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Reference: **Product Certification Statement**
Rooftop Mounted Mechanical Equipment
Fujitsu Outdoor HVAC Unit (Group 9)
Model Nos.: **AOU36RLAVM; AOU48RLAVM; AOU60RLAVM**

Based on the manufacturers cut sheets for the referenced rooftop equipment, I have performed a wind load analysis to determine compliance with wind load criteria set forth by 2017 Florida Building Code Mechanical Section 301.15, Florida Building Code Building Chapter 16 and ASCE 7-10. Analysis results demonstrate that the equipment with provisions for supplemental tie downs per details on sheet 2 of 2 of this certification, is structurally adequate to withstand wind loads at the specified mounting heights for Exposure Categories identified in Table 1. For analysis results, refer to Summary of Results at the end of the structures report associated with this certification.

TABLE 1

Design Wind Speed	Max Mounting Height Above Natural Grade (ft)		Kz
	Exposure C	Exposure D	
120	500	500	2.47
130	500	500	2.11
140	500	400	1.82
150	275	180	1.58
160	160	85	1.39
170	85	40	1.23
175	65	30	1.16
180	50	20	1.10
186	37	15	1.03
190	35	Ground Mount Only	0.99
200	18	Ground Mount Only	0.89

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8/17/2020

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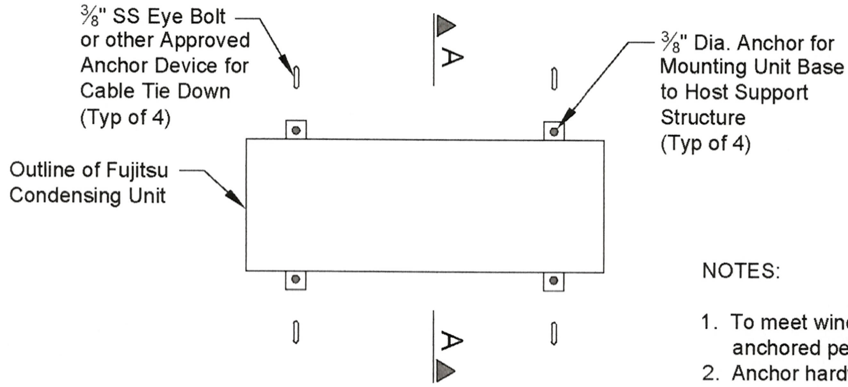
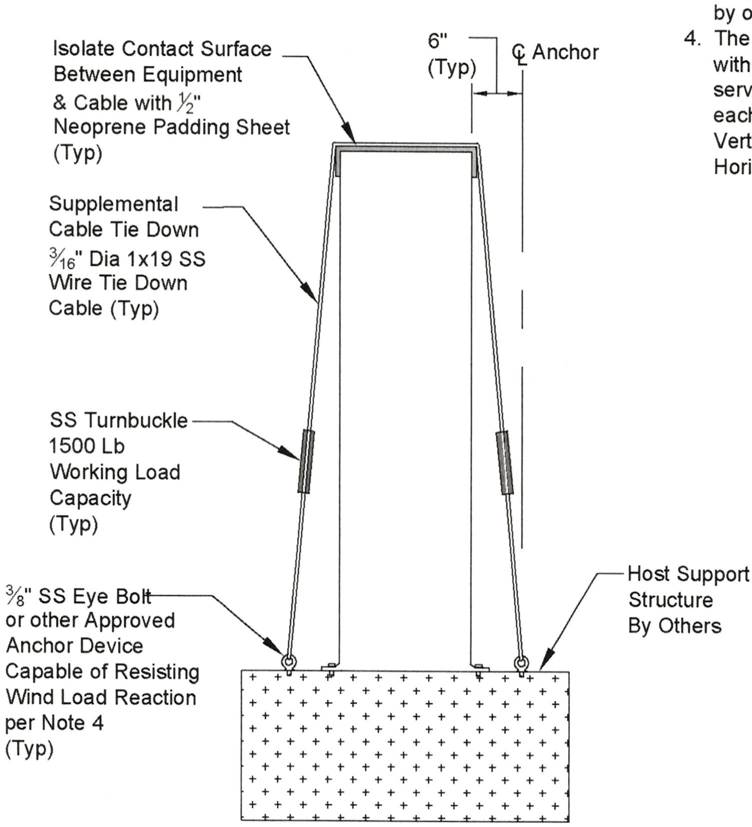


PLAN

NOTES:

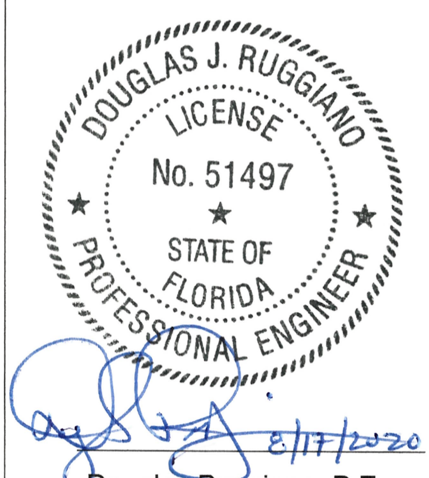
1. To meet wind certification, equipment shall be anchored per details on this sheet.
2. Anchor hardware material strength shall meet or exceed ASTM A307 requirements.
3. Anchor attachment to host support structure and certification for structural adequacy of proposed host structure to be determined by others.
4. The host support structure shall be capable of withstanding the unit weight plus the following service desgin wind load reactions acting at each cable tie down location:
   Vertical Reaction = 800 lbs
   Horizontal Reaction = 100 lbs



SECTION A-A

UNIT TIE DOWN DETAIL

Product Certification Statement
Sheet 2 of 2
Rooftop Mounted Mechanical Equipment
Fujitsu Outdoor HVAC Unit (Group 9)
Model Nos.: **AOU36RLAVM**
AOU48RLAVM
AOU60RGLX



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WIND LOAD ANALYSIS AND STRUCTURAL CALCULATIONS

FOR

WIND CERTIFICATION

OF

ROOFTOP MECHANICAL EQUIPMENT

FUJITSU OUTDOOR HVAC UNIT (GROUP 9)

MODEL NOS:
AOU36RLAVM; AOU48RLAVM; AOU60RLAVM

Prepared By:

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AUGUST 2020

Wind Load Analysis for Rooftop Mounted Equipment

Equipment:

Fujitsu 3.0 - 5.0 Ton Chassis

Model Nos: AOU36RLAVM; AOU48RLAVM; AOU60RLAVM

Approximate Weight of Unit (wt_{unit}): $wt_{unit} := 194 \cdot lbf$

Length of Unit (L_e): $L_e := 35.5 \cdot in$

Width of Unit (W_e): $W_e := 14.6 \cdot in$

Height of Unit (H_e): $H_e := 52.5 \cdot in$

Mount Hole spacing Along Length (MH_L): $MH_L := 25.6 \cdot in$

Mount Hole spacing Along Width (MH_W): $MH_W := 16.2 \cdot in$

Corner Weight at Point A (Rdl_A): $Rdl_A := \frac{wt_{unit}}{4}$ $Rdl_A = 48.5 \cdot lbf$

Corner Weight at Point B (Rdl_B): $Rdl_B := \frac{wt_{unit}}{4}$ $Rdl_B = 48.5 \cdot lbf$

Corner Weight at Point C (Rdl_C): $Rdl_C := \frac{wt_{unit}}{4}$ $Rdl_C = 48.5 \cdot lbf$

Corner Weight at Point D (Rdl_D): $Rdl_D := \frac{wt_{unit}}{4}$ $Rdl_D = 48.5 \cdot lbf$

Material Data:

Ultimate Tensile Strength of Cold Formed Sheet Metal Casing in Contact with Screw Head ($Fu1_{cas}$): $Fu1_{case} := 45 \cdot ksi$

Ultimate Tensile Strength of Cold Formed Sheet Metal Casing Not in Contact with Screw Head ($Fu2_{cas}$): $Fu2_{case} := 45 \cdot ksi$

Ultimate Strength of Metal Fasteners (Fu_{fas}): $Fu_{fas} := 50 \cdot ksi$

Yield Strength of Metal Casing (Fy) $F_y := 30 \cdot ksi$

Calculate Wind Load (Per ASCE 7-10)

Building Risk Category (B_{Risk}): $Bldg_{Risk} := \text{"IV"}$

Design Wind Speed (V): $V := 186$ mph

Mounting Height above Grade (H): $H := 15 \cdot ft$

$ExpCat := \text{"D"}$

Velocity pressure exposure coefficient at height from ground to Centroid of Equipment (K_z): $K_z := 1.03$

Topographic Factor (K_{zt}): $K_{zt} := 1.0$

Directionality Factor From Table 6-4 (Similar Structures) (K_d): $K_d := 0.90$

Ultimate Design Velocity Pressure Evaluated at height z of the Centroid of the Effective Area (q_{zULT}):

$q_{zULT} := 0.00256 \cdot K_z \cdot K_{zt} \cdot K_d \cdot V^2 \cdot psf$ $q_{zULT} = 82.1 \cdot psf$

Allowable Design Velocity Pressure Evaluated at height z of the Centroid of the Effective Area (q_z):

$q_z := q_{zULT} \cdot 0.6$ $q_z = 49.3 \cdot psf$

Lateral Pressure Coefficent $GCf_{lat} := 1.9$

Uplift Pressure Coefficent $GCf_{upl} := 1.5$

Lateral Wind Pressure (p_{lat}): $p_{lat} := q_z \cdot GCf_{lat}$ $p_{lat} = 93.6 \cdot psf$

Uplift Wind Pressure (p_{upl}): $p_{upl} := q_z \cdot GCf_{upl}$ $p_{upl} = 73.9 \cdot psf$

Projected Area Normal to Wind (A_n): $A_n := L_e \cdot H_e$ $A_n = 12.9 \cdot ft^2$

Projected Area Parallel to Wind (A_p): $A_p := L_e \cdot W_e$ $A_p = 3.6 \cdot ft^2$

Calculate the Wind Load Reactions at Unit to Curb (Refer to Figure I)

$F_h := p_{lat} \cdot A_n$ $F_h = 1.2 \cdot kip$

$F_{up} := p_{upl} \cdot A_p$ $F_{up} = 0.3 \cdot kip$

$Rwl_A := \dfrac{F_h \cdot \frac{H_e}{2}}{2 \cdot MH_W} - \dfrac{F_{up}}{4}$ $Rwl_A = 0.9 \cdot kip$ **(Downward)**

$Rwl_B := \dfrac{F_h \cdot \frac{H_e}{2}}{2 \cdot MH_W} - \dfrac{F_{up}}{4}$ $Rwl_B = 0.9 \cdot kip$ **(Downward)**

$Rwl_C := \dfrac{F_h \cdot \frac{H_e}{2}}{2 \cdot MH_W} + \dfrac{F_{up}}{4}$ $Rwl_C = 1 \cdot kip$ **(Upward)**

$Rwl_D := \dfrac{F_h \cdot \frac{H_e}{2}}{2 \cdot MH_W} + \dfrac{F_{up}}{4}$ $Rwl_D = 1 \cdot kip$ **(Upward)**

Calculate Combined Reactions at each Anchorage Location (Dead + Wind x FSstab):

Vertical Reactions:

$Rtot_A := Rdl_A + Rwl_A$ $Rtot_A = 1 \cdot kip$

$Rtot_B := Rdl_B + Rwl_B$ $Rtot_B = 1 \cdot kip$

$Rtot_C := Rdl_C - Rwl_C$ $Rtot_C = -1 \cdot kip$

$Rtot_D := Rdl_D - Rwl_D$ $Rtot_D = -1 \cdot kip$

Horizontal Reactions:

$R_{hor} := \dfrac{F_h}{4}$ $R_{hor} = 0.3 \cdot kip$

Therefore, with the assumption of 4 anchor points (1 at each corner of the unit); each anchorage to curb and corresponding building support components must be designed to withstand the Uplift Reaction of $Rtot_C = -1 \cdot kip$ and a Horizontal Shear Reaction of $R_{hor} = 0.3 \cdot kip$.

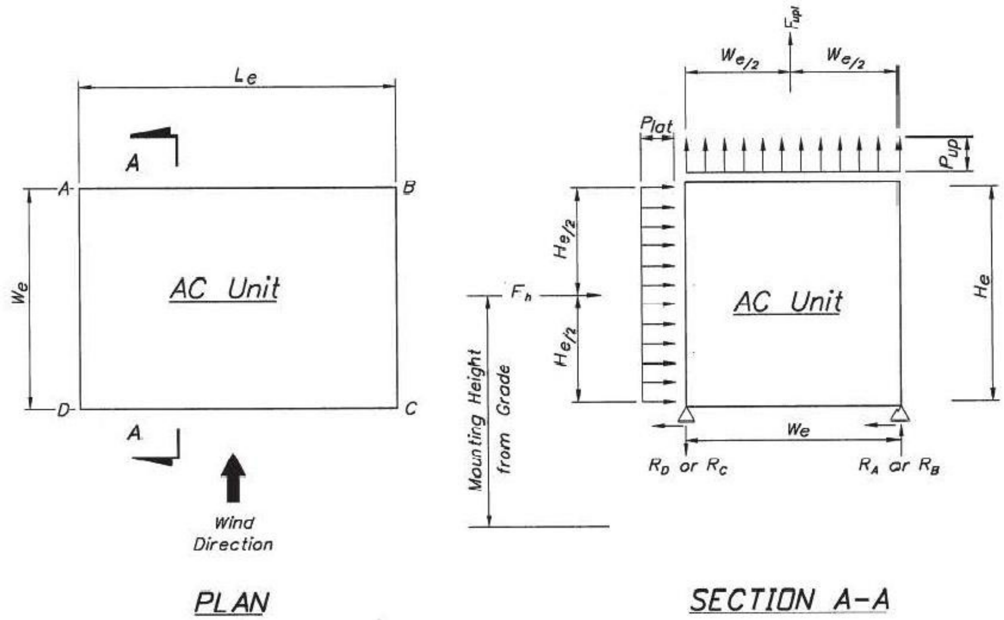
Le
A
B
C
D
We
AC Unit
Wind
Direction
PLAN
Fupl
We/2
We/2
Plat
Pup
He/2
He/2
He
Fh
Mounting Height
from Grade
AC Unit
We
RD or RC
RA or RB
SECTION A-A

FIGURE I

Calculate No. of Fasteners Req'd for Panel No. 1

Attachment Data:

Nominal Screw Diameter (Φ_{screw}): $\phi_{screw} := 0.157 \cdot in$

Thread Series, threads per in (unc): $unc := 14$

Affective Shear Stress Area of Screw (A_v):

$$A_v := \frac{\pi}{4} \cdot \left(\frac{\phi_{screw}}{in} - \frac{1.2269}{unc} \right)^2 \cdot in^2 \qquad A_v = 0.0038 \cdot in^2$$

Thickness of Metal Casing in Contact with Screw Head (t1): $t1 := 0.0315 \cdot in$

Thickness of Metal Casing Not in Contact with Screw Head (t2): $t2 := 0.0315 \cdot in$

Casing Thickness Ratio (rc): $rc := \frac{t2}{t1}$ $\qquad rc = 1$

Panel Length (L_{pan}): $L_{pan} := L_e = 35.5 \cdot in$

Panel Width (W_{pan}): $W_{pan} := W_e = 14.6 \cdot in$

Calculate Nominal Shear per Fastener Based on Bearing for rc <= 1.0 (Pns_{case}):

$$Pns1 := 4.2 \cdot \sqrt{t1^3 \cdot \phi_{screw}} \cdot Fu1_{case} \qquad Pns1 = 0.419 \cdot kip$$

$$Pns2 := 2.7 \cdot t1 \cdot \phi_{screw} \cdot Fu1_{case} \qquad Pns2 = 0.601 \cdot kip$$

$$Pns3 := 2.7 \cdot t2 \cdot \phi_{screw} \cdot Fu2_{case} \qquad Pns2 = 0.601 \cdot kip$$

$$Pns_{case} := if(Pns1 \le Pns2, if(Pns1 \le Pns3, Pns1, Pns3), if(Pns2 \le Pns3, Pns2, Pns3))$$

$$Pns_{case} = 0.419 \cdot kip$$

Calculate Nominal Shear per Fastener Based on Shear Capacity of Screw (Pns_{screw}):

$$Pns_{screw} := Fu_{fas} \cdot A_v \qquad Pns_{screw} = 0.189 \cdot kip$$

Calculate Allowable Shear per Fastener (Pas):

$$\Omega_{brg} := 3.0 \qquad Pas1 := \frac{Pns_{case}}{\Omega_{brg}} \qquad Pas1 = 0.140 \cdot kip$$

$$\Omega_{screw} := \frac{\sqrt{3}}{0.40} \qquad Pas2 := \frac{Pns_{screw}}{\Omega_{screw}} \qquad Pas2 = 0.044 \cdot kip$$

$$Pas := if(Pas1 \le Pas2, Pas1, Pas2) \qquad Pas = 0.044 \cdot kip$$

Calculate Total Uplift on Panel (F_{upl}):

$$F_{upl} := p_{upl} \cdot L_{pan} \cdot W_{pan} \qquad F_{upl} = 0.3 \cdot kip$$

Calculate Total No. of Screws Required (No_{screws}):

$$No_{screws1} := ceil\left(\frac{F_{upl}}{Pas} \right) \qquad No_{screws1} = 7$$

Calculate No. of Fasteners Req'd for Panel No. 2

Attachment Data:

Nominal Screw Diameter (Φ_{screw}): $\phi_{screw} := 0.157 \cdot in$ Dia of Hex Head: $\phi_{head} := 0.42 \cdot in$

Thread Series, threads per in (unc): $unc := 14$

Affective Tensile Stress Area of Screw (A_t):

$$A_t := \frac{\pi}{4} \cdot \left(\frac{\phi_{screw}}{in} - \frac{0.9743}{unc} \right)^2 \cdot in^2 \qquad A_t = 0.006 \cdot in^2$$

Thickness of Metal Casing in Contact with Screw Head (t1): $t1 := 0.0315 \cdot in$

Thickness of Metal Casing Not in Contact with Screw Head (t2): $t2 := 0.0315 \cdot in$

Casing Thickness Ratio (rc): $rc := \frac{t2}{t1}$ $rc = 1$

Panel Length (L_{pan}): $L_{pan} := H_e = 52.5 \cdot in$

Panel Width (W_{pan}): $W_{pan} := W_e = 14.6 \cdot in$

Calculate Nominal Tension or Pullout per Fastener Based on Bearing (Pnt_{case}):

$Pnt1 := 0.85 \cdot t2 \cdot \phi_{screw} \cdot Fu2_{case}$ $Pnt1 = 0.189 \cdot kip$

$Pnt2 := 1.5 \cdot t1 \cdot \phi_{head} \cdot Fu1_{case}$ $Pnt2 = 0.893 \cdot kip$

$Pnt_{case} := if(Pnt1 \le Pnt2, Pnt1, Pnt2)$ $Pnt_{case} = 0.189 \cdot kip$

Calculate Nominal Tensile or Pullout per Fastener Based on Tensile Capacity of Screw (Pnt_{screw}):

$Pnt_{screw} := Fu_{fas} \cdot A_t$ $Pnt_{screw} = 0.300 \cdot kip$

Calculate Allowable Pullout per Fastener (Pat):

$\Omega_{brg} := 3.0$ $Pat1 := \frac{Pnt_{case}}{\Omega_{brg}}$ $Pat1 = 0.063 \cdot kip$

$\Omega_{screw} := \frac{1}{0.40}$ $Pat2 := \frac{Pnt_{screw}}{\Omega_{screw}}$ $Pat2 = 0.120 \cdot kip$

$Pat := if(Pat1 \le Pat2, Pat1, Pat2)$ $Pat = 0.063 \cdot kip$

Calculate Total Horizontal Force on Panel (F_{horiz}):

$F_{horiz} := p_{lat} \cdot L_{pan} \cdot W_{pan}$ $F_{horiz} = 0.498 \cdot kip$

Calculate Total No. of Screws Required (No_{screws}):

$No_{screws2} := ceil\left(\frac{F_{horiz}}{Pat}\right)$ $No_{screws2} = 8$

Calculate No. of Fasteners Req'd for Panel No. 3

Attachment Data:

Nominal Screw Diameter (Φ_{screw}): $\phi_{screw} := 0.157 \cdot in$

Dia of Hex Head: $\phi_{head} := 0.42 \cdot in$

Thread Series, threads per in (unc): $unc := 14$

Affective Tensile Stress Area of Screw (A_t):

$$A_t := \frac{\pi}{4} \cdot \left(\frac{\phi_{screw}}{in} - \frac{0.9743}{unc} \right)^2 \cdot in^2 \qquad A_t = 0.006 \cdot in^2$$

Thickness of Metal Casing in Contact with Screw Head (t1): $t1 := 0.0315 \cdot in$

Thickness of Metal Casing Not in Contact with Screw Head (t2): $t2 := 0.0315 \cdot in$

Casing Thickness Ratio (rc): $rc := \frac{t2}{t1}$ $\quad rc = 1$

Panel Length (L_{pan}): $L_{pan} := L_e = 35.5 \cdot in$

Panel Width (W_{pan}): $W_{pan} := H_e = 52.5 \cdot in$

Calculate Nominal Tension or Pullout per Fastener Based on Bearing (Pnt_{case}):

$Pnt1 := 0.85 \cdot t2 \cdot \phi_{screw} \cdot Fu2_{case}$ $\quad Pnt1 = 0.189 \cdot kip$

$Pnt2 := 1.5 \cdot t1 \cdot \phi_{head} \cdot Fu1_{case}$ $\quad Pnt2 = 0.893 \cdot kip$

$Pnt_{case} := if(Pnt1 \le Pnt2, Pnt1, Pnt2)$ $\quad Pnt_{case} = 0.189 \cdot kip$

Calculate Nominal Tensile or Pullout per Fastener Based on Tensile Capacity of Screw (Pnt_{screw}):

$Pnt_{screw} := Fu_{fas} \cdot A_t$ $\quad Pnt_{screw} = 0.300 \cdot kip$

Calculate Allowable Pullout per Fastener (Pat):

$\Omega_{brg} := 3.0$ $\quad Pat1 := \frac{Pnt_{case}}{\Omega_{brg}}$ $\quad Pat1 = 0.063 \cdot kip$

$\Omega_{screw} := \frac{1}{0.40}$ $\quad Pat2 := \frac{Pnt_{screw}}{\Omega_{screw}}$ $\quad Pat2 = 0.120 \cdot kip$

$Pat := if(Pat1 \le Pat2, Pat1, Pat2)$ $\quad Pat = 0.063 \cdot kip$

Calculate Total Horizontal Force on Panel (F_{horiz}):

$\%open := 50\%$

$F_{horiz} := p_{lat} \cdot L_{pan} \cdot W_{pan} \cdot (1 - \%open)$ $\quad F_{horiz} = 0.606 \cdot kip$

Calculate Total No. of Screws Required (No_{screws}):

$No_{screws3} := ceil\left(\frac{F_{horiz}}{Pat}\right)$ $\quad No_{screws3} = 10$

Check Adequacy of Base Plate and Anchorage Hardware

Attachment Data:

Nominal Bolt Diameter (Φ_{bolt}): $\phi_{bolt} := 0.3125 \cdot in$

Affective Bolt Area (A_{eff}):

$$A_{eff} := \frac{\pi}{4} \cdot \left(\frac{\phi_{bolt}}{in}\right)^2 \cdot in^2 \qquad A_{eff} = 0.077 \cdot in^2$$

BoltMaterial := "ASTM A307 or Greater"

Allowable Tensile Strength (F_t): $F_t := 20 \cdot ksi$

Allowable Shear Strength (F_v): $F_v := 9.9 \cdot ksi$

Bolt Shear Capacity (V_{all}): $V_{all} := A_{eff} \cdot F_v = 0.8 \cdot kip$

Bolt Tension Capacity (T_{all}): $T_{all} := A_{eff} \cdot F_t = 1.5 \cdot kip$

Check Bolt Adequacy with Wind Perpendicular to Long Side

Number of Bolts Provided to resist Tension ($NoBolts_{provdtens}$): $NoBolts_{provtens} := 2$

$$t_{bolt} := \frac{\left|2Rtot_C\right|}{NoBolts_{provtens}} \qquad t_{bolt} = 1 \cdot kip$$

Number of Bolts Provided to resist Shear ($NoBolts_{provdshear}$): $NoBolts_{provshear} := 4$

$$v_{bolt} := \frac{2 \cdot R_{hor}}{NoBolts_{provshear}} \qquad v_{bolt} = 0.2 \cdot kip$$

$$CSR_{bolt} := \frac{t_{bolt}}{T_{all}} + \frac{v_{bolt}}{V_{all}} \qquad CSR_{bolt} = 0.851$$

$$Check_{bolt} := if\left(CSR_{bolt} \le 1.0, \text{"OK"}, \text{"NG"}\right) \qquad Check_{bolt} = \text{"OK"}$$

Check Base Plate

Width of Base Plate: $b_{bp} := 2.0 \cdot in$

Thickness of Base Plate: $t_{bp} := 0.047 \cdot in$

Moment Arm: $arm := 1.5in$

Calculate Effective Section Properties of Base Plate (Unit - Inches)														
b	t	hflange	I1	I2	d1	d2	A1	A2	ybar	y1	y2	Itotal	Stotal	Atotal
2	0.047	0.66	1.73E-05	0.000902	0.6365	0.3065	0.094	0.0288	0.631	0.029	0.631	0.042611	0.06753	0.122811

Area: $Ax := 0.122811 \cdot in^2$

Section Modulus: $Sx := 0.06753 \cdot in^3$

Bending Stress: $f_b := \frac{t_{bolt} \cdot arm}{Sx} = 22.2 \cdot ksi$

Shear Stress: $f_v := \frac{t_{bolt}}{Ax} = 8.1 \cdot ksi$

Allowable Bending Stress $F_b := 0.6 \cdot F_y = 18000\ psi$

Allowable Shear Stress $F_v := 0.4 \cdot F_y = 12000\ psi$

$$CSR_{bp} := \frac{f_b}{F_b} + \left(\frac{f_v}{F_v}\right)^2 = 1.7$$

$CheckBasePlate := if\left(CSR_{bp} \le 1.0, "OK", "NG"\right) = "NG"$

Since CSRbp >1.0, base mount that comes standard with equipment does not satisfy the design loads per analysis. Therefore, retrofit is required to meet design loads per this wind certification. Retrofit unit anchorage to host structure with supplemental cable Tie Downs per following analysis and Details provided with the Certification.

Supplemental Cable Tie Downs

Number of Tie Downs (No_{TD}): $No_{TD} := 2$

$X_{dim} := 6 \cdot in$

$Y_{dim} := H_e = 52.5 \cdot in$

$$\theta := atan\left(\frac{Y_{dim}}{X_{dim}}\right) = 83.5 \cdot deg$$

$$Ry := \frac{\left(\frac{F_h \cdot \frac{H_e}{2}}{W_e + X_{dim}} + \frac{F_{up}}{2}\right) - Rdl_C - Rdl_D}{No_{TD}} = 0.8 \cdot kip$$

$$T_{cable} := \frac{Ry}{\sin(\theta)} = 0.8 \cdot kip$$

$$Rx := \sqrt{T_{cable}^{\ 2} - Ry^2} = 0.1 \cdot kip$$

Sizing of Tie Down Cable

Cable Description: CableSpec := "3/16" 1x19 SS Wire Cable"

Tensile Capacity (Tcableult): $T_{cableult} := 4 \cdot kip$

$Check_{cable} := if\left(T_{cableult} \cdot 0.2 \ge T_{cable}, \text{"OK"}, \text{"NG"}\right)$ $Check_{cable} = \text{"OK"}$

Sizing of Eye Bolt

Eye Bolt Diameter $\phi_{eyebolt} := 0.375 \cdot in$

Inclination of Load Application $Inclination := 90deg - \theta = 6.5 \cdot deg$

Eye Bolt Capacity at Inclination = 0 degrees $T_{cap0} := 1300 \cdot lbf$

Eye Bolt Capacity at Inclination = 45 degrees $T_{cap45} := 325 \cdot lbf$

Selected Eye Bolt Capacity at Proposed Inclination $$T_{cap} := T_{cap0} - \frac{\left(T_{cap0} - T_{cap45}\right)}{45deg} \cdot Inclination = 1158.7\,lbf$$

$Check_{eyebolt} := if\left(T_{cap0} \ge T_{cable}, \text{"OK"}, \text{"NG"}\right) = \text{"OK"}$

Summary of Results:

$BuildingRisk := Bldg_{Risk} = "IV"$

$DesignWindSpeed := V \cdot mph = 186 \cdot mph$

$ExposureCategory := ExpCat = "D"$

$MountingHeight := H = 15 \cdot ft$

Number of Panel Fasteners Provided By Manufacturer:

Panel No. 1: $No_{screws.std1} := 10$

Panel No. 2: $No_{screws.std2} := 8$

Panel No. 3: $No_{screws.std3} := 10$

Number of Panel Fasteners Required By Analysis:

Panel No. 1: $No_{screws1} = 7$

Panel No. 2: $No_{screws2} = 8$

Panel No. 3: $No_{screws3} = 10$

Panel Fastening Check:

$check_{panel1} := if\left(No_{screws.std1} \geq No_{screws1}, "OK", "NG"\right) = "OK"$

$check_{panel2} := if\left(No_{screws.std2} \geq No_{screws2}, "OK", "NG"\right) = "OK"$

$check_{panel3} := if\left(No_{screws.std3} \geq No_{screws3}, "OK", "NG"\right) = "OK"$

Equipment Tie Down to Support By Others:

BoltMaterial = "ASTM A307 or Greater"

$TieDownBoltDia := \phi_{bolt} = 0.3125 \cdot in$

$CSR_{bolt} = 0.9$

$CSR_{bp} = 1.7$

Supplemental Tie Down:

CableSpec = "3/16" 1x19 SS Wire Cable"

$EyeBoltSize := \phi_{eyebolt} = 0.375 \cdot in$

$Check_{cable} = "OK"$

$Check_{eyebolt} := if\left(T_{cap0} \geq T_{cable}, "OK", "NG"\right) = "OK"$