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	1.00
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
GCp= 0.9 FOR LATERAL FORCES (ZONE 4)
GCp= 2.3 FOR VERTICAL FORCES (ZONE 2)

THIS DESIGN IS FOR LG HVAC UNITS AND WALL BRACKETS IN WALL WIND ZONE 4

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 WALL BRACKET 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 WALL BRACKET WHICH IS SECURED TO THE WALL. THE WALL IS DESIGNED BY OTHERS.
4. ANCHORS USED TO FASTEN THE UNIT TO THE WALL BRACKET ARE A307 OR HIGHER STRENGTH STEEL BOLTS.
5. THE WALL BRACKET IS DESIGNED AND VERIFIED BY STRUCTURAL ANALYSIS BY THIS ENGINEER.
6. ALTERNATE WALL BRACKET DESIGNS THAT ARE DESIGNED TO RESIST THE ABOVE WIND LOADS MAY BE USED AT THE CONTRACTOR'S OPTION. FOR ALTERNATE WALL BRACKET DESIGNS, PROVIDE DETAILS AND CALCULATIONS SIMILAR TO THIS SHEET AND DETAILED CALCULATIONS ON SHEET 2, STAMPED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF FLORIDA.
7. THE CONTRACTOR IS REPONSIBLE FOR SAFETY, INSTALLATION, AND SPECIAL INSPECTIONS & TESTS PER FBC CHAPTER 17.

CALCULATIONS: SEE DETAILED CALCULATIONS ON SHEET 2.

LATERAL FORCES (SLIDING):

1. THE WIND LOAD ACTING ON THE SIDE AND FRONT OF THE UNIT ACTING OUTWARD.
2. THESE LATERAL FORCES MUST BE RESISTED BY THE SHEAR STRENGTH OF THE SUM OF THE ANCHORS BOTH HOLDING THE UNIT TO THE BRACKET AND THE BRACKET TO THE WALL.

MOMENT FORCE (OVERTURN):

3. THE WIND LOAD ACTING ON THE SIDE AND FRONT OF THE AC UNIT WILL PIVOT THE UNIT ABOUT THE SIDE. THE FRONT WIND LOAD AND THE DEAD LOAD WILL PIVOT ABOUT THE BOTTOM. A SUM OF VECTORS IS ALSO CALCULATED.
4. THIS PIVOTING FORCE MUST BE RESISTED BY THE WITHDRAWAL STRENGTH OF THE ANCHORS.

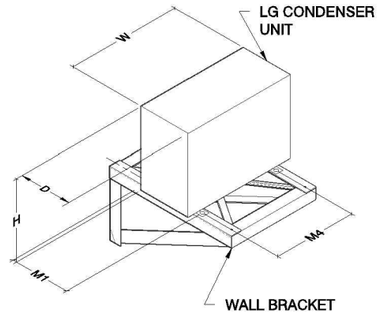
CLEARANCES:

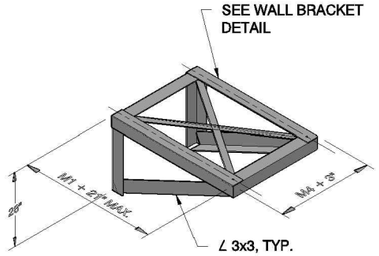
5. ANCHORS IN BRACKET METAL MUST HAVE EDGE CLEARANCES OF 1-1/2 DIAMETERS.
6. ANCHORS IN CONCRETE BLOCK MUST BE AT LEAST 12" FROM THE EDGE OF THE WALL.

ANCHOR STRENGTH: SEE TABLE THIS DRAWING.

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.



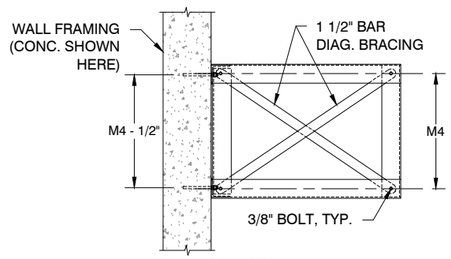


EQUIPMENT VIEW

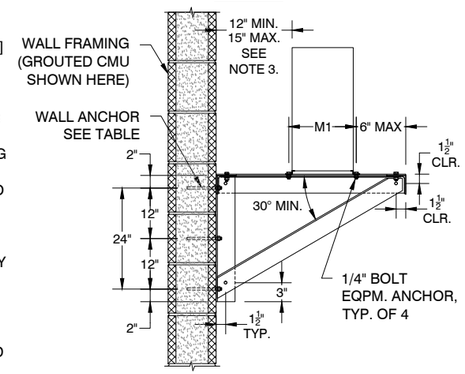
SCALE:

WALL BRACKET VIEW

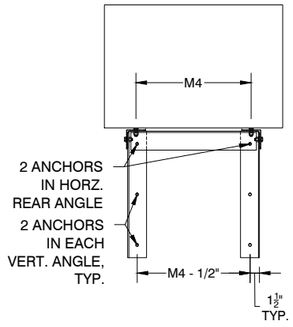
SCALE:



TOP VIEW



SIDE VIEW



FRONT VIEW

WALL BRACKET DETAIL

SCALE: 1/2" = 1'-0"

WALL BRACKET NOTES:

1. WALL BRACKET IS DESIGNED AND VERIFIED FOR THE FORCES DESCRIBED IN THIS DOCUMENT AS SUMMARIZED IN THE ENGINEERING CALCULATIONS INCLUDED.
2. WALL BRACKET HEIGHT = 28".
3. LG HVAC UNIT SHALL BE MIN 12" CLEAR FROM EXTERIOR FACE OF FINISHED WALL.
4. WALL BRACKETS SHALL BE EITHER ALL GALV STEEL MEMBERS WITH GALV BOLTS & ANCHORS, OR ALL ALUMINUM MEMBERS WITH STAINLESS STEEL BOLTS & ANCHORS (EXCEPT GALV ISOLATION ANCHORS FOR COLD FORMED STEEL STUD WALLS AND STRUCTURAL STEEL).

STEEL FABRICATION NOTES (SEE WALL BRACKET NOTE 4.):

- ALL MATERIAL SHALL BE GALVANIZED A36 STEEL WITH MIN Fy = 36 KSI.
- ALL JOINTS SHALL BE BOLTED WITH 1/2" DIAMETER GALV A307 BOLTS W/ LOCK WASHERS, OR WELDED CONTINUOUS W/ 3/16" FILLET (EXCEPT USE CONTINUOUS ⅛" FILLET WELD AT ⅛" MEMBERS).
- ALL STEEL ANGLES SHALL BE GALV L5X3X1/4 LONG LEG VERTICAL.
- ALL STEEL DIAGONAL BRACING SHALL BE 1 ½" X 1/8" GALV BARS.

ALUMINUM FABRICATION NOTES (SEE WALL BRACKET NOTE 4.):

- ALL MATERIAL SHALL BE ALUMINUM ALLOY 6061-T5 OR 6061-T6.
- ALL JOINTS SHALL BE BOLTED WITH 1/2" DIAMETER STAINLESS STEEL BOLTS W/ LOCK WASHERS, OR WELDED CONTINUOUS W/ 1/4" FILLET.
- ALL ALUMINUM ANGLES SHALL BE ALUMINUM L5X3X3/8 LONG LEG VERTICAL.
- ALL ALUMINUM DIAGONAL BRACING SHALL BE 1 ½" X 1/4" ALUMINUM BARS.

OTHER NOTES:

- EQUIPMENT SUPPORT IS NOT PART OF WALL BRACKET.

ENGINEERING CONFORMANCE ANALYSIS:

THE TABLE BELOW SHOWS DIMENSIONS AND SHELL ENCLOSURE SCREWS FOR SOME MODELS OF LG ELECTRONICS USA HVAC OUTDOOR EQUIPMENT THAT MEET THE FOLLOWING ANALYSIS:

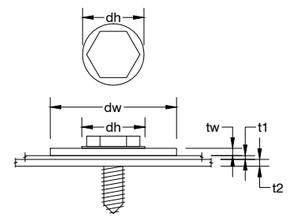
- WALL BRACKET STRENGTH: STRENGTH TO RESIST UNIT WEIGHT AND WIND LOADS ON LATERAL AND VERTICAL SURFACES
- WALL FRAME ANCHORS: PULLOUT AND SHEAR DUE TO UNIT WEIGHT AND WIND LOAD.
- EQUIPMENT METAL COVER FASTENERS: MIN NUMBER AND SIZE

MODELS: LMU3_CHV, LUU__7HV, LMU__0HV, ARUN0__GSS4									DESIGN CHECK W/ NOM/REQ'D >= 1.00 = OK				
	CONDENSER DIMENSIONS						WALL FRAME	SHELL SCREWS	STRENGTH				
MODEL #	W	D	H	M1	M4	Wt	WALL BRACKET HEIGHT (IN)	ON LONG SIDE, QTY. & SIZE	BOLT SHEAR	WALL ANCHOR SHEAR	WALL ANCHOR PULLOUT	BOLT TENSION	METAL SHELL
LMU30CHV	37.41	13.00	32.84	14.38	24.38	136.7	28	8, #10	0.24	0.87	0.53	0.29	0.44
LMU36CHV	37.41	13.00	32.84	14.38	24.38	136.7	28	8, #10	0.24	0.87	0.53	0.29	0.44
LUU187HV	37.41	13.00	32.84	14.38	24.38	132.3	28	8, #10	0.24	0.87	0.53	0.29	0.44
LUU247HV	37.41	13.00	32.84	14.38	24.38	132.3	28	8, #10	0.24	0.87	0.53	0.29	0.44
LMU480HV	37.41	13.00	54.34	14.38	24.38	213.8	28	12, #10	0.39	0.91	0.93	0.59	0.72
LMU540HV	37.41	13.00	54.34	14.38	24.38	213.8	28	12, #10	0.39	0.91	0.93	0.59	0.72
LMU600HV	37.41	13.00	54.34	14.38	24.38	213.8	28	12, #10	0.39	0.91	0.93	0.59	0.72
LUU367HV	37.41	13.00	54.34	14.38	24.38	202.8	28	12, #10	0.39	0.91	0.93	0.59	0.72
LUU427HV	37.41	13.00	54.34	14.38	24.38	202.8	28	12, #10	0.39	0.91	0.93	0.59	0.72
ARUN038GSS4	37.41	13.00	54.34	14.38	24.38	207	28	12, #10	0.39	0.91	0.93	0.59	0.72
ARUN048GSS4	37.41	13.00	54.34	14.38	24.38	207	28	12, #10	0.39	0.91	0.93	0.59	0.72
ARUN054GSS4	37.41	13.00	54.34	14.38	24.38	207	28	12, #10	0.39	0.91	0.93	0.59	0.72

WALL ANCHOR TYPE AND STRENGTH (ASD LOADS)					
WALL STRUCTURE	ANCHOR DESCRIPTION	EMBEDMENT LENGTH	MANUFACTURER	PULLOUT (LBS)	SHEAR (LBS)
CONCRETE	5/8" HILTI KWIK BOLT 3	4" EMBED	HILTI	2800	320
GROUTED CONCRETE MASONRY UNITS	1/2" HILTI HAS RODS W/ HIT-HY 200 ADHESIVE ANCHORAGE	3 1/2" EMBED	HILTI	2910	375
WOOD STUDS	NOT PERMITTED FOR THIS CASE	--	--	--	--
COLD-FORMED STEEL STUDS 14 GA. (68 MILS)	(10) #12 SCREWS @ 3/4" X 3/4"	MIN 3 EXPOSED THREADS	ANY	2613	7427
COLD-FORMED STEEL STUDS ≤ 16 GA.(54MILS)	NOT PERMITTED FOR THIS CASE	--	--	--	--
STRUCTURAL STEEL	1/2" A307 BOLT	NOT APPLICABLE	ANY	4418	2651

WALL ANCHOR NOTES:

1. Poured concrete wall is min. 3000 psi. Concrete block is medium weight, or lightweight, with f'g=2500 psi normal weight grout and max. one anchor per half block.
2. Wood stud wall is nominal 2"x4" with anchor centered in stud.
3. Anchors for steel wall brackets shall be galvanized. Anchors for aluminum wall brackets shall be stainless steel (except at steel studs and structural steel, use galvanized isolation screws that prevent direct contact between the aluminum and the galvanized anchors).
4. Install anchors per manufacturer's recommendations.



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'S TITLE: 37-13-W-128-Z4 INFORMATION & DIAGRAMS

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

REVISIONS

NO.	DATE	BY	DESCRIPTION

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

DRAWING NO.
37-13-W-128
Z4

SHEET 1 OF 2

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ENGINEERING CALCULATION DETAIL SHEET

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

THE CALCULATIONS ON THE DRAWING ARE REPRESENTATIVE OF THE FOLLOWING LG ELECTRONICS OUTDOOR CONDENSING UNITS:

LMU30CHV
LMU36CHV
LUU187HV
LUU247HV
LMU480HV
LMU540HV
LMU600HV
LUU367HV
LUU427HV
ARUN038GSS4
ARUN048GSS4
ARUN054GSS4

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.

THIS DESIGN IS FOR HVAC UNITS AND WALL BRACKETS IN WALL WIND ZONE 4. HVAC UNITS AND WALL BRACKETS SHALL NOT BE WITHIN 3 FEET OF ANY BUILDING CORNER OR TOP OF WALL. FOR THIS PURPOSE, A BUILDING CORNER IS DEFINED AS ANYWHERE TWO EXTERIOR WALLS INTERSECT.

DESIGN METHODOLOGY: ASD

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

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

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

From "29.3 Velocity Pressure" for Building Height = 200'
qz = 0.00256*Kz*Kzt*Kd*V2 = 128.3 psf (Eq. 29.3-1)
From ASCE 7 Chapter 30 "Wind Loads - Components & Cladding"
Table 30-6.1 for Building h > 60 ft.
F = qz(GCp)Af
Fvertical (uplift) = 128.3 psf * (2.3) * Af = 295 psf x Area (ft²)
Fvertical (down) = 128.3 psf * (0.9) * Af = 115 psf x Area (ft²)
Flateral = 128.3 psf * (0.9) * Af = 115 psf x Area (ft²)

Example AC Unit:
Use LUU187HV in Table w/ dims (W, D, H, Wt)=(37.41", 13.00", 32.84", 132.3 lbs)

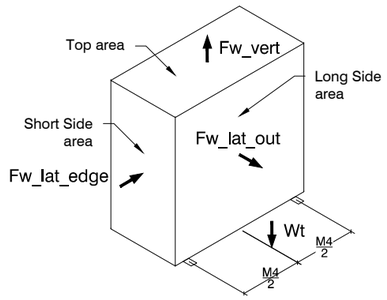
Example Anchors:
5/8" HILTI KWIK BOLT 3 with 4" embedment with capacity of combined pullout load of 2800# and shear load of 320#.

WIND LOAD FORCES:

Top Area = 37.41" * 13.00" / (144 in²/ft²) = 3.38 sf
Fw vertical (Fw_vert) = 295 psf * 3.38 sf = 997 lbs (unfactored)
Fw vertical downward (Fw_vert_down) = 115 psf * 3.38sf = 390 lbs (unfactored)
Long Side Area =37.41" * 32.84" / (144 in²/ft²)) = 8.53 sf
Fw lateral (Fw_lat_out) = 115 psf * 8.53 sf = 985 lbs (unfactored)
Short Side Area = 13.00" * 32.84" / (144 in²/ft²) = 2.97 sf
Fw lateral (Fw_lat_edge) = 115 psf * 2.97 sf = 342 lbs (unfactored)

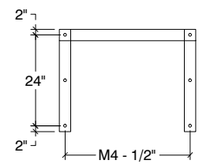
LOAD COMBINATIONS:

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

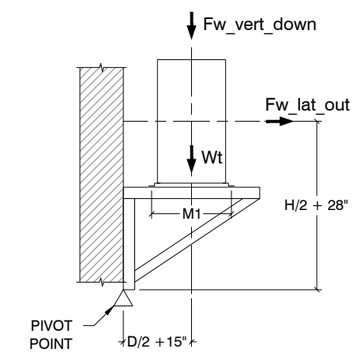


VERIFY BOLT SHEAR RESISTANCE TO AC UNIT SLIDING:
Shear Vbolt = 0.6 * √ (Fw_lat_out² + Fw_lat_edge²) = 626 lbs
Rn / Ω =663# * 4 bolts = 2652 lbs > 626 lbs
Resistance to Bolt Shear Checks OK

VERIFY WALL ANCHOR SHEAR RESISTANCE:
Shear Vwall = 0.6 * √ [(Fw_vert - Wt)² + Fw_lat_edge²] = 558 lbs
Wall Anchor Shear Capacity = 320# * 4 bolts = 1280 lbs > 558 lbs
Resistance to Wall Anchor Shear Checks OK



CHECK ANCHOR PULLOUT FROM MOMENT ABOUT BOTTOM OF BRACKET:
Consider downward vertical wind load with equal pressure to lateral suction wind load on wall.
Moment Mbot =
= 0.78 * Fw_lat_out * (H/2 + 24" + 4") + (0.67 * Wt + 0.78 * Fw_vert_down) * (D/2 + 15")
= 41.82 kip*in
Wall Anchor Pullout Capacity = 2800 lbs > Mbot / [2 anchors * (24" + 2")] =804 lbs
Resistance to Wall Anchor Pullout Checks OK

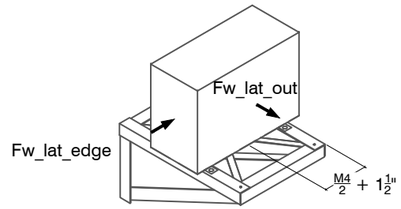


DESIGN METHODOLOGY: ASD

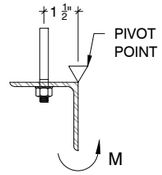
CHECK ANCHOR PULLOUT FROM MOMENT ABOUT SIDE OF BRACKET:
Moment Mside = 0.78 * Fw_lat_edge * (D/2 + 15") + 0.78 * Fw_lat_out * (M4/2 + 1.5")
= 16.28 kip*in
Wall Anchor Pullout Capacity = 2800 lbs > Mside / M4 = 16.28 kip*in / 24.41" = 667 lbs
Resistance to Wall Anchor Pullout Checks OK

CHECK ANCHOR PULLOUT FROM COMBINED MOMENTS:
Mbot / [2 anchors * (24" + 2") * R_pullout] + Mside / (1 anchor * M4 * R_pullout) = 0.525 < 1.00
Resistance to Wall Anchor Pullout Checks OK

CHECK MOMENT AND BOLT TENSION OF BRACKET BOLT:
Moment Mot = 0.78 * Fw_lat_out * H/2 + (0.78 * Fw_vert - 0.67 * Wt) * M4 / 2
= 21.03 kip*in
Bolt Tension Capacity = 1104lbs > Mot / (2 bolts * M1) = 21.03 kip*in / (2 * 14.38") = 731 lbs
Resistance to Overturning Checks OK



CHECK DIAGONAL BRACING:
Mside / 1.5" = 16.28 kip*in / 1.5" = 10853 lbs > R_pullout = 2800 lbs
Therefore, horizontal diagonal bracing is required at the top angles of the bracket.
Use X-brace with 1/8" x 1.5" bars.
Tension capacity R_bar = 1.5" * 0.125" * 36 ksi / Ω
= 1.5" * 0.125" * 36 ksi / 1.67
= 4.04 kip
Bar Tension = 0.6 * Fw_lat_edge * (M1/2 + 15") / (M1 + 15") * √ [M4² + (M1 +15")²] / M4
= .243 kip < 4.04 kip
Diagonal Bracing Resistance to Tension Checks OK

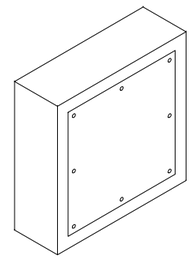


CHECK SHEET METAL ENVELOPE FASTENER RESISTANCE :
Analysis based on AISI S100-2007 "Cold Formed Steel Structural Members" Section E4:Screw Connections
Use Load Combination FBC 1605.3.1 Eq. 16-15
0.6D + 0.6W
On long side worst case
0.60 * Fw_lat_out = 0.60 * 985# = 591 lbs

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 = 591# / 170#/screw = 3.48 screws
Rounds up to min 4 screws per side, use 8 screws for symmetry and spacing.
Anchor Resistance to Metal Enclosure Pull-Off Checks OK.



SCREW PATTERN
SCALE: NTS

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DRAWING TITLE: 37-13-W-128-Z4 CALCULATIONS
PROJECT TITLE: LG ELECTRONICS USA HVAC OUTDOOR CONDENSING UNIT WALL MOUNT CONFIGURATION

REVISIONS

NO.	DATE	BY	DESCRIPTION

SCALE	DATE
NTS	11/11/16
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