|-------------------|-------------------|------------------|-------------------|---------------------|------|------------------------|
| 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 _{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 | 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 _{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 | 6343 | 0.55 | 6176 |



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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)

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

| k_{cp} | A_{Na} (in 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 | 6343 | 11230 |

| 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 |
|-----------------------------|------------------------------|---------------|---------------|--------------|---------------|------------|---------------|--------|
| 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.



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ϕV_{cpq} (lb)
15722

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

| Tension | Factored Load, N_{ua} (lb) | Design Strength, ϕN_n (lb) | Ratio | Status | |
|------------------------------------|------------------------------|----------------------------------|----------------|-----------------------|--------|
| Steel | 650 | 3394 | 0.19 | Pass | |
| Concrete breakout | 2600 | 7374 | 0.35 | Pass | |
| Adhesive | 2600 | 6176 | 0.42 | Pass (Governs) | |
| Shear | Factored Load, V_{ua} (lb) | Design Strength, ϕV_n (lb) | Ratio | Status | |
| Steel | 475 | 1765 | 0.27 | Pass | |
| T Concrete breakout x+ | 175 | 7103 | 0.02 | Pass | |
| T Concrete breakout y- | 1890 | 5313 | 0.36 | Pass | |
| Concrete breakout y- | 87 | 9797 | 0.01 | Pass | |
| Concrete breakout x- | 945 | 12680 | 0.07 | Pass | |
| Concrete breakout, combined | - | - | 0.36 | Pass (Governs) | |
| Pryout | 1898 | 15722 | 0.12 | Pass | |
| Interaction check | $N_{ua}/\phi N_n$ | $V_{ua}/\phi V_n$ | Combined Ratio | Permissible | Status |
| Sec. 17.6..1 | 0.42 | 0.00 | 42.1% | 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.

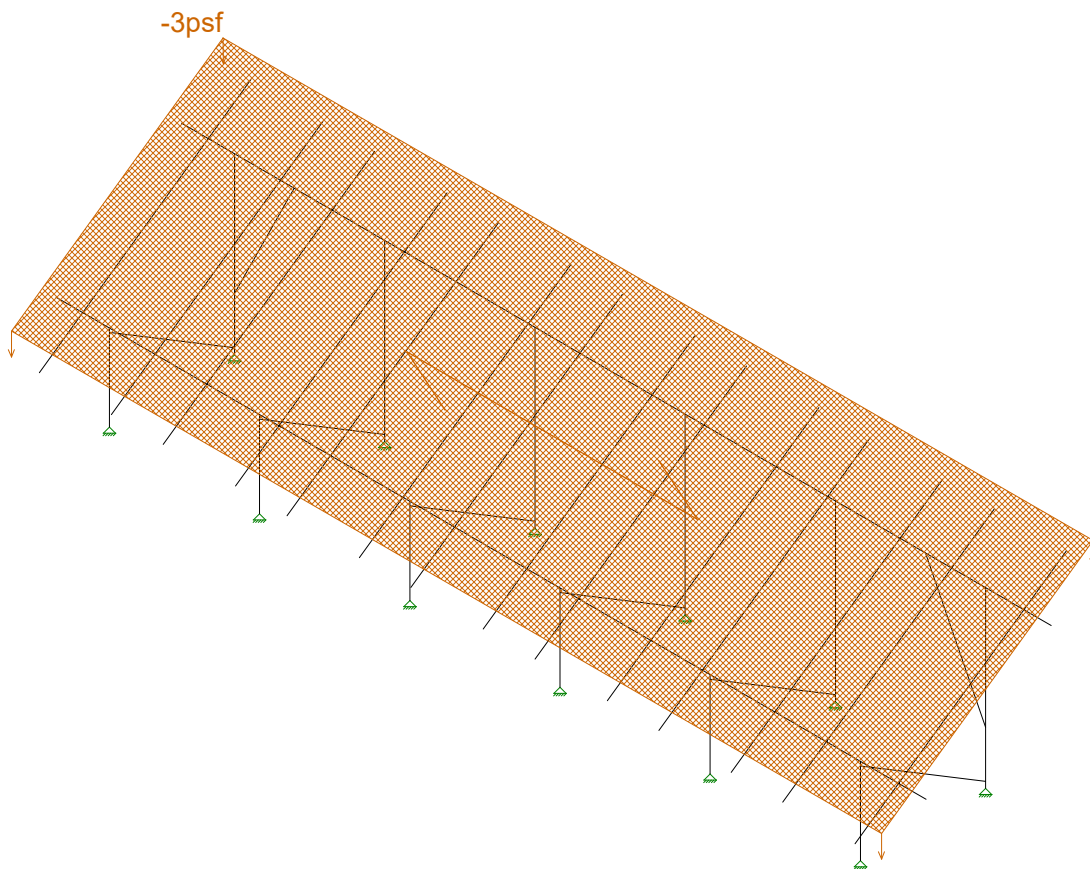


JOB NO.: U2716-070-181

DESIGNED: STB

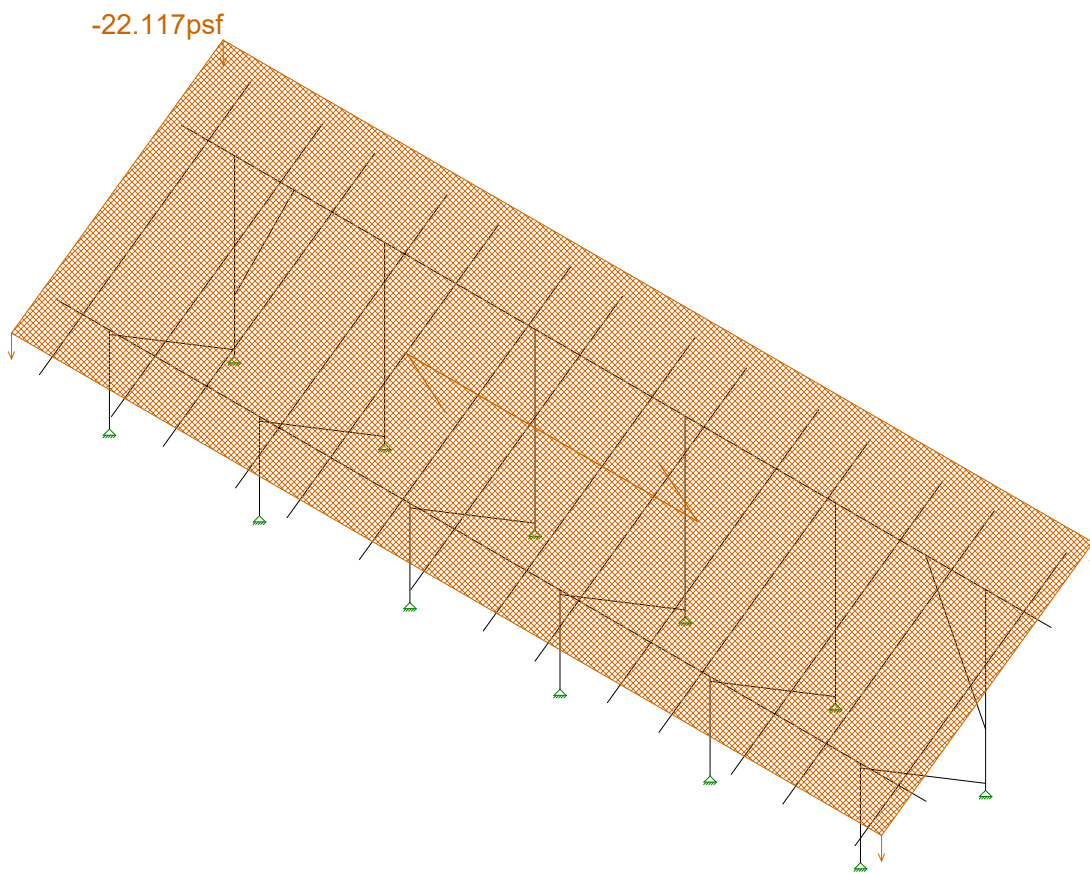
PROJECT: Ground Mount Package for Ontario Canada

Framing Analysis



Loads: BLC 2, Solar Panel Weight

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 7 |
| STB | | July 31, 2019 at 4:27 PM |
| U2716.113.191 | | New England A4.r3d |



Loads: BLC 3, Roof Live/Snow

Vector Structural Engineeri..

STB

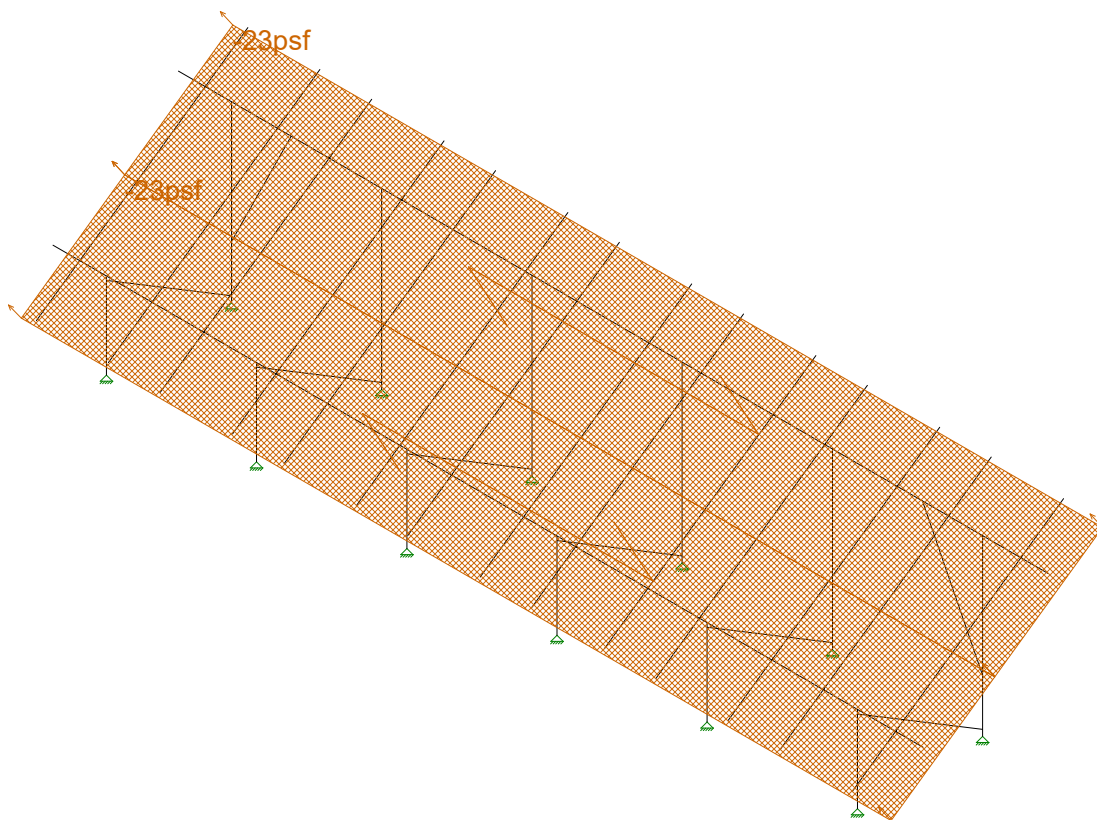
U2716.113.191

Ground Mount

SK - 8

July 31, 2019 at 4:27 PM

New England A4.r3d



Loads: BLC 4, Wind A 0 deg

Vector Structural Engineeri..

STB

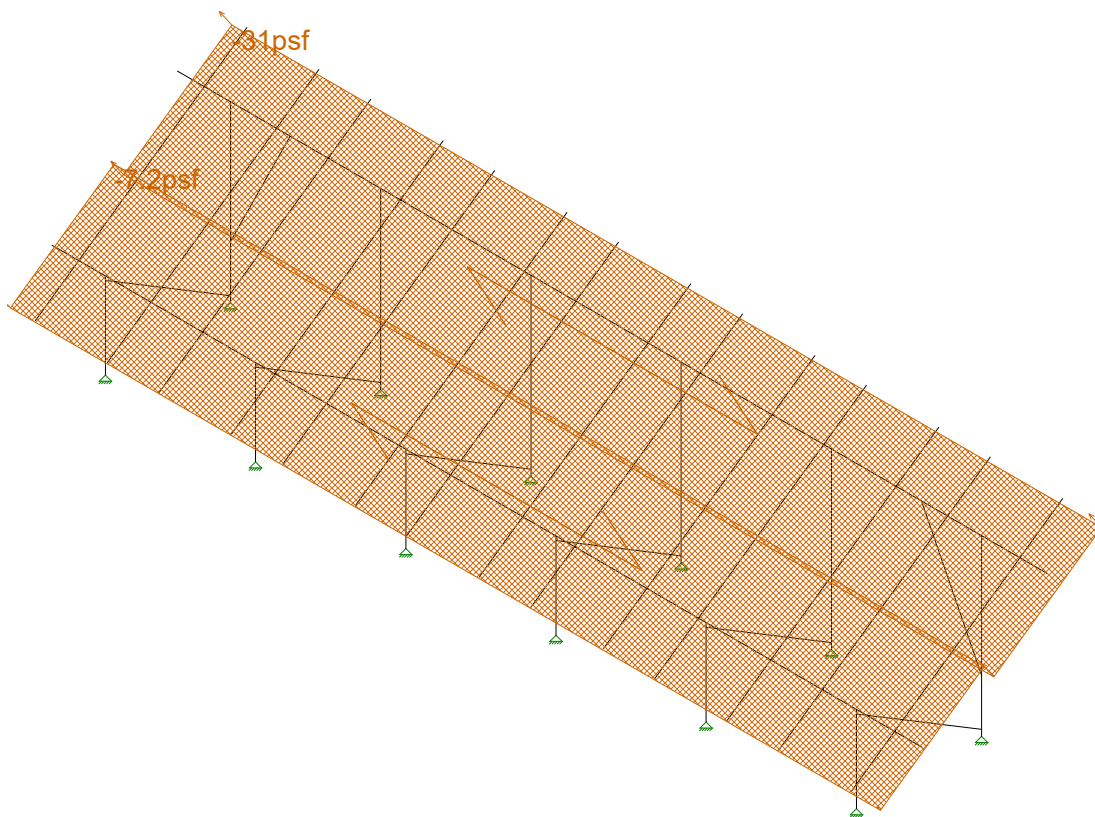
U2716.113.191

Ground Mount

SK - 9

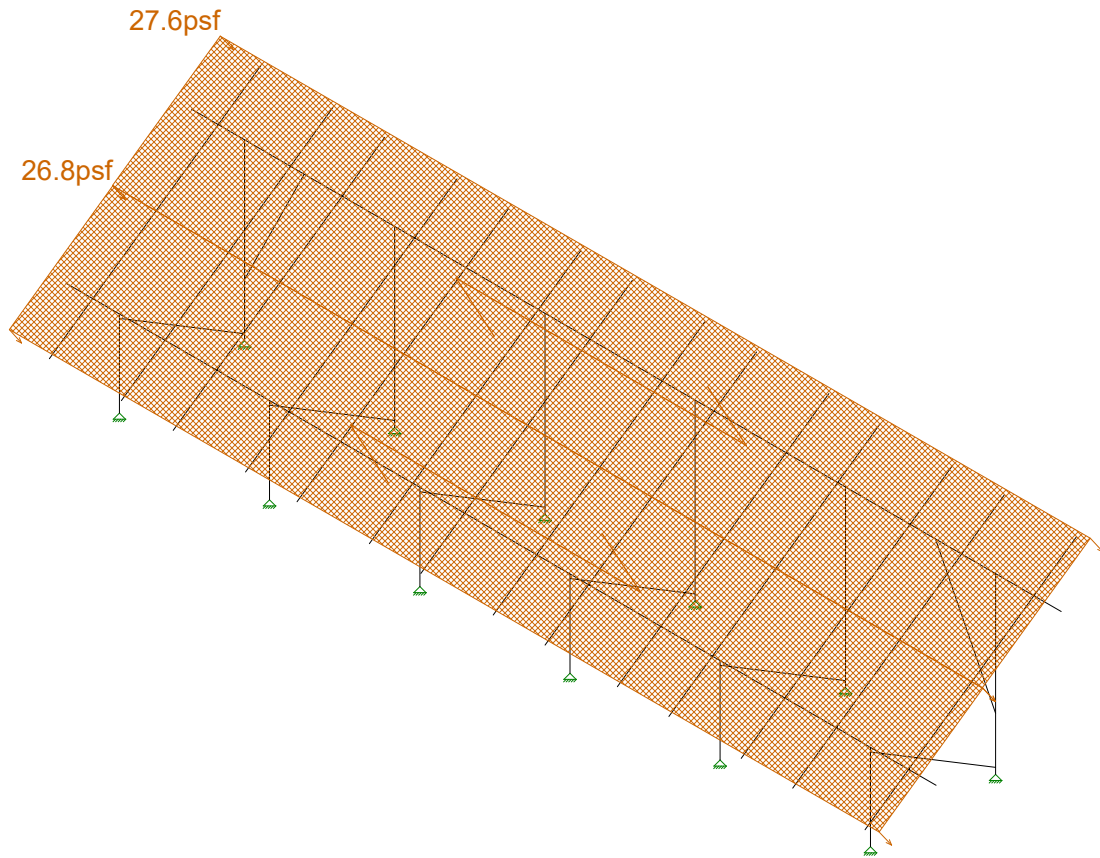
July 31, 2019 at 4:27 PM

New England A4.r3d



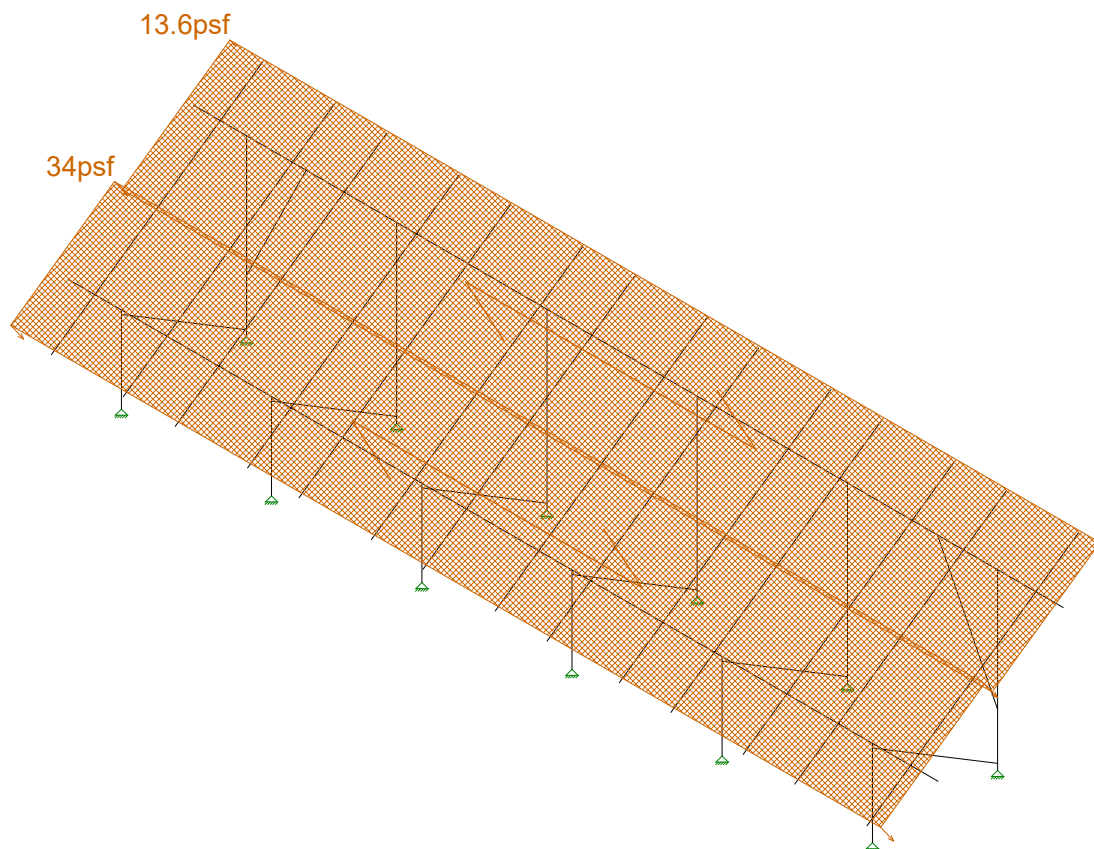
Loads: BLC 5, Wind B 0 deg

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 10 |
| STB | | July 31, 2019 at 4:27 PM |
| U2716.113.191 | | New England A4.r3d |



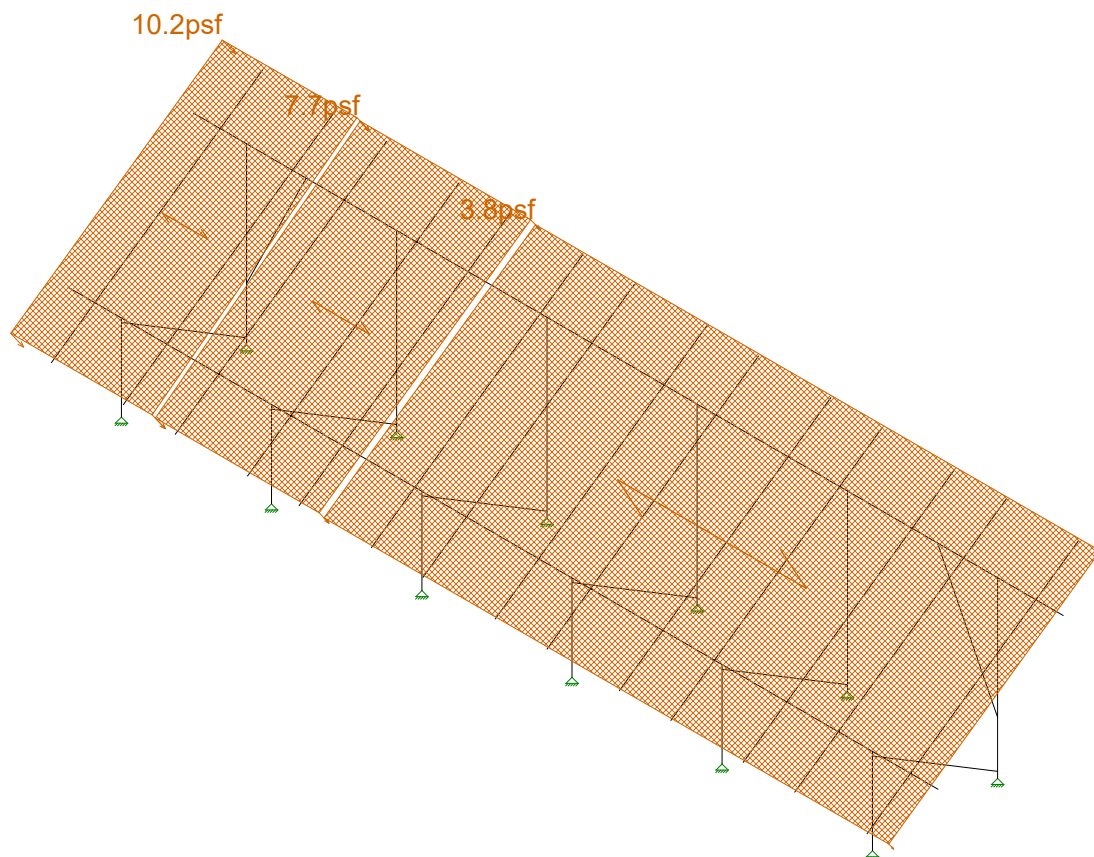
Loads: BLC 6, Wind A 180 deg

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 11 |
| STB | | July 31, 2019 at 4:27 PM |
| U2716.113.191 | | New England A4.r3d |



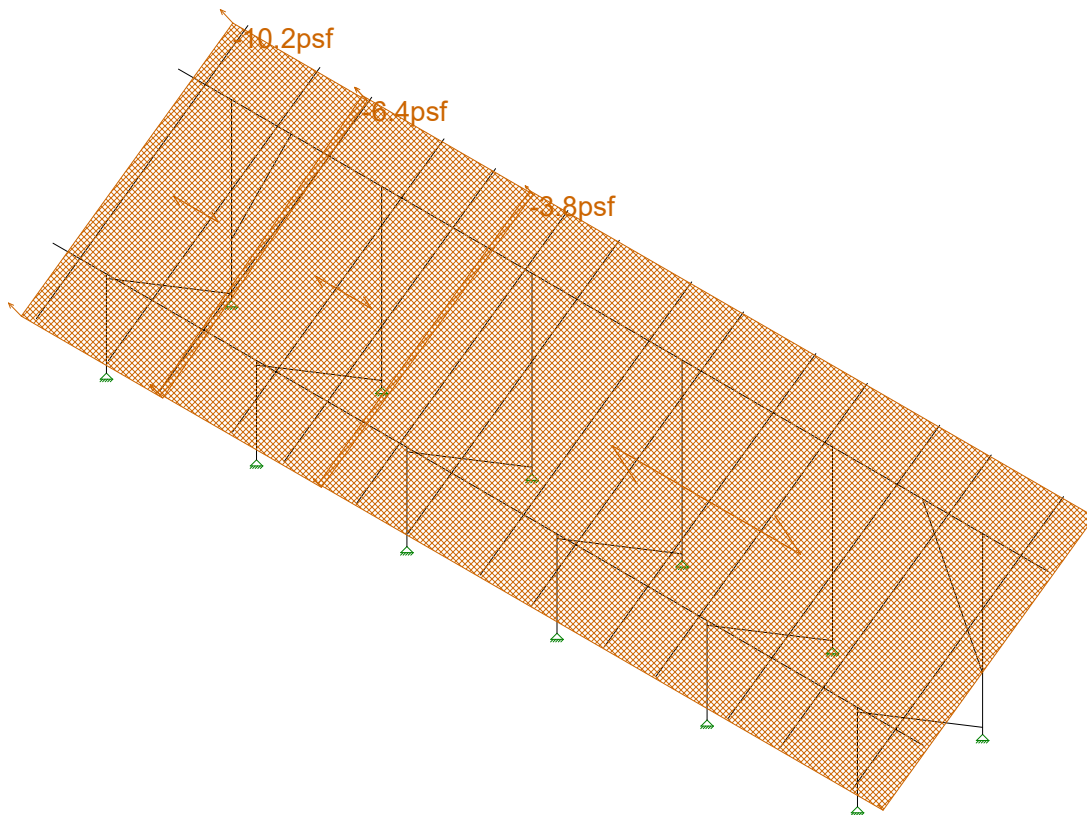
Loads: BLC 7, Wind B 180 deg

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 12 |
| STB | | July 31, 2019 at 4:27 PM |
| U2716.113.191 | | New England A4.r3d |



Loads: BLC 8, Wind A 90

| | | |
|-------------------------------|--------------|--------------------------|
| Vector Structural Engineeri.. | Ground Mount | SK - 13 |
| STB | | July 31, 2019 at 4:27 PM |
| U2716.113.191 | | New England A4.r3d |

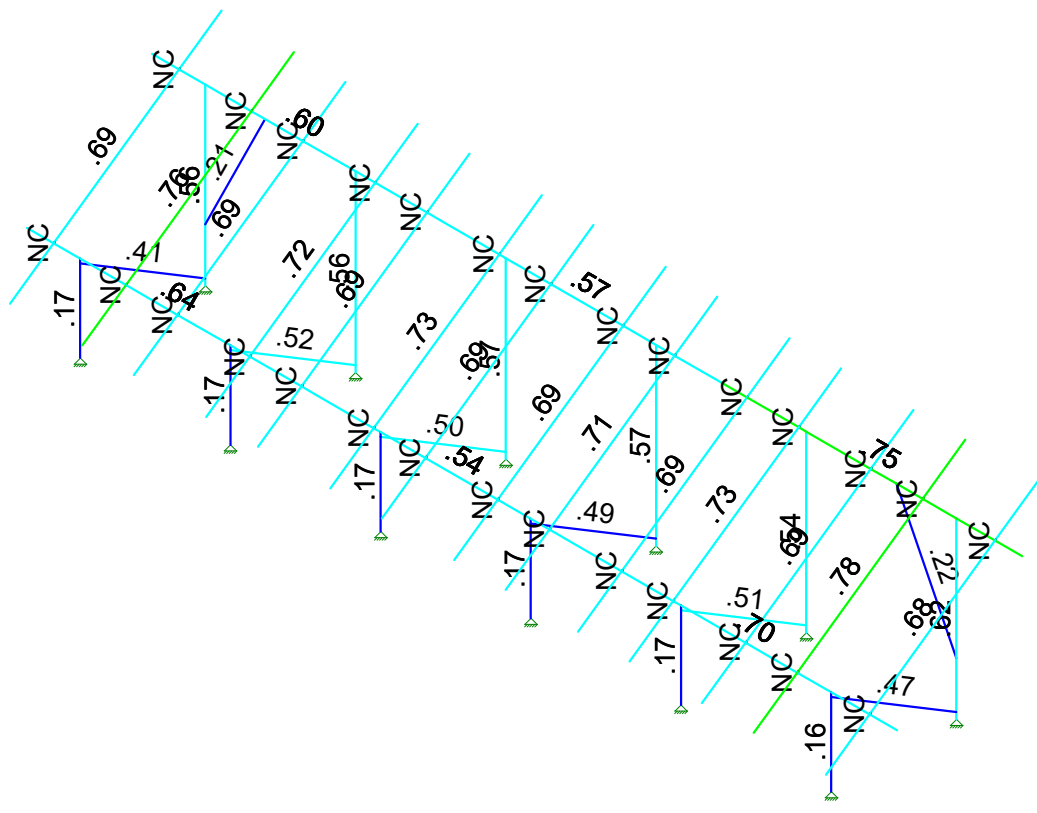


Loads: BLC 9, Wind B 90

| | | |
|--------------------------------|--------------|--------------------------|
| Vector Structural Engineeri... | Ground Mount | SK - 14 |
| STB | | July 31, 2019 at 4:28 PM |
| U2716.113.191 | | New England A4.r3d |



| Code | Check |
|--------|---------|
| NC | No Calc |
| Red | > 1.0 |
| Orange | .60-1.0 |
| Yellow | .75-.90 |
| Green | .50-.75 |
| Blue | 0-.50 |



Member Code Checks Displayed (Enveloped)
Envelope Only Solution

| | | |
|--------------------------------|--------------|--------------------------|
| Vector Structural Engineeri... | Ground Mount | SK - 3 |
| STB | | July 31, 2019 at 4:26 PM |
| U2716.113.191 | | New England A4.r3d |

(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 | HBrace | SquareTube | A572 Gr.50 | Typical | .47 | .158 | .158 | .236 |

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 | -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 | -23 |
| 2 | N198 | N201 | N199 | N196 | Perp | A-B | -23 |

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 | -31 |
| 2 | N198 | N201 | N199 | N196 | Perp | A-B | -7.2 |

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 | 27.6 |
| 2 | N198 | N201 | N199 | N196 | Perp | A-B | 26.8 |

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 | 13.6 |
| 2 | N198 | N201 | N199 | N196 | Perp | A-B | 34 |

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 | 10.2 |
| 2 | N203 | N209 | N208 | N202 | Perp | A-B | 7.7 |
| 3 | N209 | N200 | N199 | N208 | Perp | A-B | 3.8 |

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 | -10.2 |
| 2 | N203 | N209 | N208 | N202 | Perp | A-B | -6.4 |
| 3 | N209 | N200 | N199 | N208 | Perp | A-B | -3.8 |

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 |

Basic Load Cases (Continued)

| | BLC Description | Category | X Gravity | Y Gravity | Z Gravity | Joint | Point | Distributed | Area(M... Surface... |
|----|--------------------------|----------|-----------|-----------|-----------|-------|-------|-------------|----------------------|
| 3 | Roof Live/Snow | RLL | | | | | | | 1 |
| 4 | Wind A 0 deg | OL1 | | | | | | | 2 |
| 5 | Wind B 0 deg | OL2 | | | | | | | 2 |
| 6 | Wind A 180 deg | OL3 | | | | | | | 2 |
| 7 | Wind B 180 deg | OL4 | | | | | | | 2 |
| 8 | Wind A 90 | OL5 | | | | | | | 3 |
| 9 | Wind B 90 | OL6 | | | | | | | 3 |
| 10 | BLC 2 Transient Area ... | None | | | | | | 34 | |
| 11 | BLC 3 Transient Area ... | None | | | | | | 34 | |
| 12 | BLC 4 Transient Area ... | None | | | | | | 120 | |
| 13 | BLC 5 Transient Area ... | None | | | | | | 120 | |
| 14 | BLC 6 Transient Area ... | None | | | | | | 120 | |
| 15 | BLC 7 Transient Area ... | None | | | | | | 120 | |
| 16 | BLC 8 Transient Area ... | None | | | | | | 98 | |
| 17 | BLC 9 Transient Area ... | None | | | | | | 98 | |

Load Combinations

| | Description | S... | PD... | SRSS | BLC Fa... | BLC Fa... | BLC Fa... | B... | B... | B... | B... | B... | B... | B... | B... | B... | B... | B... | B... | B... | B... |
|----|------------------------|------|-------|------|-----------|-----------|-----------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1 | 1.0 D | Yes | Y | | DL 1 | | | | | | | | | | | | | | | | |
| 2 | 1.0 D + 1.0 S | Yes | Y | | DL 1 | RLL 1 | | | | | | | | | | | | | | | |
| 3 | 1.0 D + 0.6 W1 | Yes | Y | | DL 1 | RLL | OL1 | .6 | | | | | | | | | | | | | |
| 4 | 1.0 D + 0.6 W2 | Yes | Y | | DL 1 | RLL | OL2 | .6 | | | | | | | | | | | | | |
| 5 | 1.0 D + 0.6 W3 | Yes | Y | | DL 1 | RLL | OL3 | .6 | | | | | | | | | | | | | |
| 6 | 1.0 D + 0.6 W4 | Yes | Y | | DL 1 | RLL | OL4 | .6 | | | | | | | | | | | | | |
| 7 | 1.0 D + 0.6 W5 | Yes | Y | | DL 1 | RLL | OL5 | .6 | | | | | | | | | | | | | |
| 8 | 1.0 D + 0.6 W6 | Yes | Y | | DL 1 | RLL | OL6 | .6 | | | | | | | | | | | | | |
| 9 | 1.0 D + 0.45 W1 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL1 | .45 | | | | | | | | | | | | |
| 10 | 1.0 D + 0.45 W2 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL2 | .45 | | | | | | | | | | | | |
| 11 | 1.0 D + 0.45 W3 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL3 | .45 | | | | | | | | | | | | |
| 12 | 1.0 D + 0.45 W4 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL4 | .45 | | | | | | | | | | | | |
| 13 | 1.0 D + 0.45 W5 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL5 | .45 | | | | | | | | | | | | |
| 14 | 1.0 D + 0.45 W6 + 0... | Yes | Y | | DL 1 | RLL | .75 | OL6 | .45 | | | | | | | | | | | | |
| 15 | 0.6 D + 0.6 W1 | Yes | Y | | DL .6 | RLL | OL1 | .6 | | | | | | | | | | | | | |
| 16 | 0.6 D + 0.6 W2 | Yes | Y | | DL .6 | RLL | OL2 | .6 | | | | | | | | | | | | | |
| 17 | 0.6 D + 0.6 W3 | Yes | Y | | DL .6 | RLL | OL3 | .6 | | | | | | | | | | | | | |
| 18 | 0.6 D + 0.6 W4 | Yes | Y | | DL .6 | RLL | OL4 | .6 | | | | | | | | | | | | | |
| 19 | 0.6 D + 0.6 W5 | Yes | Y | | DL .6 | RLL | OL5 | .6 | | | | | | | | | | | | | |
| 20 | 0.6 D + 0.6 W6 | Yes | Y | | DL .6 | RLL | OL6 | .6 | | | | | | | | | | | | | |

Envelope Joint Reactions

| | Joint | | X [lb] | LC | Y [lb] | LC | Z [lb] | LC | MX [lb-ft] | LC | MY [lb-ft] | LC | MZ [lb-ft] | LC |
|----|-------|-----|---------|----|-----------|----|-----------|----|------------|----|------------|----|------------|----|
| 1 | N2 | max | 29.151 | 12 | 1351.371 | 10 | 38.932 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 2 | | min | -8.837 | 15 | -165.026 | 17 | -45.444 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 3 | N1 | max | 117.307 | 11 | 2208.692 | 11 | 885.972 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 4 | | min | -64.223 | 16 | -1334.791 | 16 | -749.321 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 5 | N132 | max | 6.922 | 16 | 2316.298 | 11 | 1094.17 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 6 | | min | -8.82 | 11 | -1457.719 | 16 | -924.818 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 7 | N133 | max | 3.146 | 15 | 1651.394 | 10 | 44.571 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 8 | | min | -17.352 | 12 | -218.567 | 17 | -52.131 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 9 | N109 | max | 6.874 | 11 | 2414.631 | 11 | 1124.1... | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 10 | | min | -2.409 | 16 | -1493.515 | 16 | -950.76 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 11 | N110A | max | 3.757 | 15 | 1695.436 | 10 | 44.261 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 12 | | min | -8.661 | 11 | -217.167 | 17 | -51.605 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 13 | N121 | max | 2.648 | 16 | 2505.939 | 11 | 1084.8... | 5 | 0 | 1 | 0 | 1 | 0 | 1 |



Company : Vector Structural Engineering
 Designer : STB
 Job Number : U2716.113.191
 Model Name : Ground Mount

July 31, 2019
 4:28 PM
 Checked By: _____

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 | -1.874 | 7 | -1557.321 | 16 | -917.976 | 3 | 0 | 1 | 0 | 1 | 0 | 1 | |
| 15 | N122 | max | .264 | 20 | 1640.407 | 10 | 44.862 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 16 | | min | -2.532 | 13 | -215.095 | 17 | -52.268 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 17 | N133B | max | 3.181 | 11 | 2504.714 | 11 | 1068.9 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 18 | | min | -.532 | 19 | -1532.472 | 16 | -904.912 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 19 | N134B | max | 2.781 | 15 | 1622.767 | 10 | 44.436 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 20 | | min | -8.118 | 11 | -185.973 | 17 | -51.897 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 21 | N151 | max | 59.234 | 16 | 2521.341 | 11 | 1011.0... | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 22 | | min | -111.054 | 11 | -1510.472 | 16 | -855.447 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 23 | N152 | max | 3.106 | 11 | 1530.761 | 10 | 42.556 | 3 | 0 | 1 | 0 | 1 | 0 | 1 |
| 24 | | min | -5.101 | 16 | -190.824 | 17 | -49.408 | 5 | 0 | 1 | 0 | 1 | 0 | 1 |
| 25 | Totals: | max | .093 | 11 | 19687.82 | 11 | 5966.3... | 17 | | | | | | |
| 26 | | min | -.044 | 16 | -5566.468 | 15 | -5043.... | 3 | | | | | | |

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] | Mnyy/om | ... | Mnzz/om | Cb | Eqn |
|--------|-------|----------------|---------|---------|-------|------|---------|-----|-----------|-----------|----------|----------|---------|---------|-------|---------|----|-----|
| 1 | M5 | Pipe 2.0 A2... | .169 | 52.645 | 12 | .132 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 2 | M6 | Pipe 2.0 A2... | .559 | 33.608 | 11 | .134 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 3 | M13 | Pipe 2.5 A2... | .643 | 130.... | 12 | .127 | 130.... | 12 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 1... | H1-1b | | | | |
| 4 | M14 | Pipe 2.5 A2... | .602 | 130.... | 11 | .143 | 130.... | 11 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 2... | H1-1b | | | | |
| 5 | M15 | 1.5x1.5x0.083 | .412 | 48.694 | 5 | .041 | 93.493 | y | 11 | 2716.455 | 14085.15 | 624.421 | 624.421 | 1... | H1-1a | | | |
| 6 | M80 | Pipe 2.0 A2... | .170 | 52.645 | 11 | .158 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 7 | M81 | Pipe 2.0 A2... | .542 | 3.477 | 11 | .164 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 8 | M82 | 1.5x1.5x0.083 | .505 | 48.694 | 5 | .017 | 93.493 | y | 11 | 2716.455 | 14085.15 | 624.421 | 624.421 | 1... | H1-1a | | | |
| 9 | M50 | Pipe 2.0 A2... | .167 | 52.073 | 17 | .162 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 10 | M51 | Pipe 2.0 A2... | .563 | 3.477 | 11 | .169 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 11 | M52 | 1.5x1.5x0.083 | .519 | 48.694 | 5 | .007 | 0 | y | 14 | 2716.455 | 14085.15 | 624.421 | 624.421 | 1... | H1-1a | | | |
| 12 | M56A | Pipe 2.0 A2... | .168 | 52.073 | 17 | .155 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 13 | M57A | Pipe 2.0 A2... | .572 | 3.477 | 11 | .163 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 14 | M58A | 1.5x1.5x0.083 | .501 | 48.694 | 5 | .006 | 0 | y | 13 | 2716.455 | 14085.15 | 624.421 | 624.421 | 1... | H1-1a | | | |
| 15 | M68 | Pipe 2.0 A2... | .167 | 52.073 | 17 | .154 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 16 | M69 | Pipe 2.0 A2... | .570 | 3.477 | 11 | .161 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 17 | M70 | 1.5x1.5x0.083 | .494 | 48.694 | 5 | .006 | 93.493 | y | 11 | 2716.455 | 14085.15 | 624.421 | 624.421 | 1... | H1-1a | | | |
| 18 | M68A | Pipe 2.5 A2... | .538 | 136.... | 12 | .129 | 41.25 | 12 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 1... | H1-1b | | | | |
| 19 | M69A | Pipe 2.5 A2... | .702 | 150 | 12 | .146 | 54 | 12 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 1... | H1-1b | | | | |
| 20 | M70A | Pipe 2.5 A2... | .571 | 138.75 | 11 | .161 | 41.25 | 11 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 1... | H1-1b | | | | |
| 21 | M71 | Pipe 2.5 A2... | .750 | 150 | 11 | .163 | 54 | 11 | 11641.036 | 28358.413 | 2081.747 | 2081.747 | 2... | H1-1b | | | | |
| 22 | M73 | Pipe 2.0 A2... | .159 | 52.073 | 17 | .148 | 52.645 | 5 | 16486.797 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1b | | | | |
| 23 | M74 | Pipe 2.0 A2... | .623 | 33.608 | 11 | .154 | 0 | 5 | 6062.107 | 23232.186 | 1397.505 | 1397.505 | 1... | H1-1a | | | | |
| 24 | M75 | 1.5x1.5x0.083 | .469 | 48.694 | 5 | .031 | 0 | 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... | .209 | 52.977 | 11 | .013 | 0 | z | 5 | 2260.001 | 19411.... | 770.742 | 927.083 | 6090.199 | 4101.563 | 1... | H.1-1 |
| 2 | M16 | HR250_A... | .689 | 84.234 | 11 | .079 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 3 | M35 | HR250_A... | .756 | 82.515 | 11 | .089 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 4 | M38 | HR250_A... | .690 | 84.234 | 11 | .082 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 5 | M41 | HR250_A... | .723 | 84.234 | 11 | .077 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 6 | M44 | HR250_A... | .691 | 82.515 | 11 | .078 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 7 | M47 | HR250_A... | .728 | 84.234 | 11 | .078 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 8 | M50A | HR250_A... | .688 | 34.381 | 12 | .079 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 9 | M53 | HR250_A... | .692 | 84.234 | 11 | .079 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 10 | M56 | HR250_A... | .714 | 84.234 | 11 | .077 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |
| 11 | M59 | HR250_A... | .688 | 34.381 | 12 | .078 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 | H.1-1 |



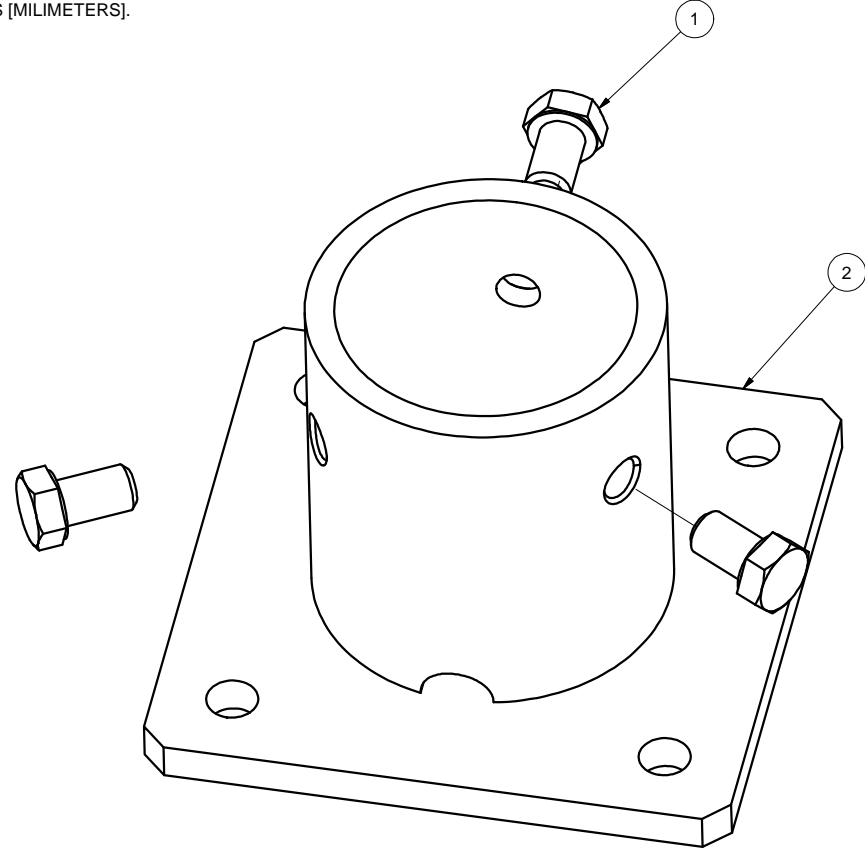
Company : Vector Structural Engineering
 Designer : STB
 Job Number : U2716.113.191
 Model Name : Ground Mount

July 31, 2019
 4:28 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.. | .726 | 84.234 | 11 | .079 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 H.1-1 |
| 13 | M65 | HR250_A.. | .688 | 34.381 | 12 | .080 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 H.1-1 |
| 14 | M68B | HR250_A.. | .780 | 80.796 | 11 | .090 | 36.1 | y | 12 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 H.1-1 |
| 15 | M71A | HR250_A.. | .676 | 84.234 | 11 | .077 | 36.1 | y | 11 | 2598.605 | 14089.... | 309.506 | 624.233 | 5108.727 | 1672.364 | 1 H.1-1 |
| 16 | M75B | RT1.5x2x... | .224 | 53.045 | 11 | .024 | 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 [MILLIMETERS].



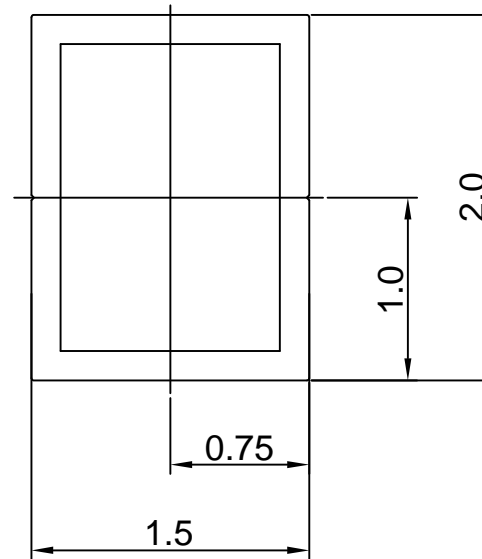
| REVISIONS | | | |
|-----------|-----------------|-----|------------|
| REV | DESCRIPTION | BY | DATE |
| A | INITIAL RELEASE | LWF | 10/20/2016 |

| 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 | | Sunmodo Corp. 1905 E 5TH STREET, STE A, VANCOUVER, WA 98661 | |
| Tolerances | | TITLE | |
| X.XXX ±0.01 [0.25mm] | | 2" PIPE BASE KIT | |
| X.XX ±0.02 [0.50mm] | | DRAWING NUMBER | |
| X.X ±0.039 [1.0mm] | | B K10268-001 | |
| Unless otherwise spec'd | | SCALE: NONE | |
| DRAWN BY | | SHEET 1 of 1 | |
| LWF | | DATE | |
| CHECKED BY | | 10/20/2016 | |
| APPROVALS | | | |

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. MATERAIL: 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

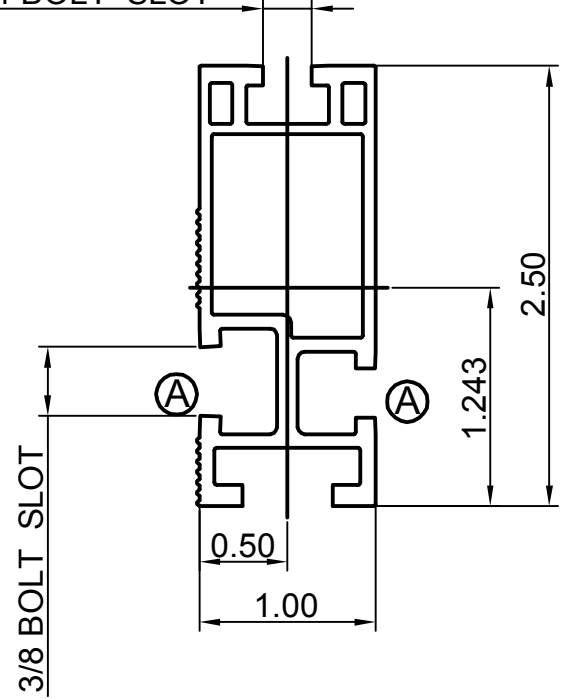
| | | | |
|---|--|---|--|
| MATERIAL | | SEE NOTES | |
| Third Angle Projection: | | <h1>Sunmodo Corp.</h1> <p>1905 E 5TH STREET, SUITE A, VANCOUVER, WA 98661</p> | |
| GENERAL SPECIFICATIONS All Dimensions in inches [millimeters] Tolerances X.XXX ± 0.01 [0.25mm] X.XX ± 0.02 [0.50mm] X.X ± 0.039 [1.0mm] Unless otherwise specified. | | | |
| DRAWN BY | | DATE | |
| zcg | | 03/12/2014 | |
| CHECKED BY | | B | |
| APPROVALS | | 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 Inertia(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 | | | |

4

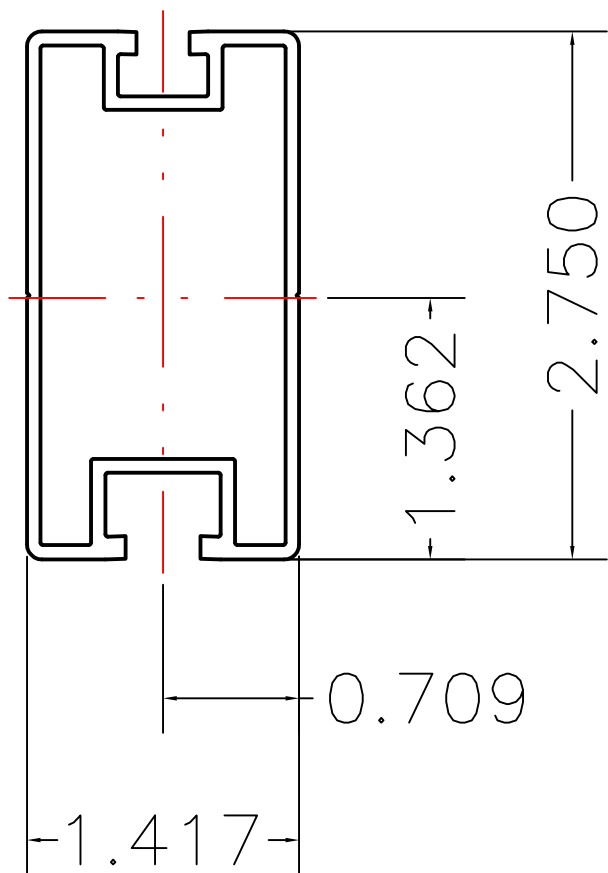
3

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 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): I_x=0.727,I_y=0.214
 Section modulus in bending(in³): W_x=0.524,W_y=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 | |

| | |
|--|--------------------------|
| SunModo Corp. | |
| 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

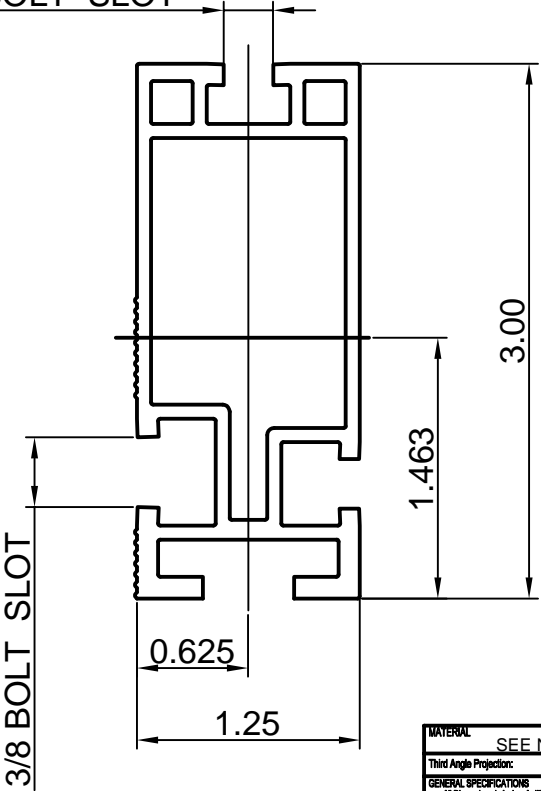
1

| 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. MATERIAL: 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 | |
| | | | |
| | | Break all sharp edges 0.10-0.25 unless otherwise specified. | |
| | | TITLE | |
| | | HELIO HEAVY RAIL | |
| | | DRAWING NUMBER | |
| | | A20145 | |
| | | SCALE: NONE | |
| | | SHEET 1 of 1 | |

B
A

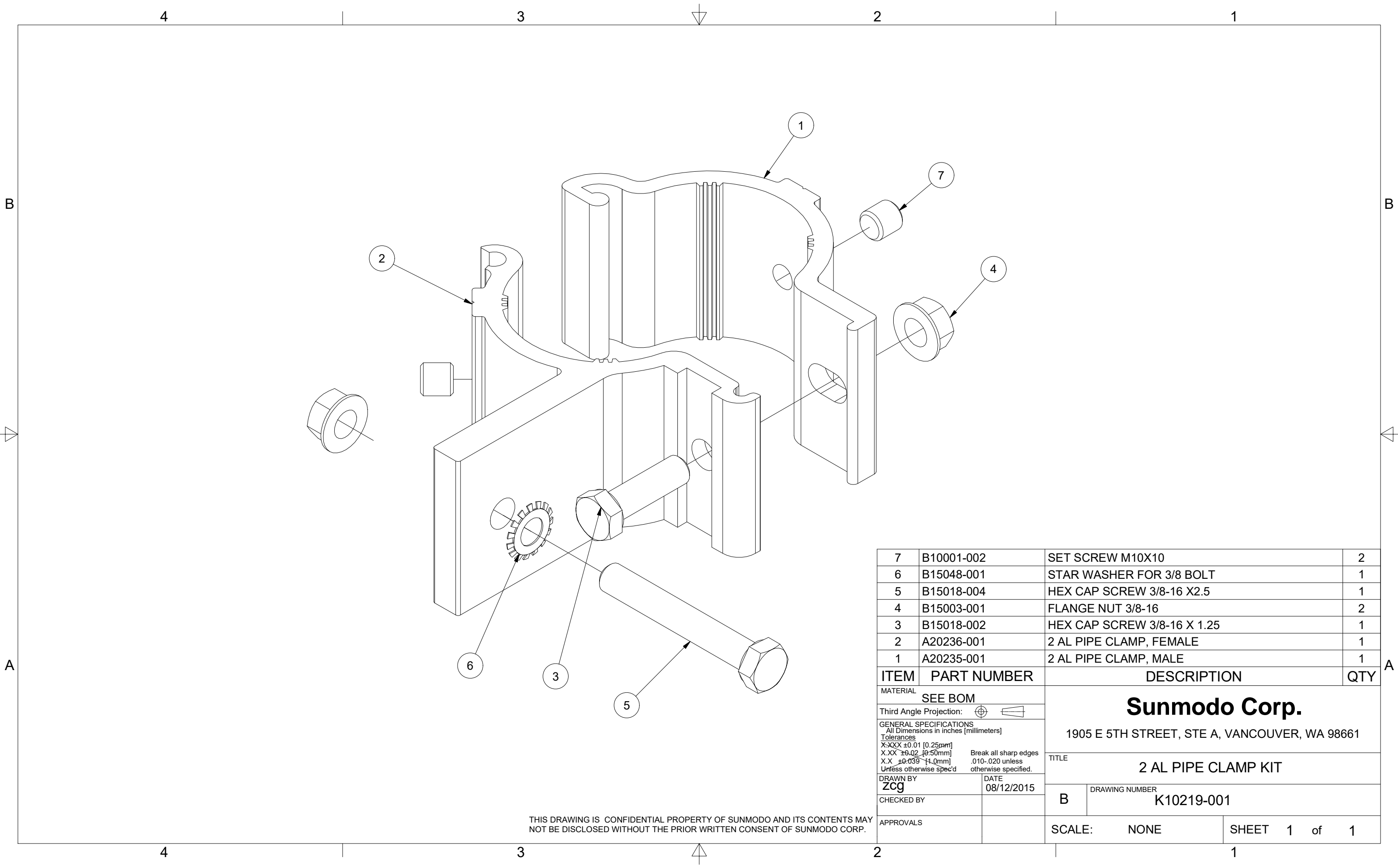
B
A

4
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1

4
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1

4
3
2
1

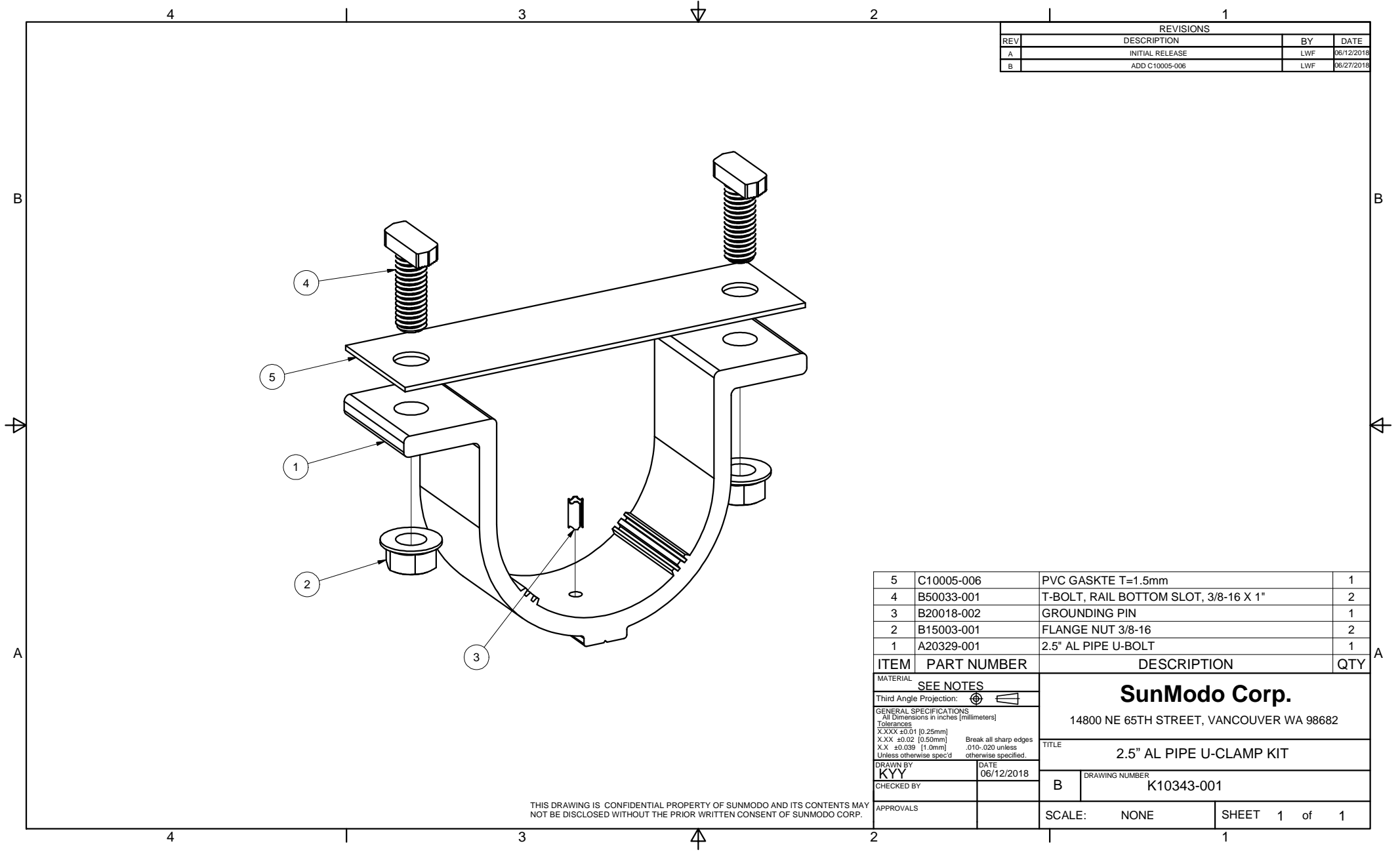
4
3
2
1



| | | | |
|---|------------|-----------------------------|---|
| 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 | | TITLE | |
| | | 2 AL PIPE CLAMP KIT | |
| APPROVALS | | DRAWING NUMBER | |
| | | B K10219-001 | |
| SCALE: | | NONE | SHEET 1 of 1 |

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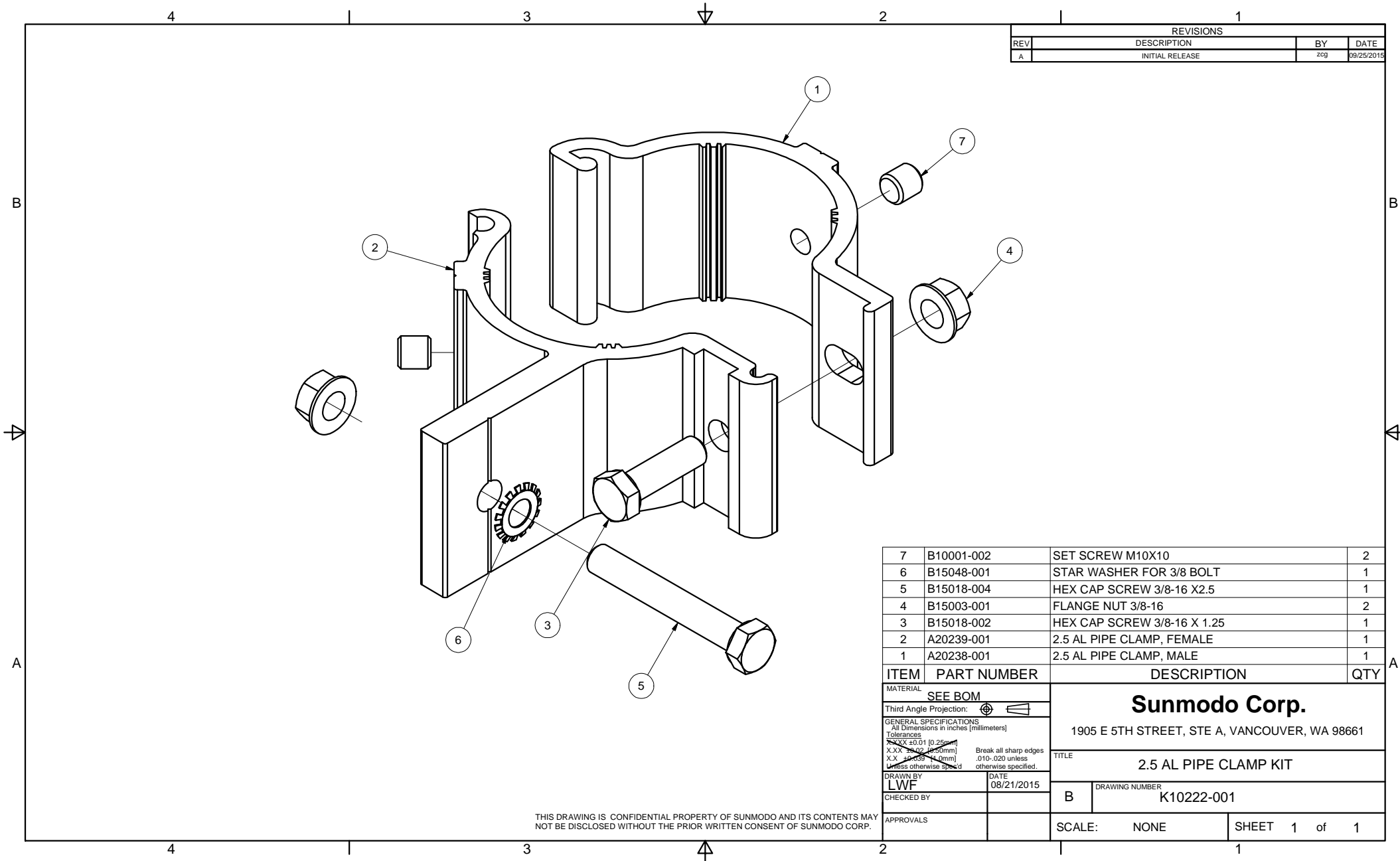


| REVISIONS | | | |
|-----------|-----------------|-----|------------|
| REV | DESCRIPTION | BY | DATE |
| A | INITIAL RELEASE | LWF | 06/12/2018 |
| B | ADD C10005-006 | LWF | 08/27/2018 |

| 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: | | | |
| SunModo Corp. 14800 NE 65TH STREET, VANCOUVER WA 98682 | | | |
| GENERAL SPECIFICATIONS | | TITLE | |
| 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 | | 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 |

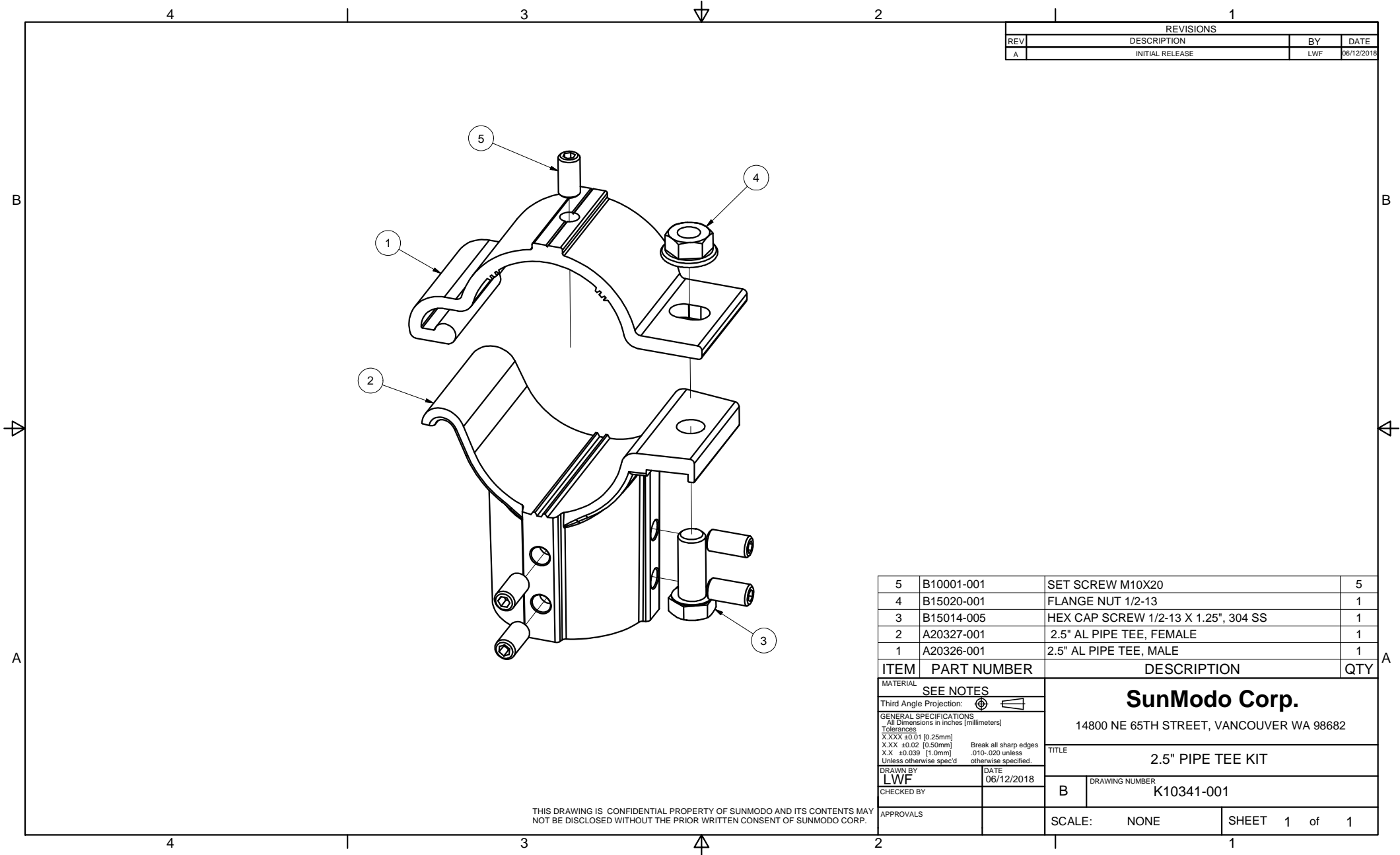
| ITEM | PART NUMBER | DESCRIPTION | QTY |
|---|-------------|-------------|----------------|
| MATERIAL | | SEE BOM | |
| Third Angle Projection: | | | |
| GENERAL SPECIFICATIONS All Dimensions in inches [millimeters] Tolerances X.XX ±0.01 (0.25mm) X.XX ±0.02 (0.50mm) X.X ±0.03 (0.75mm) Unless otherwise specified, Break all sharp edges .010-.020 unless otherwise specified. | | | |
| DRAWN BY | | DATE | |
| LWF | | 08/21/2015 | |
| CHECKED BY | | B | DRAWING NUMBER |
| | | | K10222-001 |
| 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

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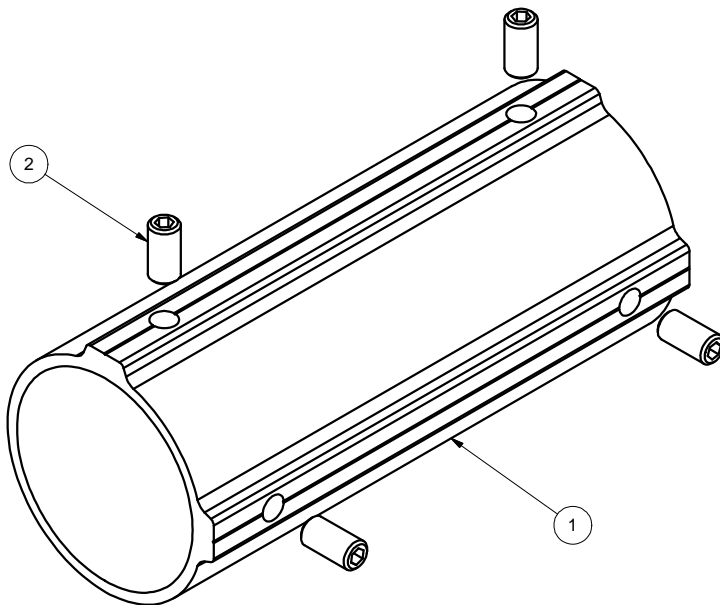
| REVISIONS | | | |
|-----------|-----------------|-----|------------|
| REV | DESCRIPTION | BY | DATE |
| A | INITIAL RELEASE | LWF | 06/12/2018 |

| 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 | |
| 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 | | 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 | |
| CHECKED BY | | DRAWING NUMBER | |
| | | B K10342-001 | |
| APPROVALS | | SCALE: NONE SHEET 1 of 1 | |

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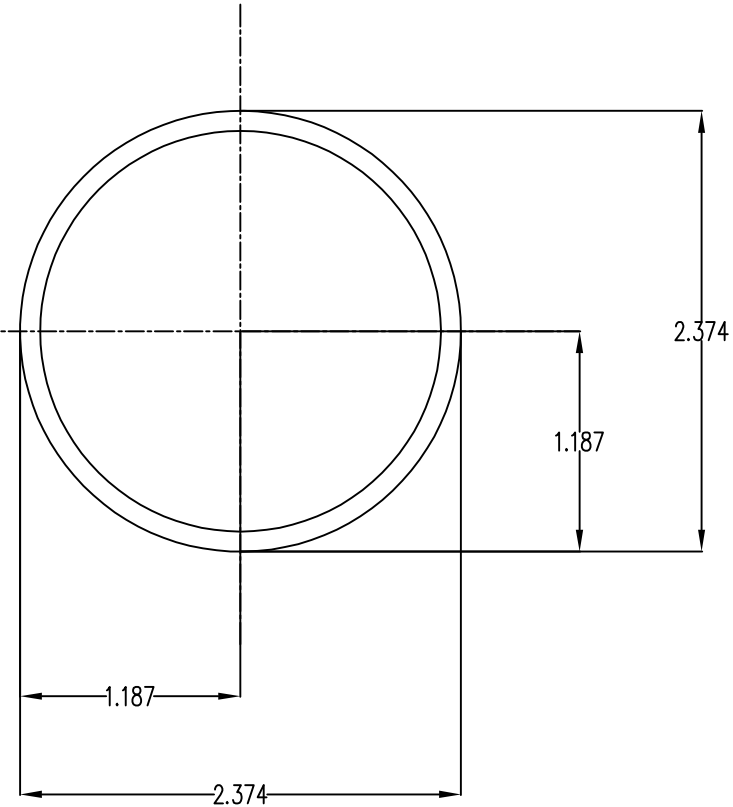
NOTES: UNLESS OTHERWISE SPECIFIED

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 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): Ix=0.499,Iy=0.499

Section modulus in bending(in³): Wx=0.420,Wy=0.420

Radii of Gyration: X: 0.802, Y: 0.802

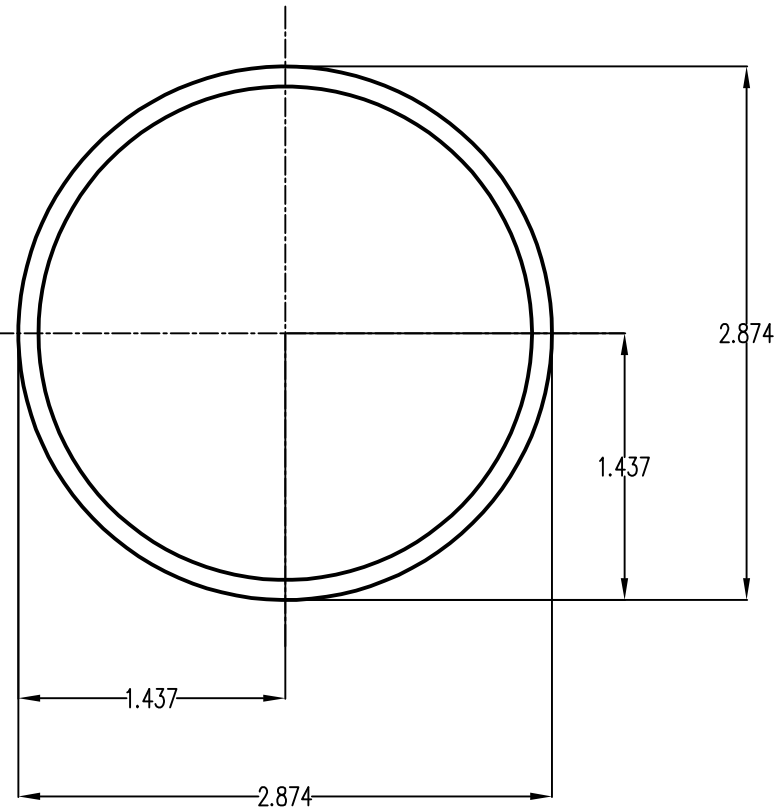
| | | | | | |
|--|------------|-----------|--|--|--|
| MATERIAL | | SEE NOTES | | Sunmodo Corp. 14800 NE 85TH STREET, VANCOUVER WA 98682 | |
| Third Angle Projection: | | | | | |
| GENERAL SPECIFICATIONS | | | | TITLE | |
| All Dimensions in Inches (millimeters) | | | | PIPE, HSS, 2.375" OD X 12 GAUGE,L=XXX | |
| Tolerances | | | | Break all sharp edges .010-.020 unless otherwise specified. | |
| XXX ±0.01 (0.25mm) | | | | | |
| XX ±0.02 (0.50mm) | | | | | |
| X ±0.050 (1.27mm) | | | | | |
| 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 in²

Perimeter: 17.378 in

Bounding Box: X: -1.437,1.437

Y: -1.437,1.437

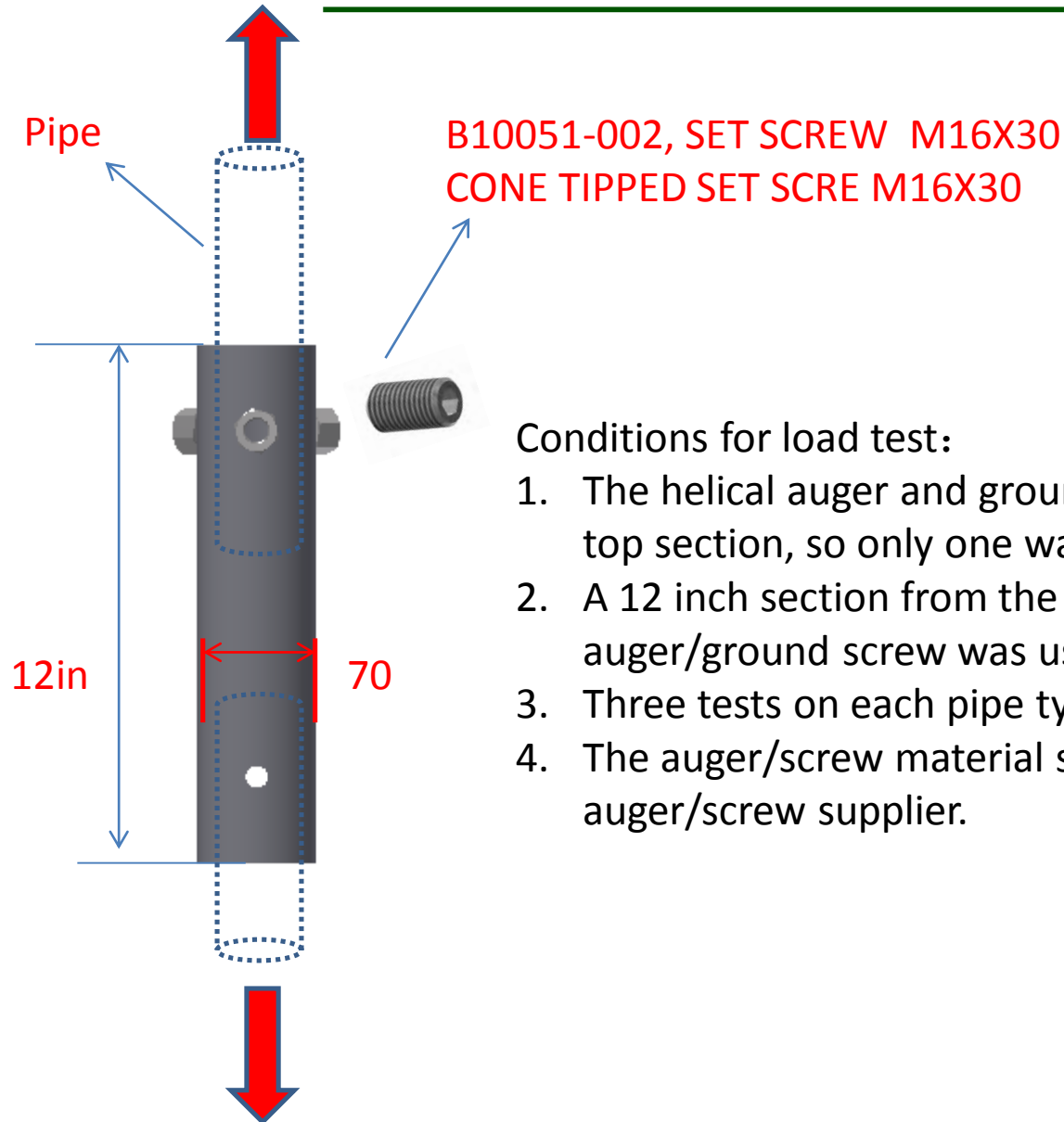
Centroid:(0.000,0.000)

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 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 | |



Conditions for load test:

1. The helical auger and ground screw use the same top section, so only one was used for testing
2. A 12 inch section from the top of the auger/ground screw was used
3. Three tests on each pipe type was used
4. The auger/screw material supplied by the auger/screw supplier.