CODES:

FLORIDA BUILDING CODE 2014, 5TH EDITION
ASCE STANDARD 7-2010
MIAMI DADE WIND SPEED = 186 MPH

WIND DESIGN REQUIREMENTS:

ULTIMATE DESIGN WIND SPEED, Vult (3 sec. gust)	186 mph
NOMINAL DESIGN WIND SPEED, Vasd	144 mph
RISK CATEGORY	IV
HEIGHT TO CENTROID	200 FT
EXPOSURE CATEGORY	D
ENCLOSURE CATEGORY	N/A
EFFECTIVE WIND AREA	N/A
INTERNAL PRESSURE COEFFICIENT GCPi	N/A
DIRECTIONALITY FACTOR Kd	0.90
TOPOGRAPHIC FACTOR Kzt	1.0
GUST EFFECT FACTOR	N/A

WIND LOAD METHOD:

VELOCITY PRESSURE:
based on ASCE 7-10, Eq. 29.3-1
$qz = 0.00256\ Kz\ Kzt\ Kd\ V^2$ psf
Kz = 1.61
V = Vult
qz = 128.3 psf

WIND PRESSURES:
based on ASCE 7-10 Eq. 29.5.1 & FBC 1620.6
F = qh GCf Af psf Eq 29.5-2
GCf = 3.10 FOR LATERAL FORCES
GCf = 1.50 FOR VERTICAL FORCES

LOAD COMBINATIONS:

POSITIVE VERTICAL FORCE:	1.0*D + 0.6*W [FBC 1605.3.1 EQ. 16-12]
SLIDING & ANCHOR PULLOUT:	0.6*D + 0.6*W [FBC 1605.3.1 EQ. 16-15]
OVERTURNING:	0.67*D + 0.78*W [FBC 1605.3.2 EQ. 16-18]

GENERAL NOTES:

1. THIS ENGINEERING REPORT DOCUMENTS THE ANALYSIS OF AC EQUIPMENT MOUNTED ON A ROOF STAND AND THE ASSOCIATED ANCHORING SYSTEMS TO RESIST DEAD WEIGHT AND WIND LOAD FORCES.
2. THE ANALYSIS CONFORMS TO THE REQUIREMENTS OF THE FLORIDA BUILDING CODE 2014 AND ASCE 7-2010, FOR USE WITHIN & OUTSIDE HVHZ.
3. THE AC UNIT IS MOUNTED ON A METAL STAND WHICH IS SECURED TO THE ROOF.
4. ANCHORS USED TO FASTEN THE UNIT TO THE ROOF STAND ARE A307 OR HIGHER STRENGTH STEEL BOLTS.
5. THE ROOF STAND IS DESIGNED AND VERIFIED BY STRUCTURAL ANALYSIS BY THIS ENGINEER.
6. ALTERNATE ROOF STAND DESIGNS (E.G. ALUMINUM) THAT ARE DESIGNED TO RESIST THE ABOVE WIND LOADS MAY BE USED AT THE CONTRACTOR'S OPTION. FOR ALTERNATE ROOF STAND DESIGNS, PROVIDE DETAILS AND CALCULATIONS SIMILAR TO THIS SHEET AND DETAILED CALCULATIONS ON DRAWING 2, STAMPED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF FLORIDA.
7. THE CONTRACTOR IS RESPONSIBLE FOR SAFETY, INSTALLATION, AND SPECIAL INSPECTIONS & TESTS PER FBC CHAPTER 17.

CALCULATIONS: SEE DETAILED CALCULATIONS ON DRAWING 2.

WIND LATERAL AND VERTICAL FORCES:

1. THE WIND LOAD ACTING NORMAL TO THE LARGE VERTICAL SIDE OF THE AC UNIT IS USED FOR WORST CASE SHEAR.
2. THE WIND LOAD ACTING ON THE TOP OF THE UNIT UPWARD AND THE HORIZONTAL WIND LOAD IS USED TO CALCULATE UPLIFT AND MOMENT.
3. THESE FORCES MUST BE RESISTED BY THE SHEAR AND TENSILE STRENGTHS OF THE ANCHORS HOLDING THE UNIT TO THE SUPPORT BAR AND ALSO THE ANCHORS HOLDING THE SUPPORT BAR TO THE ROOF STAND. THE ROOF STAND INTERNAL STRESSES ARE VERIFIED BY THIS ENGINEER TO BE WITHIN THE ALLOWABLE STRENGTHS OF ITS ELEMENTS AND CONNECTIONS.

SUPPORT BAR STRENGTH:

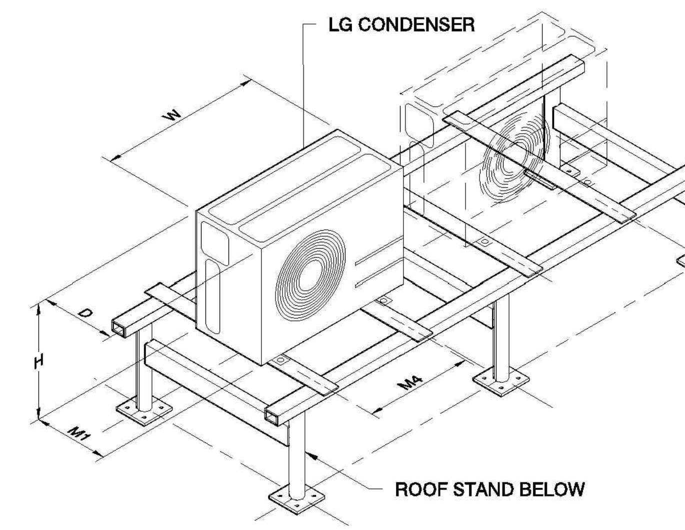
4. THE MOMENT AND SHEAR MUST BE TRANSFERRED FROM THE AC UNIT TO THE ROOF STAND BY A SUPPORT BAR AS THE AC UNIT DEPTH CAN BE UNEQUAL TO THE ROOF STAND DEPTH.
5. MAX MOMENT AND SHEAR TO THE SUPPORT BAR DETERMINE SELECTION OF THE SUPPORT BAR.

ROOF STAND STRENGTH:

6. CRITICAL LIMITS ARE THE POST LEGS AND WELD STRENGTH TO THE BASE, CROSS BRACE TO POST CONNECTION, AND RAILING TO POST CONNECTION.

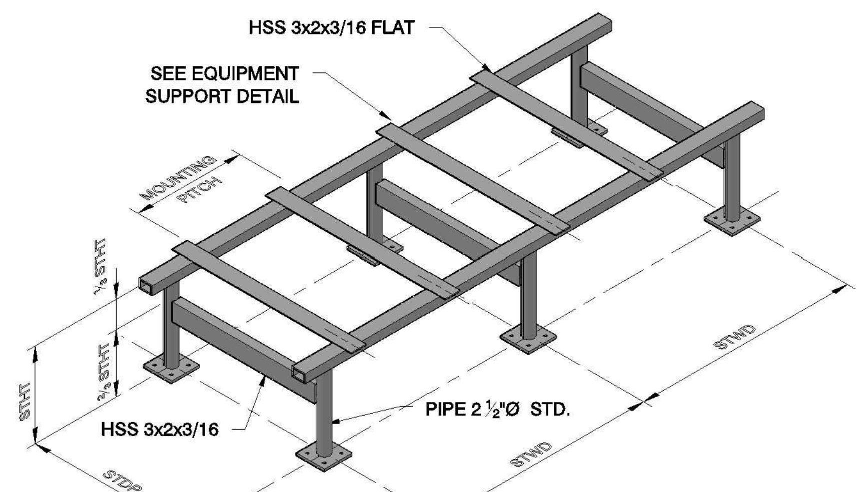
ENCLOSURE FASTENERS:

7. THE METAL SHELL FASTENERS MUST RESIST THE NEGATIVE WIND PRESSURES CAUSING TENSILE STRESS IN THE SCREWS AND PULL-OVER EFFECTS OF THE SHEET METAL.



ROOF-MOUNT CONFIGURATION

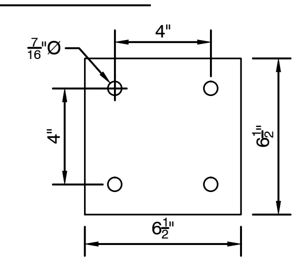
SCALE: NTS



STEEL ROOF STAND

SCALE: NTS

ROOF STAND STRENGTH LIMITS		
LIMIT TYPE	AMOUNT	UNITS
MAX SHEAR AT POST BASE	0.975	KIP
MAX PULLOUT AT POST BASE	1.775	KIP
MAX MOMENT AT POST BASE	12.40	KIP*IN
MAX MOMENT AT CROSS BRACE	16.71	KIP*IN



BASE PLATE DETAIL

ROOF STAND NOTES:

1. ROOF STAND IS DESIGNED AND VERIFIED FOR THE FORCES DESCRIBED IN THIS DOCUMENT AS SUMMARIZED IN THE ENGINEERING CALCULATIONS INCLUDED.
2. STHT = STAND HEIGHT = MIN 18", MAX 30".
3. STWD = STAND POST SPACING = 30" MIN, 36" MAX.
4. STDP = STAND DEPTH = 24" MIN, 30" MAX.
5. EQUIPMENT SUPPORT AND FASTENERS TO STAND TOP RAIL ARE DEFINED IN SEPARATE DETAIL.
6. AC UNIT MUST BE CENTERED ON SUPPORT.
7. 3/8" BASE PLATE IS ANCHORED TO CONCRETE SLAB W/ ⅜" Ø ADHESIVE ANCHORS (HILTI HIT-HY 200+HAS) WITH MIN. 3" EMBED. OF GALV HAS RODS IN CONCRETE. ANCHOR GROUP CAPACITY COMBINED TENSION = 1775 LBS, SHEAR = 975 LBS, AND MOMENT 12400 IN*LBS.
8. IF NO ROOF SLAB, BASE PLATES SHALL BE ANCHORED TO STEEL ROOF FRAMING (DESIGNED BY OTHERS FOR THESE LOADS) WITH 3/8"Ø A307 BOLTS.

STEEL FABRICATION NOTES:

- ALL MATERIAL IS STEEL WITH MIN Fy = 35 KSI.
- ALL JOINTS SHALL BE WELDED CONTINUOUS ALL AROUND W/ 3/16" FILLET.

OTHER NOTES:

- EQUIPMENT SUPPORT IS NOT PART OF ROOF STAND.
- MIN NUMBER OF POSTS IS 4; 6 OR MORE AS INDICATED IN SKETCH TYPICALLY USED FOR DOUBLE OR MULTIPLE CONDENSERS.
- 1"± NON-METALLIC NON-SHRINK GROUT MAY BE USED UNDER THE BASE PLATES.

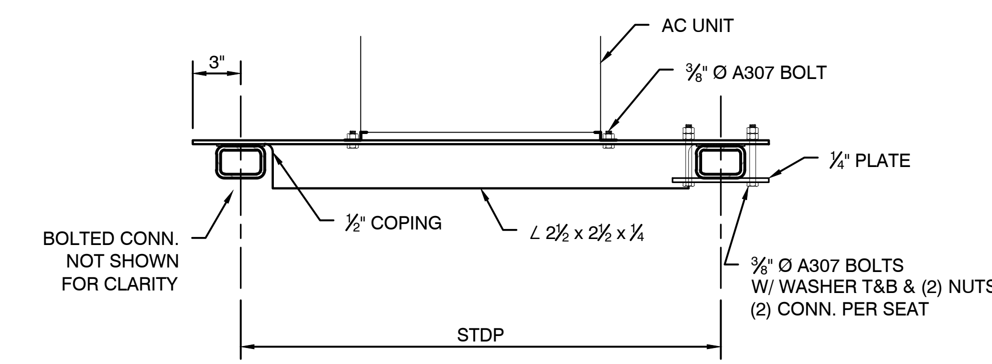
ENGINEERING CONFORMANCE ANALYSIS:

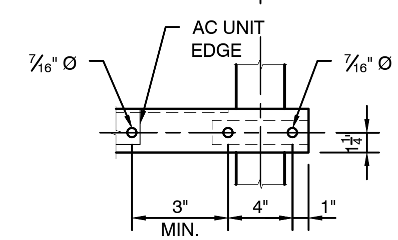
THE TABLE BELOW SHOWS DIMENSIONS, MIN STAND DEPTH, & SHELL ENCLOSURE SCREWS FOR SOME MODELS OF LG ELECTRONICS USA HVAC OUTDOOR EQUIPMENT THAT MEET THE FOLLOWING ANALYSIS:

- ROOF STAND STRENGTH: POST AND CROSS-BRACE STRENGTH TO RESIST UNIT WEIGHT AND WIND LOAD LATERAL AND VERTICAL SURFACES
- STAND POST ANCHORS: PULLOUT AND SHEAR DUE TO OVERTURNING AND SLIDING FORCE IS WITHIN REQUIREMENTS
- EQUIPMENT METAL COVER FASTENERS: MIN NUMBER AND SIZE

MODELS: LAU__HVP, LSU__HSV4, LAU090HYV1, LAU120HYV1, LUU__HV, LSU180HEV1									DESIGN CHECK W/ NOM/REQ'D >= 1.00 = OK			
	CONDENSER DIMENSIONS						ROOF STAND	SHELL SCREWS	STAND STRENGTH			METAL SHELL
MODEL #	W	D	H	M1	M4	Wt	DIMS: STDP MIN (IN)	ON LONG SIDE, QTY. & SIZE	ANCHOR SHEAR	UPLIFT	BRACE MOMENT	
LAU090HVP	30.31	11.31	21.50	13.00	22.00	81.6	24	8, #10	0.28	0.5	0.32	0.79
LAU120HVP	30.31	11.31	21.50	13.00	22.00	81.6	24	8, #10	0.28	0.5	0.32	0.79
LSU090HSV4	30.31	11.31	21.50	13.00	22.00	75	24	8, #10	0.28	0.5	0.32	0.79
LSU120HSV4	30.31	11.31	21.50	13.00	22.00	75	24	8, #10	0.28	0.5	0.32	0.79
LAU090HYV1	30.31	11.31	21.50	13.00	22.00	76.9	24	8, #10	0.28	0.5	0.32	0.79
LAU120HYV1	30.31	11.31	21.50	13.00	22.00	76.9	24	8, #10	0.28	0.5	0.32	0.79
LUU097HV	30.31	11.31	21.50	13.00	22.00	76.9	24	8, #10	0.28	0.5	0.32	0.79
LUU127HV	30.31	11.31	21.50	13.00	22.00	76.9	24	8, #10	0.28	0.5	0.32	0.79
LSU180HEV1	30.31	11.31	21.50	13.00	22.00	75.4	24	8, #10	0.28	0.5	0.32	0.79

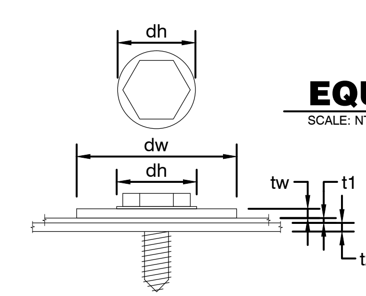
NOTE: THE STAND DIMENSIONS ARE MINIMUMS. STAND MAY BE BUILT TO SUPPORT MORE THAN ONE CONDENSER UNIT AS OUTLINED IN THE LG ELECTRONICS USA INSTALLATION MANUAL.





EQUIPMENT SUPPORT DETAIL

SCALE: NTS



ENCLOSURE FASTENERS		
DESCRIPTION	SIZE	UNITS
SCREW SIZE (d)	#10	
INTEGRAL WASHER SIZE (dw)	0.50	IN
THICKNESS OF SHEET METAL (t1)	0.043	IN
MIN. THICKNESS OF FRAME (t2)	0.07	IN
DEPTH OF PENETRATION	0.25	IN
SCREW YIELD STRENGTH	55	KSI
ALLOWABLE TENSILE STRENGTH/SCREW	321	LBS
ALLOWABLE PULLOVER STRENGTH/SCREW	371	LBS
ALLOWABLE PULL-OUT STRENGTH/SCREW	170	LBS

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DRAWING TITLE: 30-11-R-128 INFORMATION & DIAGRAMS

PROJECT TITLE: LG ELECTRONICS USA HVAC OUTDOOR CONDENSING UNIT ROOF MOUNT CONFIGURATION

REVISIONS

NO.	DATE	BY	DESCRIPTION

SCALE: NTS	DATE: 11/02/16
DRAWN BY: JDP	PROJECT MGR: PCP
PROJECT NO.: 160387	FLAT FILE:

DRAWING NO.: 30-11-R-128

SHEET 1 OF 2

ENGINEERING CALCULATION DETAIL SHEET

Outdoor Condensor Units on Roof Stand - Suitability Verification
Designed by: Paul C. Perrin, PE, SE

SINCE THIS DESIGN IS BASED ON WIND PRESSURE, qz, THIS DESIGN IS ALSO SUITABLE FOR THE FOLLOWING CASES:

- MIAMI DADE WIND SPEED = 186 MPH, RISK CATEGORY IV, EXPOSURE CATEGORY C, HEIGHT UP TO 320 FT.
- MIAMI DADE WIND SPEED = 186 MPH, RISK CATEGORY II, EXPOSURE CATEGORY D, HEIGHT UP TO 398 FT.
- BROWARD WIND SPEED = 180 MPH, RISK CATEGORY IV, EXPOSURE CATEGORY D, HEIGHT UP TO 289 FT.

DESIGN METHODOLOGY: ASD

OBJECTIVE:
Determine Wind Load on AC unit mounted on roof stand using ASCE 7 (2010), Section 29.5. Confirm stability, roof stand strength, anchor configuration and strength, and equipment envelope fastening.

WIND LOAD: (See also "Wind Design Requirements" on Drawing 1)

Vult = 186 mph (FBC 2014 1620.2) for Miami-Dade, Risk Category IV

From "29.3 Velocity Pressure"
qz = 0.00256*Kz*Kzt*Kd*V2 = 128.3 psf (Eq. 29.3-1)
From "29.5 Design Wind Loads - Other Structures"
F = qz(GCr)Af (Eq. 29.5-1)

Fvertical = 128.3 psf * (1.50) * Af = 192.5 psf x Area (ft^2)
Flateral = 128.3 psf * (3.10) * Af = 397.8 psf x Area (ft^2)

Example AC Unit:
Use LSU090HSV4 in Table w/ dims (W, D, H, Wt)=(30.31", 11.31", 21.5", 75.0 lbs)

WIND LOAD FORCES:

Top Area = 11.31" * 30.31" / (144 in^2/ft^2) = 2.38 sf
Fw vertical (Fw_vert) = 192.5 psf * 2.38 sf = 458 lbs (unfactored)

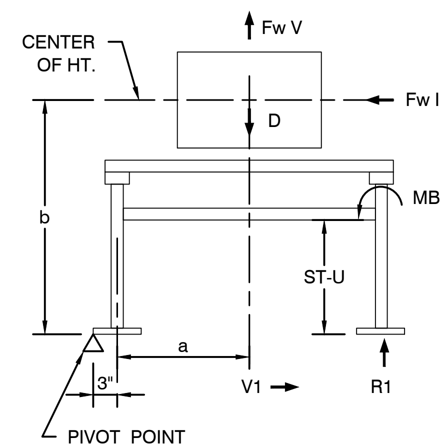
Long side Area = 30.31" * 21.5" / (144 in^2/ft^2) = 4.53 sf
Fw lateral (Fw_lat) = 397.8 psf * 4.53 sf = 1800 lbs (unfactored)

LOAD COMBINATIONS:

0.67D + 0.78W for overturning FBC 1605.3.2 Eq. 16-18
0.6D + 0.6W for sliding and anchors FBC 1605.3.1 Eq. 16-15

CALCULATE REACTION FORCES ON ROOF STAND:

Shear V1 = 0.6 * Fw_lat / 4 posts = 0.6 * 1800 #/ 4 = 270 lbs
Pull-up R1 = [0.6 * Fw_lat * b + (0.6 * Fw_vert - 0.6 * Wt) * (a+3")] / (2 * a+3")/ 2 posts
= [0.6*1800 #*(30"+21.5"/2)+(0.6*458#-0.6*75.0#)*(12"/2+3")]/(12"+3")/2
= 0.88 kips
Moment MB = V1 * ST-U = 270# * 20" = 5.40 kip*in



NOMINAL STRENGTH OF ROOF STAND:

All limits are based on posts at min. depth of 24", max. height of 30", and max. spacing of 36".
Limits: Shear at base, Uplift at one post, Moment on frame
Given:

1. (4) anchors per base with allowable max pull-up of 1775 lbs, allowable max shear of 975 lbs and allowable max moment of 12.40 in*kip per anchor group, (3/8"diameter adhesive anchor with 3" embedment in min 3000 psi concrete).
2. All welds 3/16" fillet. All materials steel with min Fy = 35 ksi.

Posts are 2.5" Ø standard pipe.

Cross brace is HSS 3 x 2 x 3/16

Limits per post:
Max shear = min(pipe shear, anchor shear)
= min(0.6 * 35 ksi * 1.61 * in^2 / 2 / 1.67, 0.975 kips)
= 0.975 kips
Max uplift at one post = anchor pull-up =879 lbs = 0.88 kips
Max moment at brace = min (brace flexural strength, weld strength, post flexural strength)
= min (46 ksi* 1.18 in^3/1.67, 2.78 kip/in * 2" * 3",35 ksi*1.01 in^3/1.67)
= min (32.5 kip*in, 16.71 kip*in, 21.2 kip*in)
=16.71 kip*in

DESIGN METHODOLOGY: ASD

VERIFY ANCHOR SHEAR RESISTANCE TO SLIDING:
Use Load Combination FBC 1605.3.1 Eq. 16-15
0.6D + 0.6W = 0.6 * Fw_lat = 0.6 * 1800# = 1080 lbs
Shear per post = 1080# / 4 = 270 lbs
Fsliding nominal = 0.975 kips
Since 0.975 kips > 0.27 kips

Resistance to Sliding Checks OK.

CHECK OVERTURNING ANCHOR PULLOUT/UPLIFT RESISTANCE:
Use Load Combination FBC 1605.3.1 Eq. 16-15
0.6D + 0.6W
On one post
Pull-up R1 = 0.88 kips
Max uplift at one post = 1.78 kips
Since 1.78 kips > 0.88 kips

Anchor Resistance to Overturning Checks OK.

CHECK BRACE RESISTANCE TO MOMENT:
Use worst case on one post
Moment at brace MB = 5.40 kip-in per post
Max moment at brace = 16.71 kip-in
Since 16.71 kip-in > 5.40 kip-in

Moment at Stand Brace Checks OK.

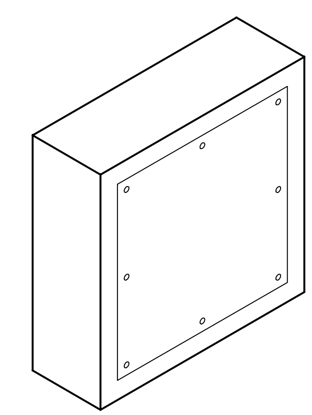
CHECK SHEET METAL ENVELOPE FASTENER RESISTANCE:
Analysis based on AISI S100-2007 "Cold Formed Steel Structural Members" Section E4:Screw Connections
Use Load Combination FBC 1605.3.1 Eq. 16-15
0.6D + 0.6W
On long side worst case
0.60 * Fw_lat = 0.60 * 1800# = 1080 lbs

Resistance to the metal shell pull-off is the minimum of the tensile strength of the screw and the pull-over strength of the sheet metal.

Inputs:
#10 screw, d = 0.19" with integral 0.5"-diameter washer
Thickness of metal shell, t1 = 0.043" (18 gauge)
Depth of penetration of screw into frame, tc = 0.25"
Strength of screw, Fu1 = 55 ksi

Based on the above data:
Allowable tensile of the screw, Pts/Ω = 321 lbs per screw (where Ω = 3.0)
Allowable Pull-out strength, Pnot/Ω = 170 lbs per screw
Allowable Pull-over strength, Pnov/Ω = 371 lbs per screw
Therefore the min number of screws per long side = 1080# / 170#/screw = 6.35 screws
Rounds up to min 7 screws per side, use 8 screws for symmetry.

Anchor Resistance to Metal Enclosure Pull-Off Checks OK.



VERIFY STRENGTH OF SUPPORT BARS AND CONNECTIONS:
Use Load Combination
0.67 D + 0.78 W
Max uplift on one side of AC Unit at mounting anchors:
F_M1 = (0.78*Fw_lat*H/2)/(2*M1)+(0.78*Fw_vert-0.67*Wt)/4 =
F_M1 = (0.78*1.80 kips*21.5 in/2)/(2*13 in)+(0.78*0.46 kips-0.67*0.08 kips)/4
F_M1 = 0.657 kips
Allowable tensile capacity of bolt = 2.49 kips > 0.657 kips

Bolt Resistance at Mounting Anchor Checks OK

Max uplift on one side of AC Unit at side support HSS:
F_STDP = (0.78*Fw_lat*H/2)/(2*STDP)+(0.78*Fw_vert-0.67*Wt)/4 =
F_STDP = (0.78*1.80 kips*21.5 in/2)/(2*30 in)+(0.78*0.46 kips-0.67*0.08 kips)/4
F_STDP = 0.328 kips
Allowable tensile capacity of 2 bolts = 2*2.49 kips=4.97 kips > 0.328 kips

Bolt Resistance at Side Supports Checks OK

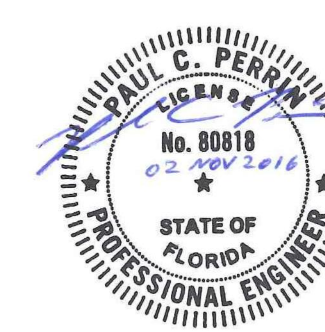
Max moment in Support Angle:
F_M1*(STDP-M1)/2 = 0.657 kips*(30 in-13in)/2 = 5.59 kip-in
Sx*Fy/Ω = 0.387 in^3 *36 ksi/1.67 = 8.34 kip-in > 5.59 kip-in

Support Angle Flexural Capacity Checks OK

Max moment in Side HSS:
F_STDP*(STWD-M4)/2 = 0.328 kips*(36 in-22 in)/2 = 2.30 kip-in
Sy*Fy/Ω = 0.932 in^3 *46 ksi/1.67 = 25.67 kip-in > 2.30 kip-in

Side HSS Flexural Capacity Checks OK

THE CALCULATIONS ON THE DRAWING ARE REPRESENTATIVE OF THE FOLLOWING LG ELECTRONICS OUTDOOR CONDENSING UNITS:
LAU090HVP
LAU120HVP
LSU090HSV4
LSU120HSV4
LAU090HYV1
LAU120HYV1
LUU097HV
LUU127HV
LSU180HEV1



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DRAWING TITLE: 30-11-R-128 CALCULATIONS

PROJECT TITLE: LG ELECTRONICS USA HVAC OUTDOOR CONDENSING UNIT ROOF MOUNT CONFIGURATION

REVISIONS

NO.	DATE	BY	DESCRIPTION

SCALE	DATE
NTS	11/02/16
DRAWN BY	PROJECT MGR
JDP	PCP
PROJECT NO.	FLAT FILE
160387	

DRAWING NO. 30-11-R-128