REPRINTED 5-9-19
CORRECTED PHONE #

HEIGHTS TOWER SYSTEMS
Manufacturers of Aluminum Towers and Structures

ORDER ACKNOWLEDGEMENT

Date: 4/29/2019
QUOTE # 19-429

To: Steve Koogler
8865 Barrington Way
Springboro, OH 45066
Email: k8dzsteve@gmail.com
Ph#: 937-266-5507

Ship To: Steve Koogler
8865 Barrington Way
Springboro, OH 45066

For a 64 ft. aluminum stacked tower rated for 22 sq. ft. in winds of 80 mph, mounted on a Fold Over Kit. Overall height of tower on Stand is approx. 69 ft., not incl. mast, which will add more height.

Supervisor	Est. Ship Time	FOB	SHIP VIA
DD	12+ Weeks ARO	Pensacola, FL	Van Truck

LINE	QTY	PRODUCT I.D.	DESCRIPTION
1	1	A64_22sf@80mph, consi	A64 22sq ft@80 mph, consisting of 8 ft. sections:
2	2	AC18-131	Aluminum Center Section - 8 ft. length
3	1	AC18-172	Aluminum Center Section - 8 ft. length
4	1	AJ22-172	Aluminum Junction Section - 8 ft. length
5	1	AC22-225	Aluminum Center Section - 8 ft. length
6	1	AJ26-225	Aluminum Junction Section - 8 ft. length
7	1	AJ30-225	Aluminum Junction Section - 8 ft. length
8	1	AC30-288	Aluminum Center Section - 8 ft. length
9	1	HBT30-288	Hinge Base, 30-288, threaded adjustable version
10	1	Rebar Cage	Pre-fabricated Rebar Cage for base pad
11	1	4' Stand, 30-288	Four Foot Stand, 30-288, for Fold Over Kit
12	1	FOK30-288	Fold Over Kit, 30-288, all aluminum
13	1	Screw System, 1.25"	Screw Actuator System, 1.25" dia, for Fold Over Kit
14	1	Pre-Wired GM Kit	Pre-wired Gearmotor Kit, for FOK, OPTIONAL
15	1	TS18-131	Top Shelf 18-131, drilled for GS-065
16	1	GS-065	Yaesu Thrust Bearing, GS-065, up to 2.66" OD mast capacit
17	1	RS18-131	Rotor Shelf 18-131, drilled for rotor
18	1	Grdg Kit, 3 leg	Grounding Kit, lightning protection, 3 ground rods, cable,etc
19	1	Cals/Diagram	Non-Stamped Calcs and Diagrams per the 2009 IBC
20	1	Packaging	Palletting and Packaging
21	1	Est. Shipping	Estimated Shipping to OH -- Price subject to change

Thank you for the opportunity to quote your tower project.

Please let us know if you have any questions.

HEIGHTS TOWER SYSTEMS

1529 Gulf Beach Hwy.
Pensacola, FL 32507
(850) 455-1210
(850) 455-4355 FAX

MAXIMUM ANTENNA WINDLOAD OF 22 SQ. FT. AT 1' - ABOVE TOP IN 80 MPH WINDS ON TOWER (69') PER 2009 INTL. BLDG. CODE.

Model: A64 22sf@80mph on FOK

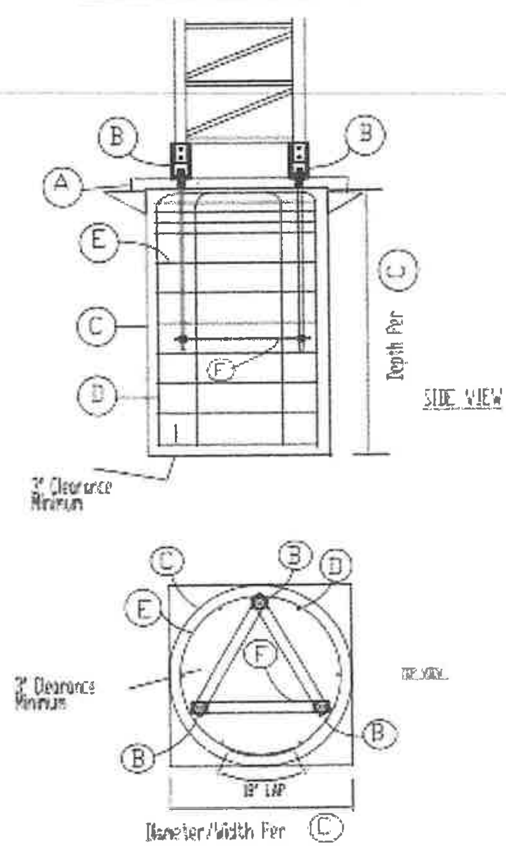
64 Ft. Tapered Fold Over Tower mounted on 4 Ft Stand. Overall height on Stand is 69 Ft.

Customer: Steve Koogler
Springboro, OH 45066

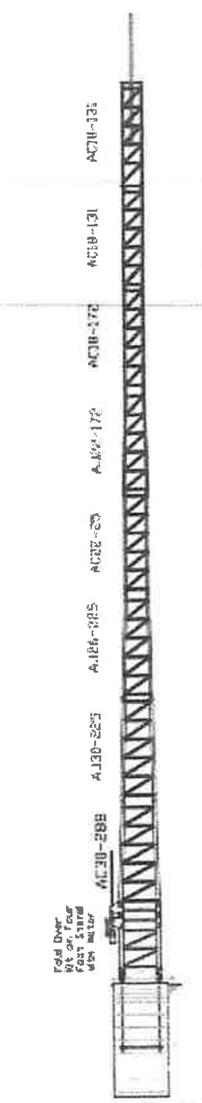
Date: May 9, 2019

Drawing NOT TO SCALE

TOWER FOUNDATION



TOWER PROFILE



FOUNDATION NOTES:

- (A) FOUNDATION SHOULD BE AT LEAST 1' to 3' ABOVE GRADE
- (B) TOWER BASE CLEVIS ASSY, BOLTED TO 1.25" Ø THREADED RODS, B7 ALLOY; TO BE EMBEDDED A MINIMUM 54" DEPTH
- (C) CONC FTG - 5' DIAMETER AND 7' 2" BELOW GRADE IF CIRCULAR. DEPTH MAY BE REDUCED IF SQUARE FOUNDATION USED.
- (D) (6) GR. 60 VERT BARS W/STD HOOK @ TOP - BAR SIZE PER CALCULATION, #6 SIZE
- (E) (4) #3 BARHOOPS @ 4" @ TOP OF FTG. #3 BARHOOPS @ 12" OC ELSEWHERE PER CALCULATION
- (F) FLATBAR SPACER BARS, 3" x 1/4", DRILLED ON TOWER LEG CENTERS OF 28.5", 1.25"Ø HOLES, AS SPECIFIED IN CALCULATIONS.

<CUA66 18sf@ 70 mph w FOK B.xls><CUA88 20sf@ 70 mph w FOK.xls><A64 22sf@80mph w FOK.xls>

K8DZ

TOWER NOTES: UNLESS OTHERWISE SPECIFIED

1. THE TOWER SHALL BE FABRICATED AND ASSEMBLED IN ACCORDANCE WITH THE 2009 INTERNATIONAL BLDG. CODE.

2. CONCRETE SLUMP SHALL NOT EXCEED 4-1/2 INCHES AND CONCRETE SHALL MEET A MINIMUM COMPRESSIVE STRENGTH OF 2500 PSI AT 28 DAYS.

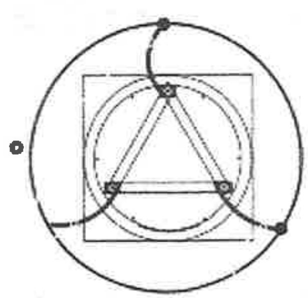
3. THE FOUNDATION DESIGN IS ADEQUATE FOR SOILS WITH ALLOWABLE LATERAL BEARING VALUES GREATER THAN OR EQUAL TO 150 LBS/SQ. FT./FOOT OF DEPTH AS LISTED IN THE IBC.

4. FOUNDATION WIDTH MAY BE SIZED FROM 5' TO 5' 6" WITHOUT ADVERSE IMPACT ON FOUNDATION. BASE PAD MAY HAVE ELLIPTICAL OR RECTANGULAR SHAPE. REBAR AND BASE MOUNT SHALL BE CENTERED ACCORDINGLY AND REQUIRED CONCRETE WILL VARY BETWEEN APPROX. 5.5 TO 8 CUBIC YARDS, DEPENDING ON EXACT SHAPE. ORDER ENTIRE READY-MIX LOAD TO AVOID SHORTAGE.

SECTION SIZES [inches]

SIZE	Leg Dia.	Leg Wall	Lattice Dia.
18-132	1.32"	0.148"	1/2"
18-172	1.72"	0.193"	9/16"
22-172	1.72"	0.193	9/16"
22-225	2.25"	0.25	5/8"
26-225	2.25"	0.25	5/8"
34-225	2.25"	0.25	5/8"
34-288	2.88"	0.276	11/16"
34-STAND	2.88"	0.276	1.31" OD x .240"

Material: 6061 T6 Alum. for legs, 6061 T6 for lattice rods



HEIGHTS
TOWER SYSTEMS
1529 Gulf Beach Hwy • Pensacola, FL 32507
Phone (850) 455-1210 • Fax (850) 455-4355
www.heightstowers.com

CALCULATIONS - Steve Koogler

64-FOOT TAPERED ALUMINUM TOWER—80MPH WIND SPEED (OVERALL HEIGHT ON STAND IS 69-FOOT)

PROJECT DATA

Tower Height: $h_{top} := 69 \cdot ft$

Antenna Wind Area: $A_{ant} := 21 \cdot ft^2$ Rotor Wind Area: $A_{rot} := 1 \cdot ft^2$

Antenna Weight: $W_{ant} := 150 \cdot lbf$ Rotator Weight: $W_{rot} := 35 \cdot lbf$

Basic Wind Speed: $bws := 80 \cdot mph$

DESIGN CRITERIA

BUILDING CODE **2009 International Building Code**

WIND LOAD IBC 2009 Sec.1609

Wind Velocity Pressure:
ASCE 7-10 Ch. 27
Qs = 0.00256*V²

$BWS := (85\ \ 90\ \ 100\ \ 105\ \ 110\ \ 120\ \ 125\ \ 130\ \ 140\ \ 150\ \ 160\ \ 170)^T \cdot mph$

$Q_S := (18.5\ \ 20.7\ \ 25.6\ \ 28.2\ \ 31.0\ \ 36.9\ \ 40.0\ \ 43.3\ \ 50.2\ \ 57.6\ \ 65.5\ \ 74.0)^T \cdot psf$

$q_s(bws) := \max\left(\text{linterp}(BWS, Q_S, bws), Q_{S_0}\right)$

Topographic Factor:
ASCE 7-10 Section 26.8.2

$K_{zt} := 1.0$

Wind Directionality Factor:
ASCE 7-10 Section 26.6

$K_d := 0.85$

Gust Factor:
ASCE 7-10 Section 26.9

$G := 0.85$

Velocity Pressure Coefficients :
ASCE 7-10 Table 27.3-1,
Exposure "D"

$H := (15\ \ 20\ \ 25\ \ 30\ \ 40\ \ 50\ \ 60\ \ 70\ \ 80)^T \cdot ft$

$K_z := (1.03\ \ 1.08\ \ 1.12\ \ 1.16\ \ 1.22\ \ 1.27\ \ 1.31\ \ 1.34\ \ 1.38)^T$

$K_z(h) := \max\left(\text{linterp}(H, K_z, h), K_{z_0}\right)$

Force Pressure Coefficient:
ASCE 7-10 *Figure 29.5-1 & 29.5-2*

$C_f := 1.3$ *Cylindrical elements, < 2" in diameter.* $C_{fAnt} := 1.3$ $C_{fRot} := 1.3$

Design Wind Load Functions:
ASCE 7-10 *Section 29.5*

$P_w(h, bws) := 0.6\left(K_z(h) \cdot q_s(bws) \cdot K_d \cdot K_{zt}\right) \cdot C_f \cdot G$ *Tower*

$P_{wAnt}(h, bws) := 0.6\left(K_z(h) \cdot q_s(bws) \cdot K_d \cdot K_{zt}\right) \cdot C_{fAnt} \cdot G$ *Antenna*

$P_{wRot}(h, bws) := 0.6\left(K_z(h) \cdot q_s(bws) \cdot K_d \cdot K_{zt}\right) \cdot C_{fRot} \cdot G$ *Rotator*

TOWER SECTION PROPERTIES

Section Index Values: i = 0 (11"), 1 (14"), 2 (18"), 3 (22"), 4 (26"), 5 (30"), 6 (35")

i =	0	1	2	3	4	5	6
	11"	14"	18"	22"	26"	30"	35"

Leg Tube Index Values:

j =	0	1	2	3	4
	100	131	172	225	288

Tower Section Length: $L_s := 8 \cdot ft$

Tower Section Leg Moment Arm: $d := (8.66\ \ 11.26\ \ 14.51\ \ 17.75\ \ 21.22\ \ 24.68\ \ 28.80)^T \cdot in$

Tower Section Allowable Moment:

100 131 172 225 288 350 400 288S

$$M_R := \begin{pmatrix} 4200 & 6900 & 0 & 0 & 0 & 0 & 0 & 0 \\ 5400 & 8900 & 17300 & 0 & 0 & 0 & 0 & 0 \\ 0 & 11400 & 22100 & 38500 & 0 & 0 & 0 & 0 \\ 0 & 30000 & 26900 & 47200 & 0 & 0 & 0 & 0 \\ 0 & 0 & 32000 & 56400 & 85400 & 0 & 0 & 0 \\ 0 & 0 & 37200 & 65600 & 96300 & 135400 & 0 & 0 \\ 0 & 0 & 43100 & 76500 & 112300 & 158000 & 0 & 333100 \\ 0 & 0 & 0 & 0 & 0 & 185300 & 0 & 389400 \\ 0 & 0 & 0 & 0 & 0 & 223400 & 200500 & 453300 \end{pmatrix} \cdot lbf \cdot ft$$

288 350 400 288S

Tower Section Allowable Shear:

$$V_R := \begin{pmatrix} 390 & 390 & 0 & 0 & 0 & 0 & 0 & 0 \\ 740 & 750 & 770 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1210 & 1230 & 1270 & 0 & 0 & 0 & 0 \\ 0 & 1760 & 1820 & 1820 & 0 & 0 & 0 & 0 \\ 0 & 0 & 2290 & 2350 & 2560 & 0 & 0 & 0 \\ 0 & 0 & 1930 & 1990 & 2050 & 4580 & 0 & 0 \\ 0 & 0 & 2320 & 2380 & 2450 & 3580 & 0 & 3470 \\ 0 & 0 & 0 & 0 & 0 & 2230 & 0 & 3290 \\ 0 & 0 & 0 & 0 & 0 & 2230 & 3050 & 2940 \end{pmatrix} \cdot lbf$$

Tower Section Wind Areas:

$$A_w := \begin{pmatrix} 1.8 & 2.2 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1.9 & 2.3 & 2.9 & 0 & 0 & 0 & 0 & 0 \\ 0 & 2.5 & 3.0 & 3.7 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3.3 & 4.0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 3.5 & 4.2 & 5.0 & 0 & 0 & 0 \\ 0 & 0 & 3.7 & 4.4 & 5.2 & 6.24 & 0 & 0 \\ 0 & 0 & 4.1 & 4.8 & 5.6 & 6.5 & 0 & 5.70 \\ 0 & 0 & 0 & 0 & 0 & 9.92 & 0 & 8.62 \\ 0 & 0 & 0 & 0 & 0 & 9.92 & 11.11 & 8.94 \end{pmatrix} \cdot ft^2$$

Tower Section Weight:

$$W_s := \begin{pmatrix} 15 & 20 & 0 & 0 & 0 & 0 & 0 & 0 \\ 19 & 23 & 36 & 0 & 0 & 0 & 0 & 0 \\ 0 & 28 & 40 & 59 & 0 & 0 & 0 & 0 \\ 0 & 0 & 46 & 65 & 0 & 0 & 0 & 0 \\ 0 & 0 & 54 & 73 & 93 & 0 & 0 & 0 \\ 0 & 0 & 58 & 77 & 96 & 131 & 0 & 0 \\ 0 & 0 & 70 & 89 & 108 & 138 & 0 & 243 \\ 0 & 0 & 0 & 0 & 0 & 218 & 0 & 372 \\ 0 & 0 & 0 & 0 & 361 & 217 & 217 & 388 \end{pmatrix} \cdot lbf$$

TOWER DESIGN

TOP OF TOWER (Antenna / Rotator)

Top of Tower: $h := h_{top}$

Shear @ Top of Tower: $V := P_{wAnt}(h, bws) \cdot A_{ant} + P_{wRot}(h, bws) \cdot A_{rot}$ $V = 306.7 \cdot lbf$

Weight @ Top of Tower: $W := W_{ant} + W_{rot}$ $W = 185 \cdot lbf$

Moment @ Top of Tower: $M := 0 \cdot lbf \cdot ft$

Tower Section Length: $L_s := 12 \cdot ft$

SECTION 1

Tower Section Length: $L_s := 8 \cdot ft$

Section Size Index: $i := 2$ Leg Tube Index: $j := 1$

Wind Area: $A_{w_{i,j}} = 2.5\,ft^2$ Allowable Moment: $M_{R_{i,j}} = 11400 \cdot lbf \cdot ft$

Weight: $W_{s_{i,j}} = 28 \cdot lbf$ Allowable Shear: $V_{R_{i,j}} = 1210 \cdot lbf$

Bottom Height: $h := h - L_s$ $h = 61\,ft$

Wind Force on Section: $F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$ $F_{wind} = 34.5 \cdot lbf$

Weight @ Bottom: $W := W + W_{s_{i,j}}$ $W = 213 \cdot lbf$

Moment @ Bottom: $M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$ $M = 2677 \cdot lbf \cdot ft$ $< M_r \rightarrow$ OK

Shear @ Bottom: $V := V + F_{wind}$ $V = 341 \cdot lbf$ $< V_r \rightarrow$ OK

REQUIRED SECTION: 18" x 131

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SECTION 2

Tower Section Length: $L_s := 8 \cdot ft$

Section Size Index:	$i := 2$	Leg Tube Index:	$j := 1$
Wind Area:	$A_{w_{i,j}} = 2.5\,ft^2$	Allowable Moment:	$M_{R_{i,j}} = 11400 \cdot lbf \cdot ft$
Weight:	$W_{s_{i,j}} = 28 \cdot lbf$	Allowable Shear:	$V_{R_{i,j}} = 1210 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 53\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$	$F_{wind} = 33.8 \cdot lbf$	
Weight @ Bottom:	$W := W + W_{s_{i,j}}$	$W = 241 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 5639 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 375 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: **18" x 131**

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SECTION 3

Tower Section Length: $L_s := 8 \cdot ft$

Section Size Index:	$i := 2$	Leg Tube Index:	$j := 2$
Wind Area:	$A_{w_{i,j}} = 3\,ft^2$	Allowable Moment:	$M_{R_{i,j}} = 22100 \cdot lbf \cdot ft$
Weight:	$W_{s_{i,j}} = 40 \cdot lbf$	Allowable Shear:	$V_{R_{i,j}} = 1230 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 45\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$	$F_{wind} = 39.6 \cdot lbf$	
Weight @ Bottom:	$W := W + W_{s_{i,j}}$	$W = 281 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 8911 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 415 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: **18" x 172**

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SECTION 4

Tower Section Length: $L_s := 8 \cdot ft$

Section Size Index:	$i := 3$	Leg Tube Index:	$j := 2$
Wind Area:	$Aw_{i,j} = 3.3\,ft^2$	Allowable Moment:	$MR_{i,j} = 26900 \cdot lbf \cdot ft$
Weight:	$Ws_{i,j} = 46 \cdot lbf$	Allowable Shear:	$VR_{i,j} = 1820 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 37\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot Aw_{i,j}$	$F_{wind} = 42.1 \cdot lbf$	
Weight @ Bottom:	$W := W + Ws_{i,j}$	$W = 327 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 12558 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 457 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: 22" x 172

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SECTION 5

Tower Section Length: $L_s := 8 \cdot ft$

Section Size Index:	$i := 3$	Leg Tube Index:	$j := 3$
Wind Area:	$Aw_{i,j} = 4\,ft^2$	Allowable Moment:	$MR_{i,j} = 47200 \cdot lbf \cdot ft$
Weight:	$Ws_{i,j} = 65 \cdot lbf$	Allowable Shear:	$VR_{i,j} = 1820 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 29\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot Aw_{i,j}$	$F_{wind} = 49.1 \cdot lbf$	
Weight @ Bottom:	$W := W + Ws_{i,j}$	$W = 392 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 16601 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 506 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: 22" x 225

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SECTION 6

Tower Section Length:	$L_s := 8 \cdot ft$		
Section Size Index:	$i := 4$	Leg Tube Index:	$j := 3$
Wind Area:	$A_{w_{i,j}} = 4.2\,ft^2$	Allowable Moment:	$M_{R_{i,j}} = 56400 \cdot lbf \cdot ft$
Weight:	$W_{s_{i,j}} = 73 \cdot lbf$	Allowable Shear:	$V_{R_{i,j}} = 2350 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 21\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$	$F_{wind} = 49.0 \cdot lbf$	
Weight @ Bottom:	$W := W + W_{s_{i,j}}$	$W = 465 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 21118 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 555 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: **26" x 225**

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SECTION 7

Tower Section Length:	$L_s := 8 \cdot ft$		
Section Size Index:	$i := 5$	Leg Tube Index:	$j := 3$
Wind Area:	$A_{w_{i,j}} = 4.4\,ft^2$	Allowable Moment:	$M_{R_{i,j}} = 65600 \cdot lbf \cdot ft$
Weight:	$W_{s_{i,j}} = 77 \cdot lbf$	Allowable Shear:	$V_{R_{i,j}} = 1990 \cdot lbf$

Bottom Height:	$h := h - L_s$	$h = 13\,ft$	
Wind Force on Section:	$F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$	$F_{wind} = 48.2 \cdot lbf$	
Weight @ Bottom:	$W := W + W_{s_{i,j}}$	$W = 542 \cdot lbf$	
Moment @ Bottom:	$M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$	$M = 26122 \cdot lbf \cdot ft$	$< M_r \rightarrow$ OK
Shear @ Bottom:	$V := V + F_{wind}$	$V = 603 \cdot lbf$	$< V_r \rightarrow$ OK

REQUIRED SECTION: **30" x 225**

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BASE SECTION

Tower Section Length:	$L_s := 8 \cdot ft$		
Section Size Index:	$i := 5$	Leg Tube Index:	$j := 4$
Wind Area:	$A_{w_{i,j}} = 5.2\, ft^2$	Allowable Moment:	$M_{R_{i,j}} = 96300 \cdot lbf \cdot ft$
Weight:	$W_{s_{i,j}} = 96 \cdot lbf$	Allowable Shear:	$V_{R_{i,j}} = 2050 \cdot lbf$

Bottom Height: $h := h - L_s$ $\quad h = 5\, ft$

Wind Force on Section: $F_{wind} := P_w\left(h + \frac{L_s}{2}, bws\right) \cdot A_{w_{i,j}}$ $\quad F_{wind} = 55.8 \cdot lbf$

Weight @ Bottom: $W := W + W_{s_{i,j}}$ $\quad W = 638 \cdot lbf$

Moment @ Bottom: $M := M + V \cdot L_s + F_{wind} \cdot \frac{L_s}{2} + \frac{W}{3} \cdot d_i$ $\quad M = 31607 \cdot lbf \cdot ft$ $\quad < M_r \rightarrow$ OK

Shear @ Bottom: $V := V + F_{wind}$ $\quad V = 659 \cdot lbf$ $\quad < V_r \rightarrow$ OK

REQUIRED SECTION: **30" x 288**

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FOOTING DESIGN -- 64' Tower 22 sq. ft. in winds of 80 mph

Materials:

Concrete: $f'_c := 2500 \cdot psi$ *For design, min. 3000 psi to be specified.*

Reinforcement: $f_y := 60 \cdot ksi$

Threaded Anchor Rod Legs, B-7 alloy: $f_z := 144 \cdot ksi$

FOOTING SIZE BASED ON SOIL REQUIREMENTS *(IBC 2009 Sec. 1806.7.3)*

Applied Moment: $M = 31.6 \cdot k \cdot ft$

Applied Horizontal Force: $V = 0.66 \cdot k$

Base Section Size: $bss := 30 \cdot in$

Effective Height of Horizontal Force: $h' := \frac{M}{V}$ $h' = 48.0\,ft$

Soil Bearing Pressure: $S_1 := 150pcf$ *IBC 2009 Table 1806.2. Based on sand, silty sand, clayey sand, silty gravel and clayey gravel*

$$b := \frac{bss + 2.88 \cdot in}{\sin(60 \cdot deg)} + 7 \cdot in \qquad b = 45.0 \cdot in$$

USE: $b := 60 \cdot in$

Depth of Embedment: IBC 2009 Sect 1807.3.2 Eq 18-1

$$D_{reqd} := root\left[D - 0.5\left[\frac{2.34 \cdot V}{\left(\frac{D}{3}\right) \cdot S_1 \cdot b}\right] \cdot \left[1 + \sqrt{1 + \frac{4.36 \cdot h'}{\left[\frac{2.34 \cdot V}{\left(\frac{D}{3}\right) \cdot S_1 \cdot b}\right]}}\right], D\right]$$

$D_{reqd} = 7.16 \cdot ft$

CONCRETE FOOTING DESIGN *(IBC 2009 Sec. 1810)*

Note: *Vertical load is negligible compared to moment, so design as flexure without axial load; use singly-reinforced approach to be conservative.*

Design Moment: $M_f := \frac{[M + V \cdot (2 \cdot b)]}{0.6}$ $M_f = 63.7 \cdot k \cdot ft$

Factored Moment: $M_u := 1.0 \cdot M_f$ $M_u = 63.7 \cdot k \cdot ft$

Reduction Factor: $\phi := 0.9$

Over-Reinforcement: $ORF := 1.33$

Effective Depth: $d := \frac{b}{2} + \left(\frac{b}{2} - 4 \cdot in\right) \cdot \sin(60 \cdot deg)$ $d = 52.517 \cdot in$

Angle of Circular Segment Compression Block:

$$\Theta(r, A_s) := root\left[\frac{A_s \cdot f_y}{0.85 \cdot f'_c} - \left[\pi \cdot r^2 \cdot \left(\frac{\theta}{2 \cdot \pi}\right) - \frac{2 \cdot r \cdot \sin\left(\frac{\theta}{2}\right) \cdot \left(r - \frac{2 \cdot r \cdot \sin\left(\frac{\theta}{2}\right)}{2} \cdot \tan\left(\frac{\theta}{4}\right)\right)}{2}\right], \theta\right]$$

∴ 5'x5' or 5' DIA ROUND HOLE, 7.16' DEEP

Distance from Extreme Fiber to Centroid of Compression Block:

$$y(\alpha) := \frac{b}{2} - \frac{b}{3} \cdot \left(\frac{\sin(\alpha)^3}{\alpha - \sin(\alpha) \cdot \cos(\alpha)} \right)$$

Required Tension Steel:

$$A_s := \mathrm{root}\left[\phi \cdot A_s \cdot f_y \cdot \left(d - y\left(\frac{\Theta\left(\frac{b}{2}, A_s\right)}{2} \right) \right) - M_u, A_s \right] \cdot ORF \qquad A_s = 0.36 \cdot in^2$$

Try #6 Bars, on each side:

$$A_b := .44 \cdot in^2 \qquad A_s := 2 \cdot A_b \qquad A_s = 0.88 \cdot in^2$$

Check Factored Nominal Moment:

$$\phi M_n := \phi \cdot A_s \cdot f_y \cdot \left(d - y\left(\frac{\Theta\left(\frac{b}{2}, A_s\right)}{2} \right) \right) \qquad \phi M_n = 203.7 \cdot k \cdot ft \qquad > M_u \therefore OK$$

REQUIRED FOOTING: 5'-0"ϕ x 7' 2" DEEP FOOTING W/ (6) #6 VERTICAL BARS W/ STANDARD HOOKS @ TOP & (6) #3 CIRCULAR TIES @ 4" AT TOP, #3 CIRCULAR TIES @ 12" ELSEWHERE.

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