TOWER ENGINEERING PROFESSIONALS

Mr. Michael McFadden
MCF Communications
733 Turnpike Street
Suite 105
North Andover, MA 01845

Subject: **130 Monopole Tower (MT)**
40-ft Fall Zone Radius
Groton, New London County, CT
TEP # 080004.10

Dear Mr. McFadden:

The referenced tower has been designed in strict accordance with the ANSI/TIA/EIA-222-F-1996 and the Connecticut State Building Code. The design loading is as outlined in the attached documentation. In addition to the overall tower design, a specific fall radius of 40-ft has been requested.

To achieve this requirement, the tower has an engineered location designed to control the tower capacity. A flange connection has been designed at 90-ft. The flange consists of plates welded to the monopole sections. These plates are then connected to each other by bolts. These bolts are designed to reach their capacity prior to the rest of the structure. The bolt capacity is 97%, while the next closest capacity in any other structural member on the tower is 87.1%. Thus, during an extreme wind event which would have to greatly surpass the design wind event, the most likely mode of failure will be flange tensile rupture at the 90-ft connection.

Best Regards,
Tower Engineering Professionals, Inc. (TEP)

J. Russell Hill, P.E.
Senior Project Engineer

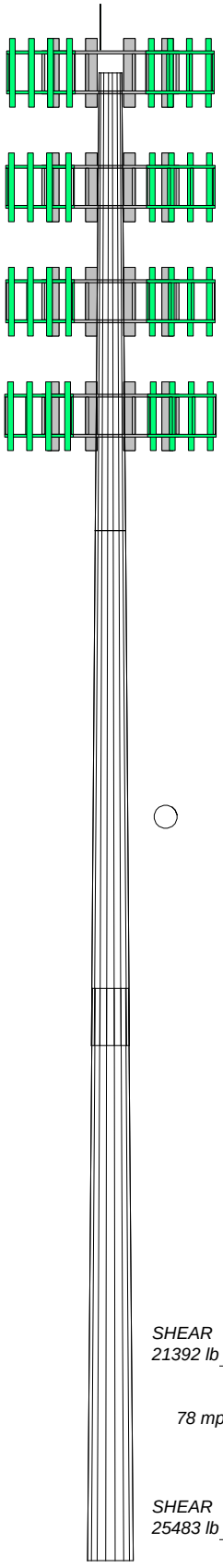
Attachments:
Tower Design
Engineered Flange Design at 90-ft

TOWER ENGINEERING PROFESSIONALS

TOWER DESIGN

3703 Junction Boulevard, Raleigh, NC 27603-5263 o) 919.661.6351 f) 919.661.6350
www.tepgroup.net rhill@tepgroup.net

Section	Length (ft)	Number of Sides	Thickness (in)	Lap Splice (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (lb)
1	40.00	18	0.1875		24.0000	31.5742		2235.7
2	45.00	18	0.3125		31.5742	40.0952	A572-65	5395.2
3	50.00	18	0.3750	5.00	38.5234	47.9912		8684.0
								16314.9



DESIGNED APPURTENANCE LOADING

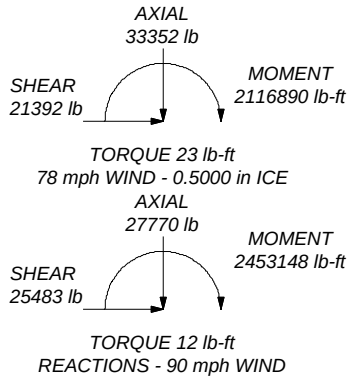
TYPE	ELEVATION	TYPE	ELEVATION
Fred A Nudd 14' Low-profile Monopole	130	(4) 1' x 6' Antenna	110
(4) 1' x 6' Antenna	130	(4) 1' x 6' Antenna	110
(4) 1' x 6' Antenna	130	(4) 1' x 6' Antenna	110
(4) 1' x 6' Antenna	130	Fred A Nudd 14' Low-profile Monopole	110
5/8-in x 4-ft Lightning Rod	130	(4) 1' x 6' Antenna	100
(4) 1' x 6' Antenna	120	(4) 1' x 6' Antenna	100
(4) 1' x 6' Antenna	120	(4) 1' x 6' Antenna	100
(4) 1' x 6' Antenna	120	Fred A Nudd 14' Low-profile Monopole	100
Fred A Nudd 14' Low-profile Monopole	120		

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	65 ksi	80 ksi			

TOWER DESIGN NOTES

1. Tower is located in Middlesex County, Massachusetts.
2. Tower designed for a 90 mph basic wind in accordance with the TIA/EIA-222-F Standard.
3. Tower is also designed for a 78 mph basic wind with 0.50 in ice.
4. Deflections are based upon a 60 mph wind.
5. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
6. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
7. Welds are fabricated with ER-70S-6 electrodes.
8. Proposed Antenna Mounts are assumed CaAa = 21.13 s.f. [1311 lbs] (No ICE)
9. Proposed Antenna Mounts are assumed CaAa = 28.19 s.f. [1792 lbs] (0.5 in. ICE)
10. Proposed Antennas are assumed Front CaAa = 6 s.f.; Side CaAa = 3 s.f. [35 lbs] (No ICE)
11. Proposed Antennas are assumed Front CaAa = 6.59 s.f.; Side CaAa = 3.5 s.f. [50 lbs] (0.5 in. ICE)
12. Coax is assumed to be routed inside the pole. [(12) - 1 5/8 Coax per carrier]
13. TOWER RATING: 87.1%



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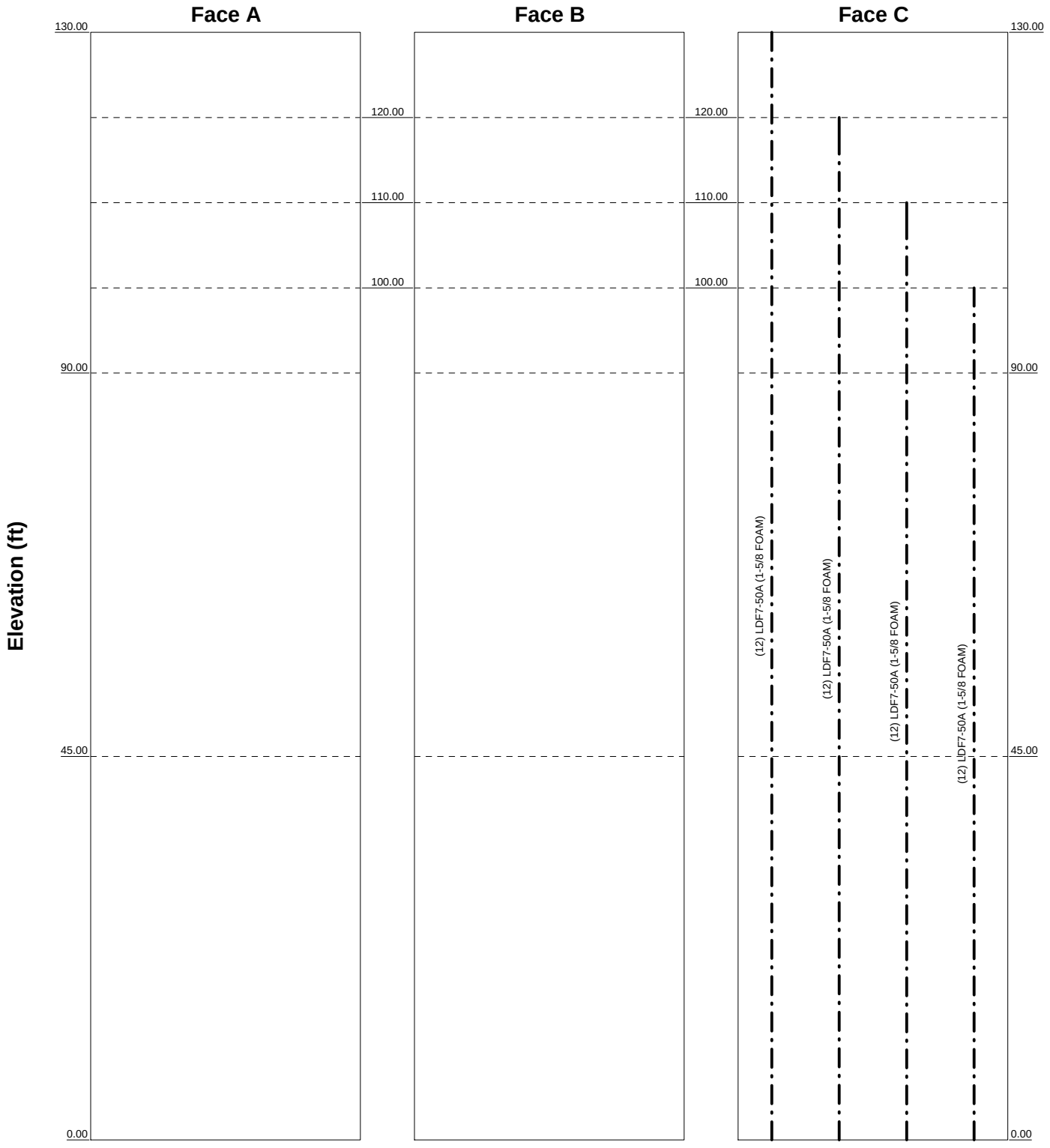
Job: ***Groton, MA***			
Project: ***TEP#: 080004.10***			
Client: Fred A. Nudd Corporation	Drawn by: WHM	App'd:	
Code: TIA/EIA-222-F	Date: 03/04/08	Scale: NTS	
Path: H:\2008\0004_Fred Nudd\10_Groton\Risa\Run #2\Run #2.eri		Dwg No. E-1	

Feedline Distribution Chart
0' - 130'

Round Flat App In Face App Out Face Truss Leg



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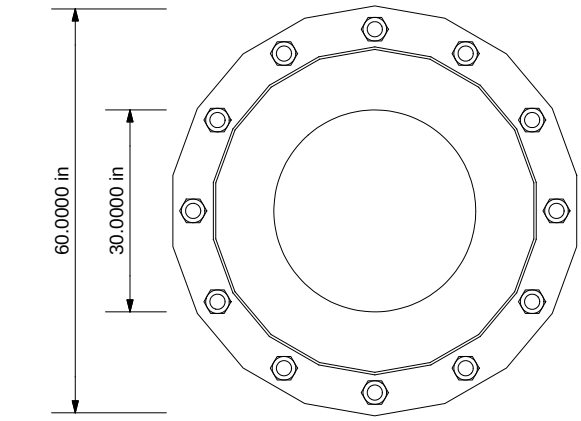
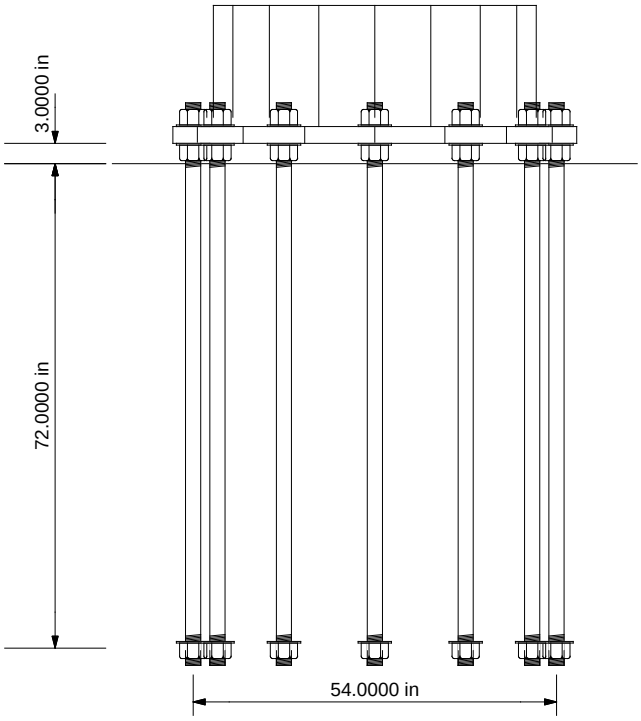
Path: H:\2008\0004_Fred Nudd\10_Groton\Risa\Run #2\Run #2.eri		Dwg No. E-7	





FOUNDATION NOTES

1. Plate thickness is 2.5000 in.
2. Plate grade is A572-50.
3. Anchor bolt grade is F1554-105.
4. f'c is 4 ksi.

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Tower Input Data

There is a pole section.
This tower is designed using the TIA/EIA-222-F standard.
The following design criteria apply:

Tower is located in Middlesex County, Massachusetts.
Basic wind speed of 90 mph.
Nominal ice thickness of 0.5000 in.
Ice density of 56 pcf.
A wind speed of 78 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 60 mph.
Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications..
Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards..
Welds are fabricated with ER-70S-6 electrodes..
Proposed Antenna Mounts are assumed CaAa = 21.13 s.f. [1311 lbs] (No ICE).
Proposed Antenna Mounts are assumed CaAa = 28.19 s.f. [1792 lbs] (0.5 in. ICE).
Proposed Antennas are assumed Front CaAa = 6 s.f.; Side CaAa = 3 s.f. [35 lbs] (No ICE).
Proposed Antennas are assumed Front CaAa = 6.59 s.f.; Side CaAa = 3.5 s.f. [50 lbs] (0.5 in. ICE).
Coax is assumed to be routed inside the pole. [(12) - 1 5/8 Coax per carrier].
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.333.
Local bending stresses due to climbing loads, feedline supports, and appurtenance mounts are not considered.

Options

	Consider Moments - Legs		Distribute Leg Loads As Uniform		Treat Feedline Bundles As Cylinder
	Consider Moments - Horizontals		Assume Legs Pinned		Use ASCE 10 X-Brace Ly Rules
	Consider Moments - Diagonals	√	Assume Rigid Index Plate	√	Calculate Redundant Bracing Forces
	Use Moment Magnification	√	Use Clear Spans For Wind Area		Ignore Redundant Members in FEA
√	Use Code Stress Ratios	√	Use Clear Spans For KL/r		SR Leg Bolts Resist Compression
√	Use Code Safety Factors - Guys	√	Retension Guys To Initial Tension	√	All Leg Panels Have Same Allowable
	Escalate Ice		Bypass Mast Stability Checks		Offset Girt At Foundation
	Always Use Max Kz	√	Use Azimuth Dish Coefficients		Consider Feedline Torque
	Use Special Wind Profile	√	Project Wind Area of Appurt.		Include Angle Block Shear Check
√	Include Bolts In Member Capacity	√	Autocalc Torque Arm Areas		Poles
√	Leg Bolts Are At Top Of Section		SR Members Have Cut Ends		Include Shear-Torsion Interaction
√	Secondary Horizontal Braces Leg		Sort Capacity Reports By Component		Always Use Sub-Critical Flow
	Use Diamond Inner Bracing (4 Sided)	√	Triangulate Diamond Inner Bracing		Use Top Mounted Sockets
	Add IBC .6D+W Combination				

Tapered Pole Section Geometry

Section	Elevation ft	Section Length ft	Splice Length ft	Number of Sides	Top Diameter in	Bottom Diameter in	Wall Thickness in	Bend Radius in	Pole Grade
L1	130.00-90.00	40.00	0.00	18	24.0000	31.5742	0.1875	0.7500	A572-65 (65 ksi)
L2	90.00-45.00	45.00	5.00	18	31.5742	40.0952	0.3125	1.2500	A572-65 (65 ksi)
L3	45.00-0.00	50.00		18	38.5234	47.9912	0.3750	1.5000	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in^2	I in^4	r in	C in	I/C in^3	J in^4	It/Q in^2	w in	w/t
L1	24.3702	14.1714	1015.2211	8.4534	12.1920	83.2694	2031.7780	7.0871	3.8940	20.768
	32.0613	18.6790	2324.7882	11.1423	16.0397	144.9396	4652.6354	9.3413	5.2271	27.878
L2	32.0613	31.0077	3828.5379	11.0979	16.0397	238.6913	7662.1135	15.5068	5.0071	16.023
	40.7137	39.4595	7890.0117	14.1229	20.3684	387.3659	15790.4052	19.7335	6.5068	20.822
L3	40.0791	45.4062	8348.4510	13.5427	19.5699	426.5964	16707.8872	22.7074	6.1201	16.32
	48.7316	56.6752	16234.5457	16.9038	24.3795	665.9087	32490.4533	28.3430	7.7865	20.764

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in
L1 130.00-90.00				1	1	1		
L2 90.00-45.00				1	1	1		
L3 45.00-0.00				1	1	1		

Monopole Base Plate Data

Base Plate Data	
Base plate is square	
Base plate is grouted	
Anchor bolt grade	F1554-105
Anchor bolt size	2.2500 in
Number of bolts	12
Embedment length	72.0000 in
f'_c	4 ksi
Grout space	3.0000 in
Base plate grade	A572-50
Base plate thickness	2.5000 in
Bolt circle diameter	54.0000 in
Outer diameter	60.0000 in
Inner diameter	30.0000 in
Base plate type	Plain Plate

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
LDF7-50A (1-5/8 FOAM)	C	No	Inside Pole	130.00 - 0.00	12	No Ice	0.00	0.82
						1/2" Ice	0.00	0.82
LDF7-50A (1-5/8 FOAM)	C	No	Inside Pole	120.00 - 0.00	12	No Ice	0.00	0.82
						1/2" Ice	0.00	0.82
LDF7-50A (1-5/8 FOAM)	C	No	Inside Pole	110.00 - 0.00	12	No Ice	0.00	0.82
						1/2" Ice	0.00	0.82
LDF7-50A (1-5/8 FOAM)	C	No	Inside Pole	100.00 - 0.00	12	No Ice	0.00	0.82
						1/2" Ice	0.00	0.82

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight lb
L1	130.00-90.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	984.00
L2	90.00-45.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	1771.20
L3	45.00-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	0.000	0.000	1771.20

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight lb
L1	130.00-90.00	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	984.00
L2	90.00-45.00	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	1771.20
L3	45.00-0.00	A	0.500	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	0.000	0.000	1771.20

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight lb
Fred A Nudd 14' Low-profile Monopole	C	None		0.0000	130.00	No Ice	21.13	21.13	1311.00
						1/2" Ice	28.19	28.19	1792.00
(4) 1' x 6' Antenna	A	From Leg	3.00	0.0000	130.00	No Ice	6.00	3.00	35.00

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Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight lb
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	B	From Leg	3.00	0.0000	130.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	C	From Leg	3.00	0.0000	130.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
Fred A Nudd 14' Low-profile Monopole	C	None		0.0000	120.00	No Ice	21.13	21.13	1311.00
						1/2" Ice	28.19	28.19	1792.00
(4) 1' x 6' Antenna	A	From Leg	3.00	0.0000	120.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	B	From Leg	3.00	0.0000	120.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	C	From Leg	3.00	0.0000	120.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
Fred A Nudd 14' Low-profile Monopole	C	None		0.0000	110.00	No Ice	21.13	21.13	1311.00
						1/2" Ice	28.19	28.19	1792.00
(4) 1' x 6' Antenna	A	From Leg	3.00	0.0000	110.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	B	From Leg	3.00	0.0000	110.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	C	From Leg	3.00	0.0000	110.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
Fred A Nudd 14' Low-profile Monopole	C	None		0.0000	100.00	No Ice	21.13	21.13	1311.00
						1/2" Ice	28.19	28.19	1792.00
(4) 1' x 6' Antenna	A	From Leg	3.00	0.0000	100.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	B	From Leg	3.00	0.0000	100.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
(4) 1' x 6' Antenna	C	From Leg	3.00	0.0000	100.00	No Ice	6.00	3.00	35.00
			0.00			1/2" Ice	6.59	3.50	50.00
			0.00						
5/8-in x 4-ft Lightning Rod	C	From Leg	0.00	0.0000	130.00	No Ice	0.25	0.25	4.58
			0.00			1/2" Ice	0.66	0.66	7.39
			4.00						

Tower Pressures - No Ice

G_H = 1.690

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 130.00-90.00	109.35	1.408	29	92.624	A	0.000	92.624	92.624	100.00	0.000	0.000
					B	0.000	92.624		100.00	0.000	0.000
					C	0.000	92.624		100.00	0.000	0.000
L2 90.00-45.00	67.15	1.225	25	134.380	A	0.000	134.380	134.380	100.00	0.000	0.000
					B	0.000	134.380		100.00	0.000	0.000
					C	0.000	134.380		100.00	0.000	0.000
L3 45.00-0.00	21.80	1	21	163.990	A	0.000	163.990	163.990	100.00	0.000	0.000
					B	0.000	163.990		100.00	0.000	0.000
					C	0.000	163.990		100.00	0.000	0.000

Tower Pressure - With Ice

G_H = 1.690

Section Elevation ft	z ft	K_Z	q_z psf	t_Z in	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 130.00-90.00	109.35	1.408	22	0.5000	95.957	A	0.000	95.957	95.957	100.00	0.000	0.000
						B	0.000	95.957		100.00	0.000	0.000
						C	0.000	95.957		100.00	0.000	0.000
L2 90.00-45.00	67.15	1.225	19	0.5000	138.130	A	0.000	138.130	138.130	100.00	0.000	0.000
						B	0.000	138.130		100.00	0.000	0.000
						C	0.000	138.130		100.00	0.000	0.000
L3 45.00-0.00	21.80	1	16	0.5000	167.740	A	0.000	167.740	167.740	100.00	0.000	0.000
						B	0.000	167.740		100.00	0.000	0.000
						C	0.000	167.740		100.00	0.000	0.000

Tower Pressure - Service

G_H = 1.690

Section Elevation ft	z ft	K_Z	q_z psf	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 130.00-90.00	109.35	1.408	13	92.624	A	0.000	92.624	92.624	100.00	0.000	0.000
					B	0.000	92.624		100.00	0.000	0.000
					C	0.000	92.624		100.00	0.000	0.000
L2 90.00-45.00	67.15	1.225	11	134.380	A	0.000	134.380	134.380	100.00	0.000	0.000
					B	0.000	134.380		100.00	0.000	0.000
					C	0.000	134.380		100.00	0.000	0.000
L3 45.00-0.00	21.80	1	9	163.990	A	0.000	163.990	163.990	100.00	0.000	0.000
					B	0.000	163.990		100.00	0.000	0.000
					C	0.000	163.990		100.00	0.000	0.000

Tower Forces - No Ice - Wind Normal To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	2966.50	74.16	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	3730.35	82.90	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	3743.98	83.20	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	656481.48 lb-ft	10440.82		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	2966.50	74.16	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	3730.35	82.90	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	3743.98	83.20	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	656481.48 lb-ft	10440.82		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	2966.50	74.16	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	3730.35	82.90	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	3743.98	83.20	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	656481.48 lb-ft	10440.82		

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Tower Forces - With Ice - Wind Normal To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2933.98	A	1	0.65	1	1	1	95.957	2304.94	57.62	C
			B	1	0.65	1	1	1	95.957			
			C	1	0.65	1	1	1	95.957			
L2 90.00-45.00	1771.20	6404.27	A	1	0.65	1	1	1	138.130	2875.84	63.91	C
			B	1	0.65	1	1	1	138.130			
			C	1	0.65	1	1	1	138.130			
L3 45.00-0.00	1771.20	9912.44	A	1	0.65	1	1	1	167.740	2872.20	63.83	C
			B	1	0.65	1	1	1	167.740			
			C	1	0.65	1	1	1	167.740			
Sum Weight:	4526.40	19250.69						OTM	507758.97 lb-ft	8052.97		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2933.98	A	1	0.65	1	1	1	95.957	2304.94	57.62	C
			B	1	0.65	1	1	1	95.957			
			C	1	0.65	1	1	1	95.957			
L2 90.00-45.00	1771.20	6404.27	A	1	0.65	1	1	1	138.130	2875.84	63.91	C
			B	1	0.65	1	1	1	138.130			
			C	1	0.65	1	1	1	138.130			
L3 45.00-0.00	1771.20	9912.44	A	1	0.65	1	1	1	167.740	2872.20	63.83	C
			B	1	0.65	1	1	1	167.740			
			C	1	0.65	1	1	1	167.740			
Sum Weight:	4526.40	19250.69						OTM	507758.97 lb-ft	8052.97		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2933.98	A	1	0.65	1	1	1	95.957	2304.94	57.62	C
			B	1	0.65	1	1	1	95.957			
			C	1	0.65	1	1	1	95.957			
L2 90.00-45.00	1771.20	6404.27	A	1	0.65	1	1	1	138.130	2875.84	63.91	C
			B	1	0.65	1	1	1	138.130			
			C	1	0.65	1	1	1	138.130			
L3 45.00-0.00	1771.20	9912.44	A	1	0.65	1	1	1	167.740	2872.20	63.83	C
			B	1	0.65	1	1	1	167.740			
			C	1	0.65	1	1	1	167.740			
Sum Weight:	4526.40	19250.69						OTM	507758.97 lb-ft	8052.97		

Tower Forces - Service - Wind Normal To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	1318.44	32.96	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	1657.93	36.84	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	1663.99	36.98	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	291769.55 lb-ft	4640.37		

Tower Forces - Service - Wind 60 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	1318.44	32.96	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	1657.93	36.84	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	1663.99	36.98	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	291769.55 lb-ft	4640.37		

Tower Forces - Service - Wind 90 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
L1 130.00-90.00	984.00	2235.66	A	1	0.65	1	1	1	92.624	1318.44	32.96	C
			B	1	0.65	1	1	1	92.624			
			C	1	0.65	1	1	1	92.624			
L2 90.00-45.00	1771.20	5395.17	A	1	0.65	1	1	1	134.380	1657.93	36.84	C
			B	1	0.65	1	1	1	134.380			
			C	1	0.65	1	1	1	134.380			
L3 45.00-0.00	1771.20	8684.04	A	1	0.65	1	1	1	163.990	1663.99	36.98	C
			B	1	0.65	1	1	1	163.990			
			C	1	0.65	1	1	1	163.990			
Sum Weight:	4526.40	16314.87						OTM	291769.55	4640.37		

Section Elevation ft	Add Weight lb	Self Weight lb	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F lb	w plf	Ctrl. Face
									lb-ft			

Force Totals

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M_x lb-ft	Sum of Overturning Moments, M_z lb-ft	Sum of Torques lb-ft
Leg Weight	16314.87					
Bracing Weight	0.00					
Total Member Self-Weight	16314.87			2.29	3.97	
Total Weight	27769.85			2.29	3.97	
Wind 0 deg - No Ice		0.00	-25484.39	-2391424.88	3.97	-11.32
Wind 90 deg - No Ice		25484.39	0.00	2.29	-2391423.20	6.54
Wind 180 deg - No Ice		0.00	25484.39	2391429.46	3.97	11.32
Member Ice	2935.82					
Total Weight Ice	33352.48			3.70	6.40	
Wind 0 deg - Ice		0.00	-21392.48	-2046445.15	6.40	-22.54
Wind 90 deg - Ice		21392.48	0.00	3.70	-2046442.45	13.01
Wind 180 deg - Ice		0.00	21392.48	2046452.55	6.40	22.54
Total Weight	27769.85			2.29	3.97	
Wind 0 deg - Service		0.00	-11326.40	-1062854.23	3.97	-5.03
Wind 90 deg - Service		11326.40	0.00	2.29	-1062852.55	2.91
Wind 180 deg - Service		0.00	11326.40	1062858.81	3.97	5.03

Load Combinations

Comb. No.	Description
1	Dead Only
2	Dead+Wind 0 deg - No Ice
3	Dead+Wind 90 deg - No Ice
4	Dead+Wind 180 deg - No Ice
5	Dead+Ice+Temp
6	Dead+Wind 0 deg+Ice+Temp
7	Dead+Wind 90 deg+Ice+Temp
8	Dead+Wind 180 deg+Ice+Temp
9	Dead+Wind 0 deg - Service
10	Dead+Wind 90 deg - Service
11	Dead+Wind 180 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
L1	130 - 90	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	5	-13493.37	6.40	-3.70
			Max. Mx	3	-8905.56	-455167.26	-2.11

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
			Max. My	4	-8905.56	3.66	-455173.64
			Max. Vy	3	18654.82	-455167.26	-2.11
			Max. Vx	4	18654.83	3.66	-455173.64
			Max. Torque	8			-22.95
L2	90 - 45	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	5	-20684.86	6.40	-3.70
			Max. Mx	3	-15647.97	-1266544.67	-2.34
			Max. My	4	-15647.97	4.05	-1266551.16
			Max. Vy	3	21906.30	-1266544.67	-2.34
			Max. Vx	4	21906.30	4.05	-1266551.16
			Max. Torque	6			22.92
L3	45 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	5	-33352.48	6.40	-3.70
			Max. Mx	3	-27746.98	-2453141.93	-2.38
			Max. My	4	-27746.98	4.12	-2453148.48
			Max. Vy	3	25507.39	-2453141.93	-2.38
			Max. Vx	4	25507.39	4.12	-2453148.48
			Max. Torque	6			22.87

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical lb	Horizontal, X lb	Horizontal, Z lb
Pole	Max. Vert	5	33352.48	0.00	-0.00
	Max. H_x	11	27769.84	0.00	-11325.56
	Max. H_z	2	27769.77	0.00	25482.58
	Max. M_x	2	2453143.68	0.00	25482.58
	Max. M_z	3	2453141.93	-25482.58	-0.00
	Max. Torsion	6	22.85	0.00	21391.89
	Min. Vert	4	27769.77	0.00	-25482.58
	Min. H_x	3	27769.77	-25482.58	-0.00
	Min. H_z	4	27769.77	0.00	-25482.58
	Min. M_x	4	-2453148.48	0.00	-25482.58
	Min. M_z	6	-6.71	0.00	21391.89
	Min. Torsion	8	-22.85	0.00	-21391.89

Tower Mast Reaction Summary

Load Combination	Vertical lb	$Shear_x$ lb	$Shear_z$ lb	Overturning Moment, M_x lb-ft	Overturning Moment, M_z lb-ft	Torque lb-ft
Dead Only	27769.85	-0.00	0.00	2.29	3.97	0.00
Dead+Wind 0 deg - No Ice	27769.77	-0.00	-25482.58	-2453143.68	4.12	-11.55
Dead+Wind 90 deg - No Ice	27769.77	25482.58	0.00	2.38	-2453141.93	6.67

Load Combination	Vertical	$Shear_x$	$Shear_z$	Overturning Moment, M_x	Overturning Moment, M_z	Torque
	lb	lb	lb	lb-ft	lb-ft	lb-ft
Dead+Wind 180 deg - No Ice	27769.77	-0.00	25482.58	2453148.48	4.12	11.55
Dead+Ice+Temp	33352.48	-0.00	0.00	3.70	6.40	0.00
Dead+Wind 0 deg+Ice+Temp	33352.45	-0.00	-21391.89	-2116881.95	6.71	-22.85
Dead+Wind 90 deg+Ice+Temp	33352.45	21391.89	0.00	3.87	-2116879.07	13.19
Dead+Wind 180 deg+Ice+Temp	33352.45	-0.00	21391.89	2116889.82	6.71	22.85
Dead+Wind 0 deg - Service	27769.84	-0.00	-11325.56	-1091282.25	4.16	-5.17
Dead+Wind 90 deg - Service	27769.84	11325.56	0.00	2.40	-1091280.49	2.99
Dead+Wind 180 deg - Service	27769.84	-0.00	11325.56	1091287.07	4.16	5.17

Solution Summary

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX lb	PY lb	PZ lb	PX lb	PY lb	PZ lb	% Error
1	0.00	-27769.85	0.00	0.00	27769.85	-0.00	0.000%
2	0.00	-27769.85	-25484.39	0.00	27769.77	25482.58	0.005%
3	25484.39	-27769.85	0.00	-25482.58	27769.77	-0.00	0.005%
4	0.00	-27769.85	25484.39	0.00	27769.77	-25482.58	0.005%
5	0.00	-33352.48	0.00	0.00	33352.48	-0.00	0.000%
6	0.00	-33352.48	-21392.48	0.00	33352.45	21391.89	0.001%
7	21392.48	-33352.48	0.00	-21391.89	33352.45	-0.00	0.001%
8	0.00	-33352.48	21392.48	0.00	33352.45	-21391.89	0.001%
9	0.00	-27769.85	-11326.40	0.00	27769.84	11325.56	0.003%
10	11326.40	-27769.85	0.00	-11325.56	27769.84	-0.00	0.003%
11	0.00	-27769.85	11326.40	0.00	27769.84	-11325.56	0.003%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	6	0.00000001	0.00000001
2	Yes	12	0.00005302	0.00010939
3	Yes	12	0.00005302	0.00010939
4	Yes	12	0.00005302	0.00010939
5	Yes	6	0.00000001	0.00000001
6	Yes	13	0.00000001	0.00013448
7	Yes	13	0.00000001	0.00013448
8	Yes	13	0.00000001	0.00013448
9	Yes	12	0.00000001	0.00006912
10	Yes	12	0.00000001	0.00006912
11	Yes	12	0.00000001	0.00006912

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	130 - 90	33.208	11	2.1671	0.0001
L2	90 - 45	16.277	11	1.7039	0.0000

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L3	50 - 0	5.068	11	0.9285	0.0000

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
130.00	Fred A Nudd 14' Low-profile Monopole	11	33.208	2.1671	0.0001	23451
120.00	Fred A Nudd 14' Low-profile Monopole	11	28.719	2.0813	0.0001	11725
110.00	Fred A Nudd 14' Low-profile Monopole	11	24.332	1.9836	0.0000	5862
100.00	Fred A Nudd 14' Low-profile Monopole	11	20.151	1.8618	0.0000	3907

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	130 - 90	74.563	4	4.8672	0.0003
L2	90 - 45	36.564	4	3.8279	0.0001
L3	50 - 0	11.388	4	2.0867	0.0000

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
130.00	Fred A Nudd 14' Low-profile Monopole	4	74.563	4.8672	0.0003	10561
120.00	Fred A Nudd 14' Low-profile Monopole	4	64.489	4.6622	0.0003	5280
110.00	Fred A Nudd 14' Low-profile Monopole	4	54.644	4.4352	0.0002	2638
100.00	Fred A Nudd 14' Low-profile Monopole	4	45.260	4.1644	0.0001	1757

Base Plate Design Data

Plate Thickness in	Number of Anchor Bolts	Anchor Bolt Size in	Actual Allowable Ratio Bolt Tension lb	Actual Allowable Ratio Bolt Compression lb	Actual Allowable Ratio Plate Stress ksi	Actual Allowable Ratio Stiffener Stress ksi	Controlling Condition	Ratio
2.5000	12	2.2500	179402.45 164013.23 1.09	184026.95 272261.95 0.68	42.245 37.500 1.13		Plate	1.13 ✔

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	F_a ksi	A in^2	Actual P lb	Allow. P_a lb	Ratio $\frac{P}{P_a}$
L1	130 - 90 (1)	TP31.5742x24x0.1875	40.00	130.00	140.0	7.618	18.6790	-8905.55	142300.00	0.063
L2	90 - 45 (2)	TP40.0952x31.5742x0.3125	45.00	130.00	113.2	11.663	38.5204	-15648.00	449280.00	0.035
L3	45 - 0 (3)	TP47.9912x38.5234x0.375	50.00	130.00	92.3	17.515	56.6752	-27747.00	992691.00	0.028

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M_x lb-ft	Actual f_{bx} ksi	Allow. F_{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M_y lb-ft	Actual f_{by} ksi	Allow. F_{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	130 - 90 (1)	TP31.5742x24x0.1875	455173.33	-37.685	37.061	1.017	0.00	0.000	37.061	0.000
L2	90 - 45 (2)	TP40.0952x31.5742x0.3125	1266550.00	-41.180	39.000	1.056	0.00	0.000	39.000	0.000
L3	45 - 0 (3)	TP47.9912x38.5234x0.375	2453150.00	-44.207	39.000	1.134	0.00	0.000	39.000	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Size	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	130 - 90 (1)	TP31.5742x24x0.1875	0.063	1.017	0.000	1.079 ✔	1.333	H1-3 ✔
L2	90 - 45 (2)	TP40.0952x31.5742x0.3125	0.035	1.056	0.000	1.091 ✔	1.333	H1-3 ✔
L3	45 - 0 (3)	TP47.9912x38.5234x0.375	0.028	1.134	0.000	1.161 ✔	1.333	H1-3 ✔

Section Capacity Table

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Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	SF*P_{allow} lb	% Capacity	Pass Fail
L1	130 - 90	Pole	TP31.5742x24x0.1875	1	-8905.55	189685.89	81.0	Pass
L2	90 - 45	Pole	TP40.0952x31.5742x0.3125	2	-15648.00	598890.22	81.8	Pass
L3	45 - 0	Pole	TP47.9912x38.5234x0.375	3	-27747.00	1323257.05	87.1	Pass
							Summary	
						Pole (L3)	87.1	Pass
						Base Plate	84.5	Pass
						RATING =	**87.1**	**Pass**

TOWER ENGINEERING PROFESSIONALS

ENGINEERED FLANGE DESIGN AT 90-FT

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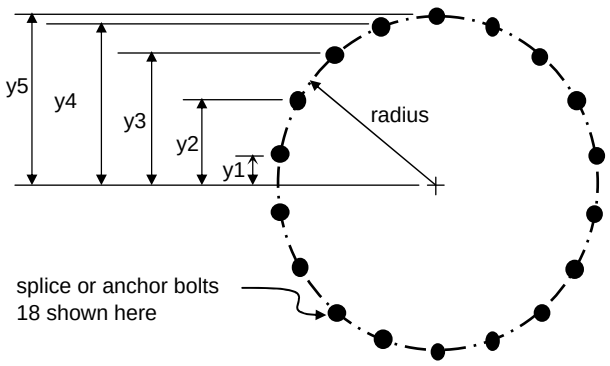
www.tepgroup.net rhill@tepgroup.net



INPUT		
Elevation	(ft)	90
Moment	(k-ft)	455
Download	(kips)	9.5
Radius	(in)	17.5
Bolt Size	(in)	0.875
Ft	(ksi)	44
Total number of bolts		18

Note: This sheet is to be used when bolts are in a pattern similar to that shown above

Formula:

T_{max} = [Moment*radius/SUM((# of bolts at distance y)*y^2)] - [(Download)/(total # of bolts)]

Number of bolts used in calc. 18

Number of y's 5

y number	angle (deg)	distance y, (in)	# of bolts at dist y	#'s to be summed
y5	90	17.5	2	612.50
y4	70.00	16.44	4	1081.70
y3	50.00	13.41	4	718.86
y2	30.00	8.75	4	306.25
y1	10.00	3.04	4	36.94

OUTPUT	
Sum =	2756.25
4/3*Ft=	58.7
T_{max} =	34.15
4/3*Allow =	35.28
Ratio =	0.97

BASE PLATE FLEXURAL ANALYSIS:
AISC ASD

TEP Job No.: 080004.10
Date: 03-03-2008

Input - PROPERTIES AND FORCES:

$T_{max} := 33.18 \cdot kip$ = Maximum bolt tension

$d := 2.30 \cdot in$ = Distance from flat to center line of bolt

$boltcircle := 35.5 \cdot in$ = Bolt circle diameter

$tower\_diameter := 30.91 in$ = Diameter of Pole (flat to flat)

$n := 18$ = number of bolts at connection

$t := 1.75 \cdot in$ = Thickness of base plate

$F_y := 50 \cdot ksi$ = Yield strength of the base plate

Output - CALCULATION OF BOLT SPACING, b:

$\theta := \frac{360}{n} \cdot deg$

$b_1 := \sin\left(\frac{\theta}{2}\right) \cdot tower\_diameter$ $\quad b_1 = 5.367\,in$

$b_2 := 2 \cdot d$ (AISC 45 degree rule) $\quad b_2 = 4.6\,in$

$b_{eff} := \min(b_1, b_2)$ $\quad b_{eff} = 4.6\,in$

Output - CALCULATION OF fb/Fb:

$M := T_{max} \cdot d$ $\quad M = 6.36\,ft \cdot kip$

$f_b := \frac{6 \cdot M}{b_{eff} \cdot t^2}$ $\quad f_b = 32.5 ksi$

$F_b := 0.75 \cdot F_y \cdot \frac{4}{3}$ $\quad F_b = 50 ksi$

$Stressratio := \frac{f_b}{F_b}$ $\quad Stressratio = 0.65$

Output - CALCULATION OF Tall:

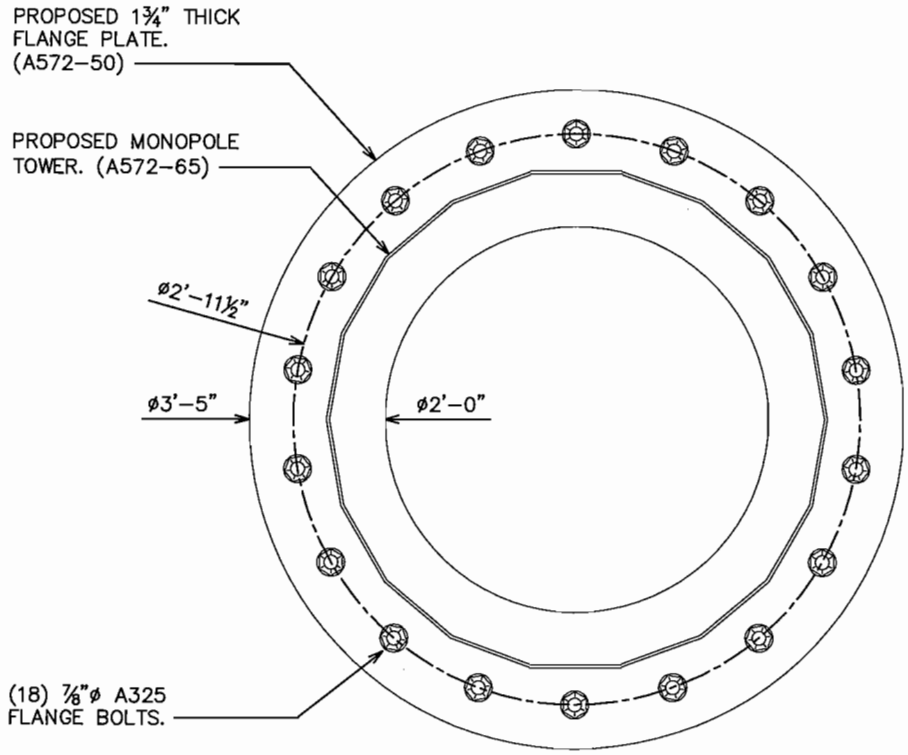
$M_{lim} := \frac{F_b \cdot b_{eff} \cdot t^2}{6}$

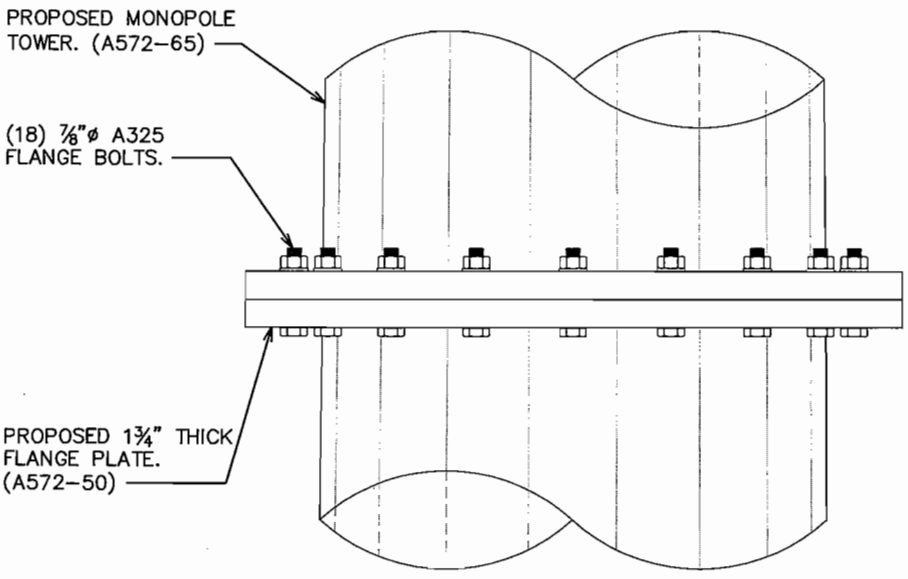
$T_{maxlim} := \frac{M_{lim}}{d}$ $\quad T_{maxlim} = 51.04 kip$

CONSTANTS: $\Psi \equiv 1$ $\quad E \equiv 29000 \cdot ksi$ $\quad psi \equiv \frac{lb}{in^2}$ $\quad ksi \equiv 1000 \cdot psi$ $\quad kip \equiv 1000 \cdot lb$

Project Name: GROTON, MA
Project #: 080004.10
Date: 03-04-08
Design: WHM
Check:
Page ____ of ____

FLANGE DESIGN





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