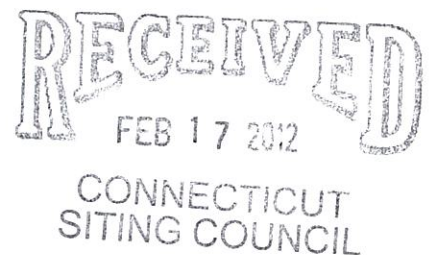


280 Trumbull Street
Hartford, CT 06103-3597
Main (860) 275-8200
Fax (860) 275-8299
kbaldwin@rc.com
Direct (860) 275-8345

February 16, 2012

Linda Roberts
Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051



Re: **Notice of Exempt Modification – Antenna Swap
8 Upper Meadow Road, Granby, Connecticut**

Dear Ms. Roberts:

Cellco Partnership d/b/a Verizon Wireless ("Cellco") currently maintains twelve (12) wireless telecommunications antennas at the 137-foot level on the existing 150-foot tower at the above-referenced address. The tower is owned by the Cellco. The Council approved Cellco's use of the tower in 2007. Cellco now intends to modify its installation by replacing ten (10) of its existing antennas with four (4) model LPA-80063-6CF cellular antennas; three (3) model BXA-171080-12CF PCS antennas; and three (3) model BXA-70063-6CF LTE antennas, all at the same 137-foot level on the tower. Cellco also intends to install six (6) coax cable diplexers on its antenna platform and six (6) additional coax cables. Attached behind Tab 1 are the specifications for the replacement antennas and cable diplexers.

Please accept this letter as notification pursuant to R.C.S.A. § 16-50j-73, for construction that constitutes an exempt modification pursuant to R.C.S.A. § 16-50j-72(b)(2). In accordance with R.C.S.A. § 16-50j-73, a copy of this letter is being sent to William F. Smith, Jr., Town Manager of the Town of Granby. A copy of this letter is also being sent to Tower Meadow LLC, the owner of the property on which the tower is located.

The planned modifications to the facility fall squarely within those activities explicitly provided for in R.C.S.A. § 16-50j-72(b)(2).

1. The proposed modifications will not result in an increase in the overall height of the existing tower. Cellco's replacement antennas and diplexers will be located at the 137-foot level on the existing 150-foot tower.



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Linda Roberts
February 16, 2012
Page 2

2. The proposed modifications will not involve any change to ground-mounted equipment and, therefore, will not require the extension of the site boundaries.

3. The proposed modifications will not increase noise levels at the facility by six decibels or more.

4. The operation of the replacement antennas will not increase radio frequency (RF) power density levels at the facility to a level at or above the Federal Communications Commission (FCC) adopted safety standard. A cumulative power density table for Cellco's modified facility is included behind Tab 2.

Also attached is a Detailed Structural Analysis and Evaluation confirming that the tower and foundation can support Cellco's proposed modifications. (See Tab 3).

For the foregoing reasons, Cellco respectfully submits that the proposed modifications to the above-referenced telecommunications facility constitutes an exempt modification under R.C.S.A. § 16-50j-72(b)(2).

Sincerely,



Kenneth C. Baldwin

Enclosures

Copy to:

William F. Smith, Jr., Granby Town Manager
Tower Meadow LLC
Sandy M. Carter



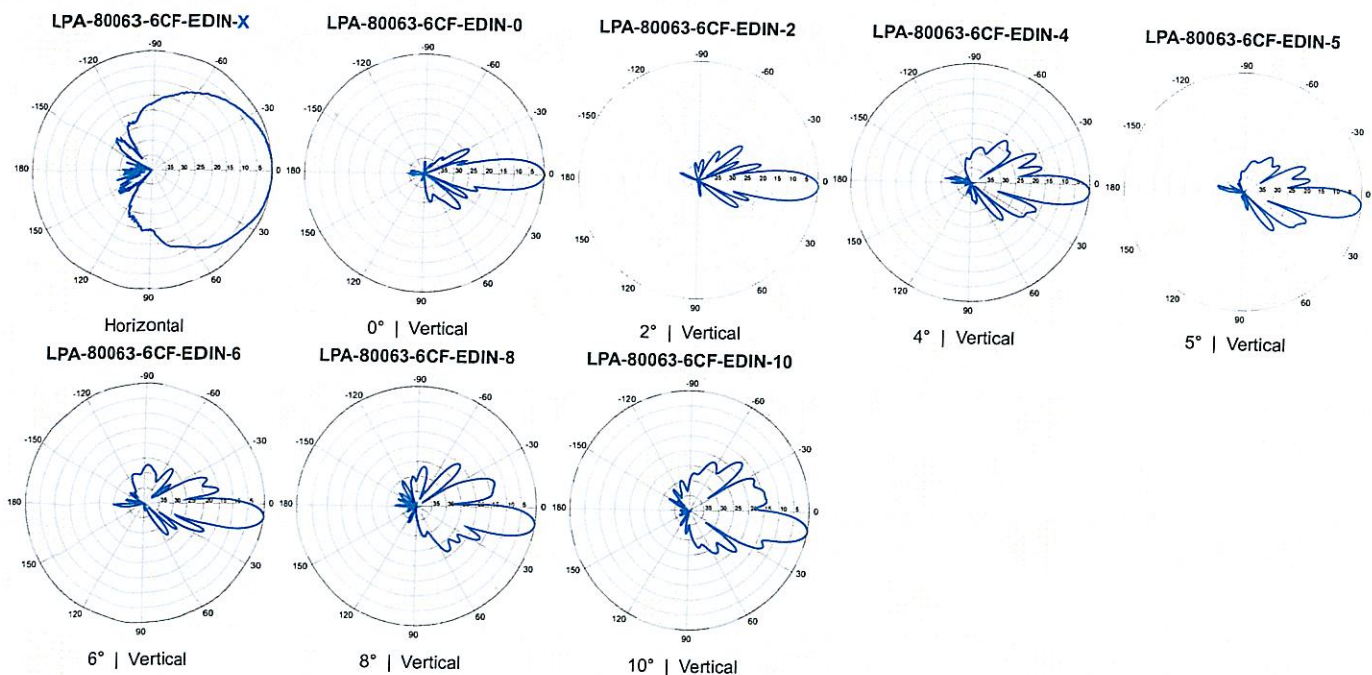
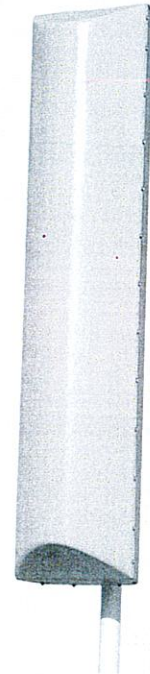
LPA-80063-6CF-EDIN-X

V-Pol | Log Periodic | 63° | 14.5 dBd

Replace "X" with desired electrical downtilt.

Antenna is also available with NE connector(s). Replace "EDIN" with "NE" in the model number when ordering.

Electrical Characteristics			
Frequency bands	806-960 MHz		
Polarization	Vertical		
Horizontal beamwidth	63°		
Vertical beamwidth	10°		
Gain	14.5 dBd (16.6 dBi)		
Electrical downtilt (X)	0, 2, 4, 5, 6, 8, 10		
Impedance	50Ω		
VSWR	≤1.4:1		
Null fill	5% (-26.02 dB)		
Input power	500 W		
Lightning protection	Direct Ground		
Connector(s)	1 Port / EDIN or NE / Female / Center (Back)		
Mechanical Characteristics			
Dimensions Length x Width x Depth	1805 x 385 x 332 mm71.1 x 15.2 x 13.1 in		
Depth of antenna with z-bracket	372 mm14.6 in		
Weight without mounting brackets	12.3 kg27 lbs		
Survival wind speed	> 201 km/hr> 125 mph		
Wind area	Front: 0.70 m ² Side: 0.59 m ² Front: 7.5 ft ² Side: 6.3 ft ²		
Wind load @ 161 km/hr (100 mph)	Front: 885 N Side: 757 NFront: 199 lbf Side: 170 lbf		
Mounting Options			
	Part Number	Fits Pipe Diameter	Weight
3-Point Mounting & Downtilt Bracket Kit (0-20°)	21700000	50-102 mm 2.0-4.0 in	11 kg 25 lbs
Lock-Down Brace	If the lock-down brace is used, the maximum diameter of the mounting pipe is 88.9 mm or 3.5 in.		



Quoted performance parameters are provided to offer typical or range values only and may vary as a result of normal manufacturing and operational conditions. Extreme operational conditions and/or stress on structural supports is beyond our control. Such conditions may result in damage to this product. Improvements to product may be made without notice.

LPA-171080-12CF-EDIN-X

V-Pol | Log Periodic | 80° | 17.5 dBi

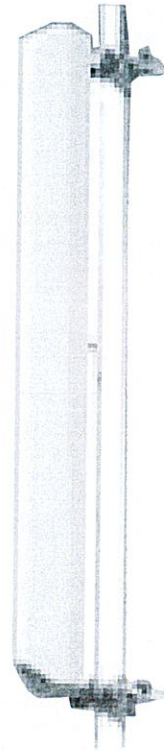
Replace "X" with desired electrical downtilt.

Antenna is available with NE connector(s)
 Replace "EDIN" with "NE" in the model number
 when ordering.

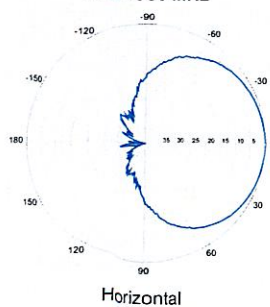
Electrical Characteristics		1710-2170 MHz		
Frequency bands		1710-1880 MHz	1850-1990 MHz	1920-2170 MHz
Polarization		Vertical		
Horizontal beamwidth		80°	82°	80°
Vertical beamwidth		3°	4°	3°
Gain		14.9 dBd (17.0 dBi)	15.4 dBd (17.5 dBi)	14.9 dBd (17.0 dBi)
Electrical downtilt (X)		0, 2		
Impedance		50Ω		
VSWR		≤ 1.5:1		
Null fill		5% (-26.02 dB)		
Input power		250 W		
Lightning protection		Direct Ground		
Connector(s)		1 Port / EDIN or NE / Female / Center (Back)		

Mechanical Characteristics			
Dimensions Length x Width x Depth		1876 x 105 x 175 mm	73.9 x 4.1 x 6.9 in
Depth with +/- Bracket		203 mm	8.0 in
Weight without mounting brackets		4.8 kg	11 lbs
Survival wind speed		>201 km/hr	>125 mph
Wind area		Front: 0.20 m ² Side: 0.32 m ²	Front: 2.1 ft ² Side: 3.5 ft ²
Wind load @ 161 km/hr (100 mph)		Front: 265 N Side: 504 N	Front: 60 lbf Side: 113 lbf

Mounting Options	Part Number	Fits Pipe Diameter	Weight
2-Point Mounting Bracket Kit	26799997	50-102 mm 2.0-4.0 in	2.3 kg 5.0 lbs
2-Point Mounting and Downtilt Bracket Kit	26799999	50-102 mm 2.0-4.0 in	2.3 kg 5.0 lbs



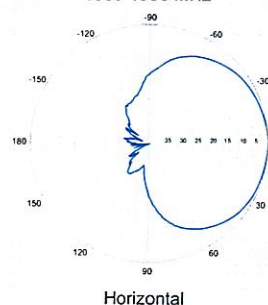
1710-1880 MHz



Horizontal

0° | Vertical

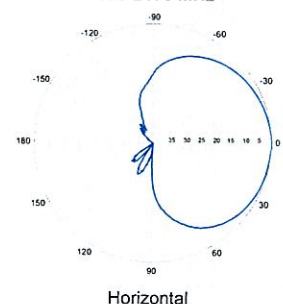
1850-1990 MHz



Horizontal

0° | Vertical

1920-2170 MHz



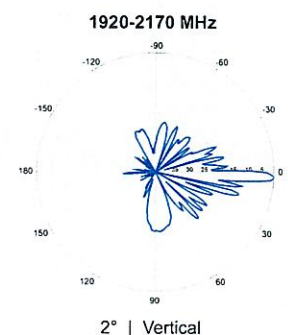
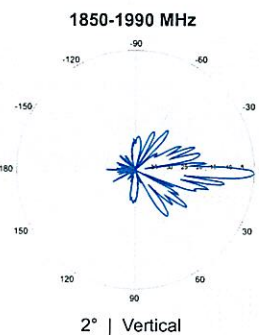
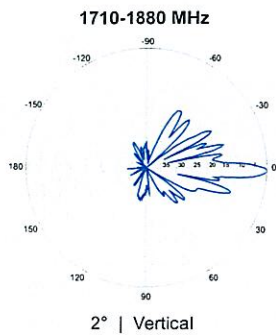
Horizontal

0° | Vertical

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LPA-171080-12CF-EDIN-X

V-Pol | Log Periodic | 80° | 17.5 dBi



Quoted performance parameters are provided to offer typical or range values only and may vary as a result of normal manufacturing and operational conditions. Extreme operational conditions and/or stress on structural supports is beyond our control. Such conditions may result in damage to this product. Improvements to product may be made without notice.

BXA-70063-6CF-EDIN-X

X-Pol | FET Panel | 63° | 14.5 dBd

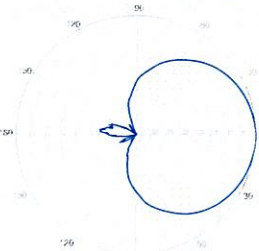
Replace "X" with desired electrical downtilt.

Antenna is also available with NE connector(s). Replace "EDIN" with "NE" in the model number when ordering.

Electrical Characteristics	696-900 MHz			
Frequency bands	696-806 MHz		806-900 MHz	
Polarization	±45°			
Horizontal beamwidth	65°		63°	
Vertical beamwidth	13°		11°	
Gain	14.0 dBd (16.1 dBi)		14.5 dBd (16.6 dBi)	
Electrical downtilt (X)	0, 2, 3, 4, 5, 6, 8, 10			
Impedance	50Ω			
VSWR	≤1.35:1			
Upper sidelobe suppression (0°)	-18.3 dB		-18.2 dB	
Front-to-back ratio (+/-30°)	-33.4 dB		-36.3 dB	
Null fill	5% (-26.02 dB)			
Isolation between ports	< -25 dB			
Input power with EDIN connectors	500 W			
Input power with NE connectors	300 W			
Lightning protection	Direct Ground			
Connector(s)	2 Ports / EDIN or NE / Female / Center (Back)			
Mechanical Characteristics				
Dimensions Length x Width x Depth	1804 x 285 x 132 mm		71.0 x 11.2 x 5.2 in	
Depth with z-brackets	172 mm		6.8 in	
Weight without mounting brackets	7.9 kg		17 lbs	
Survival wind speed	> 201 km/hr		> 125 mph	
Wind area	Front: 0.51 m ²	Side: 0.24 m ²	Front: 5.5 ft ²	Side: 2.6 ft ²
Wind load @ 161 km/hr (100 mph)	Front: 759 N	Side: 391 N	Front: 169 lbf	Side: 89 lbf
Mounting Options	Part Number	Fits Pipe Diameter		Weight
3-Point Mounting & Downtilt Bracket Kit	36210008	40-115 mm 1.57-4.5 in		6.9 kg 15.2 lbs
Concealment Configurations	For concealment configurations, order BXA-70063-6CF-EDIN-X-FP			

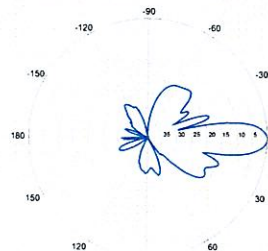


BXA-70063-6CF-EDIN-X



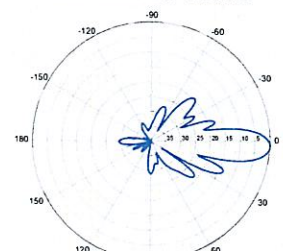
Horizontal | 750 MHz

BXA-70063-6CF-EDIN-0

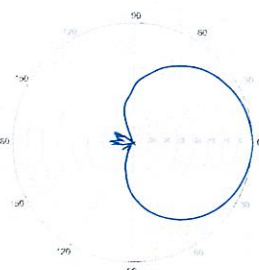


0° | Vertical | 750 MHz

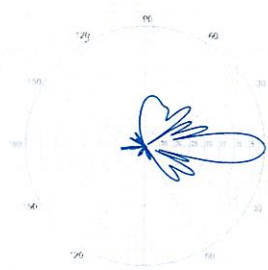
BXA-70063-6CF-EDIN-2



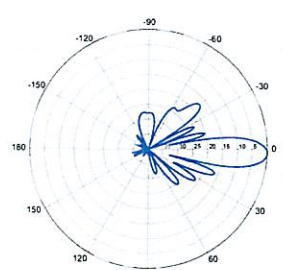
2° | Vertical | 750 MHz



Horizontal | 850 MHz



0° | Vertical | 850 MHz



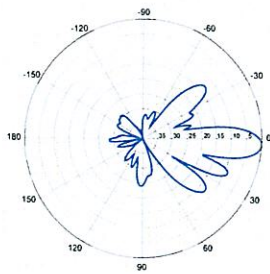
2° | Vertical | 850 MHz

Quoted performance parameters are provided to offer typical or range values only and may vary as a result of normal manufacturing and operational conditions. Extreme operational conditions and/or stress on structural supports is beyond our control. Such conditions may result in damage to this product. Improvements to product may be made without notice.

BXA-70063-6CF-EDIN-X

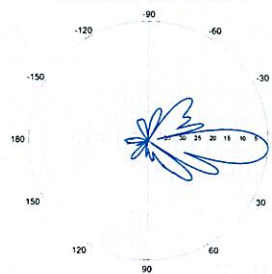
X-Pol | FET Panel | 63° | 14.5 dBd

BXA-70063-6CF-EDIN-3



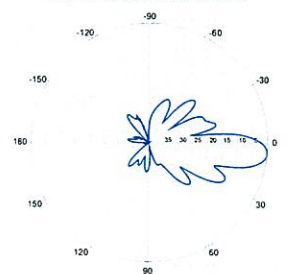
3° | Vertical | 750 MHz

BXA-70063-6CF-EDIN-4

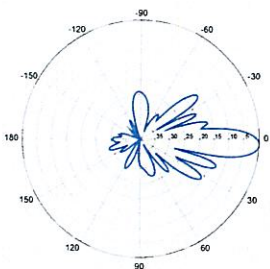


4° | Vertical | 750 MHz

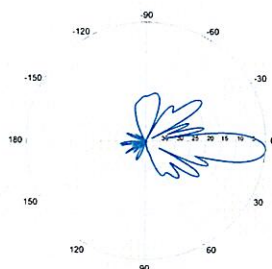
BXA-70063-6CF-EDIN-5



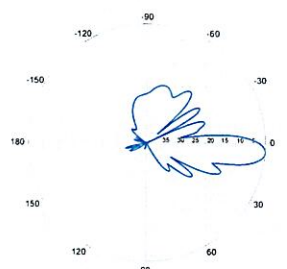
5° | Vertical | 750 MHz



3° | Vertical | 850 MHz

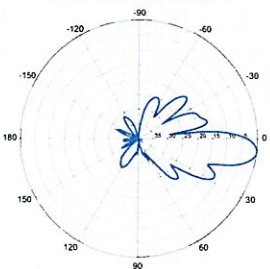


4° | Vertical | 850 MHz



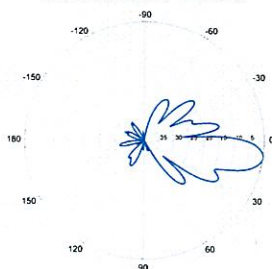
5° | Vertical | 850 MHz

BXA-70063-6CF-EDIN-6



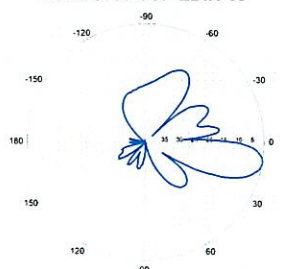
6° | Vertical | 750 MHz

BXA-70063-6CF-EDIN-8

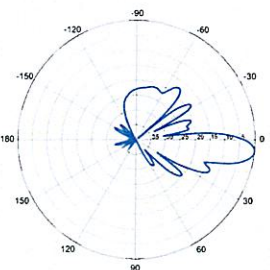


8° | Vertical | 750 MHz

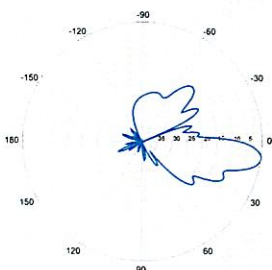
BXA-70063-6CF-EDIN-10



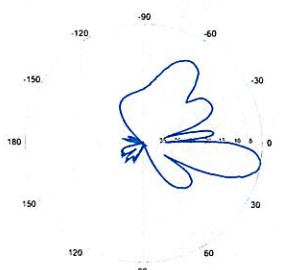
10° | Vertical | 750 MHz



6° | Vertical | 850 MHz



8° | Vertical | 850 MHz



10° | Vertical | 850 MHz

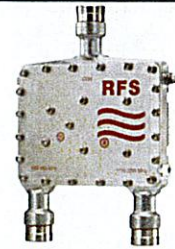
Quoted performance parameters are provided to offer typical or range values only and may vary as a result of normal manufacturing and operational conditions. Extreme operational conditions and/or stress on structural supports is beyond our control. Such conditions may result in damage to this product. Improvements to product may be made without notice.



ShareLite Wideband Diplexer – In-line 698-960 MHz/1710-2200 MHz, DC pass in high frequency path

Product Description

The ShareLite FD9R6004 Series of diplexers are designed to enable feeder sharing between systems in the 698-960 MHz range and in the 1710-2200 MHz range. The diplexer is equipped with in-line connector placement so it can be installed in the BTS cabinet or at the tower top. This is especially valuable in crowded sites or when the feeders are not easily accessible. Due to its wideband design, the FD9R6004 Series can accommodate many combining solutions between 698-960 MHz and 1710-2200 MHz systems such as LTE 700 MHz, Cellular 800 MHz with PCS, GSM900 with GSM1800, or GSM900 with UMTS. This diplexer features a highly selective filter. It provides a high level of isolation between ports, while keeping the insertion loss on both paths at an extremely low level. The FD9R6004 diplexers are available with various DC pass options, helpful in configurations with or without the Tower Mount Amplifiers installed.



Features/Benefits

- LTE ready design
- Extremely Low Insertion Loss
- High level of Rejection between bands – Protection against interferences
- Extremely High Power Handling Capability
- Integrated DC block/bypass versions available
- Very compact & small size design – Easy installation and reduced tower load
- In-line long-neck connectors for easy connection & waterproofing
- Exceptional reliability & environmental protection (IP 67)
- Equipped with 1 * Breathable Vent – Prevent any humidity inside the product
- Mounting hardware for Wall and Pole mount provided (P/N SEM2-1A)
- Grounding already provided through the mounting bracket
- Kit available for easy dual mount

Technical Specifications

Product Type	Diplexer/Cross Band Coupler
Frequency Range 1, MHz	698-960
Frequency Range 2, MHz	1710-2200
Application	LTE700, GSM900, UMTS, GSM1800, Cellular 800, PCS
Configuration	Sharelite Single diplexer, outdoor, DC pass in the 1710-2170MHz path, with mounting hardware SEM2-1A
Mounting	Wall Mounting: With 4 screws (maximum 6mm diameter); Pole Mounting: With included clamp set 40-110mm (1.57-4.33)
Return Loss All Ports Min/Typ, dB	19/23
Power Handling Continuous, Max, W	1250 at common port; 750 in low frequency path & 500 in high frequency path
Power Handling Peak, Max, W	15000 in low frequency path & 8000 in high frequency path
Impedance, Ohms	50
Insertion Loss, Path 1, dB	0.07 typ.
Insertion Loss, Path 2, dB	0.13 typ.
Rejection Between Bands Min/Typ, dB	58/64@698-960MHz; 60/70@1710-2200MHz
IMP Level at the COM Port, Typ, dBm	-112 @ 2x43
DC Pass in Low Frequency Path	No
DC Pass in High Frequency Path	Yes
Temperature Range, °C (°F)	-40 to +60 (-40 to +140)
Environmental	ETSI 300-019-2-4 Class 4.1E
Ingress Protection	IP 67
Lightning Protection	EN/IEC61000-4-5 Level 4
Connectors	In-line long-neck 7-16-Female
Weight, kg (lb)	1.2 (2.6)
Shipping Weight, kg (lb)	3.2 (7) for 2 * single units in 1 * box, 9.8 (21.6) for 6 * units = 3 * Boxes in 1 * overwrap
Dimensions, H x W x D, mm (in)	147 x 164 x 37 (5.8 x 6.5 x 1.5)
Shipping Dimensions, H x W x D, mm (in)	254 x 406 x 82 (10 x 16 x 3.2) for 2 * Single Units in 1 * box, 280 x 406 x 241 (11 x 16 x 9.5) for 6 * units = 3 * Boxes in 1 * overwrap
Volume, L	0.43
Housing	Aluminum

Notes

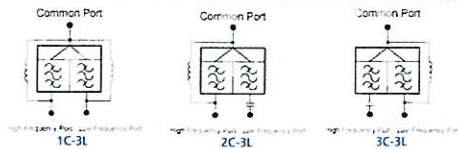
All information contained in the present datasheet is subject to confirmation at time of ordering

ShareLite Wideband Diplexer – In-line 698-960 MHz/1710-2200 MHz, DC pass in high frequency path

Other Documentation

FD9R6004/2C-3L Installation Instructions: [Wideband_Diplexer_Installation_Rev5.pdf](#)

Selection Guide Diplexer 698-960 / 1710-2200MHz					
	Model Number	Full DC Pass	DC Pass High Band	DC Pass Low Band	Mounting Hardware Included
Single	FD9R6004/1C-3L				X
	FD9R6004/2C-3L				X
	FD9R6004/3C-3L				X
Dual	KIT-FD9R6004/1C-DL				X
	KIT-FD9R6004/2C-DL				X
	KIT-FD9R6004/3C-DL				X



The FD9R6004 Series is upgradeable to a Dual Diplexer kit by means of 2 diplexers and mounting hardware kits SEM2-1A and SEM2-3

Mounting Hardware and Ground Cable Ordering Information	
Model Number	Description
SEM2-1A	Mounting Hardware, Pole mount ø40-110mm (Included with the Single and Dual Diplexer) Wall Screws M6 (Not included with the product)
SEM2-3	Assembly kit for 2 pcs of FD9R6004/xC-3L (Can be ordered separately but included with the Dual Diplexer Kit)
CA020-2	Ground Cable, 2m, includes lugs (Optional)
CA030-2	Ground Cable, 2m, includes lugs (Optional)
SEM6	Mounting Hardware for 6 Diplexers, Tower Base (Optional)

	General	Power	Density				
Site Name: West Granby							
Tower Height: Verizon @ 137ft							
CARRIER	# OF CHAN.	WATTS ERP	HEIGHT	CALC. POWER DENS	FREQ.	MAX. PERMISS. EXP.	FRACTION MPE
*AT&T	4	250	170	0.0124	1945	1.0000	1.24%
Verizon PCS	3	334	137	0.0192	1970	1.0000	1.92%
Verizon Cellular	9	393	137	0.0678	869	0.5793	11.70%
Verizon AWS	1	670	137	0.0128	2145	1.0000	1.28%
Verizon 700	1	817	137	0.0157	698	0.4653	3.36%
							19.51%
* Source: Siting Council							

DETAILED STRUCTURAL ANALYSIS AND EVALUATION OF AN EXISTING 149' MONOPOLE FOR PROPOSED ANTENNA ARRANGEMENT

Site I.D: West Granby CT
Address: 8 Upper Meadow Road
West Granby, CT 06090

prepared for



Verizon Wireless
99 East River Drive
East Hartford, Connecticut 06108

prepared by



URS CORPORATION
500 ENTERPRISE DRIVE, SUITE 3B
ROCKY HILL, CT 06067
TEL. 860-529-8882

36922259.00000
VZ5-101

December 14, 2011

TABLE OF CONTENTS

- 1. EXECUTIVE SUMMARY**
- 2. INTRODUCTION**
- 3. ANALYSIS METHODOLOGY AND LOADING CONDITIONS**
- 4. FINDINGS AND EVALUATION**
- 5. CONCLUSIONS AND RECOMMENDATIONS**
- 6. DRAWINGS AND DATA**
 - **TNX TOWER INPUT / OUTPUT SUMMARY**
 - **TNX TOWER DETAILED OUTPUT**
 - **ANCHOR BOLT AND BASE PLATE ANALYSIS**
 - **FOUNDATION ANALYSIS**

1. EXECUTIVE SUMMARY

This report summarizes the structural analysis of the existing 149' steel tapered monopole structure, located at 8 Upper Meadow Road in West Granby, Connecticut. The analysis was conducted in accordance with the 2005 Connecticut State Building Code and the TIA/EIA-222-F standard for a wind velocity of 80 mph (fastest mile) and 69 mph (fastest mile) concurrent with 1/2" ice. The antenna loading considered in the analysis consists of all existing and proposed antennas, transmission lines, and ancillary items as outlined in the Introduction Section of this report. The proposed Verizon Wireless installation is as follows:

Proposed Antenna and Mount	Carrier	Antenna Center Elevation
Remove: (4) Amphenol LPA-80080-6CF-EDIN (2 per Alpha and Beta Sectors) (6) Amphenol LPA-185080-12CF-EDIN	Verizon (existing)	@ 137'
Install: (3) Amphenol BXA-70063-6CF-EDIN (4) Amphenol LPA-80063-6CF-EDIN (2 per Alpha & Beta Sectors) (6) Amphenol LPA-171080-12CF-EDIN (6) Diplexers (6) 1 5/8" coaxial cables (located inside existing monopole)	Verizon (Proposed)	@ 137'

The results of the analysis indicate that the tower structure has the capacity to support the proposed loading conditions. **The tower and its foundation are considered structurally adequate with the wind load classification specified above and the proposed antenna loading.**

This analysis is based on:

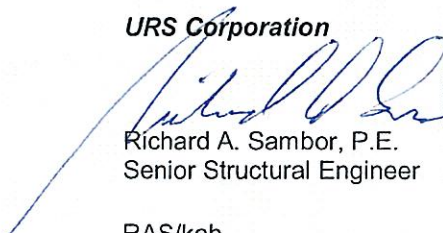
- 1) The tower structure's theoretical capacity, not including any assessment of the condition of the tower.
- 2) Tower geometry and structural member sizes utilized in the preparation of this report were obtained from manufacturers original design documents prepared by Paul J. Ford and Company on behalf of PennSummit Tubular, LLC., Job no. 29204-0021, signed and sealed January 29, 2004.
- 3) Geotechnical report prepared by Jaworski Geotech, Inc. dated January 27, 2004.
- 4) Antenna and mount configuration as specified within Section 2 and 6 of this report.

This report is only valid as per the assumptions and data utilized in this report for antenna inventory, mounts and associated cables. The user of this report shall field verify the assumption of the antenna and mount configuration as well as the physical condition of the tower. Notify the engineer in writing immediately if any of the information in this report is found to be other than specified.

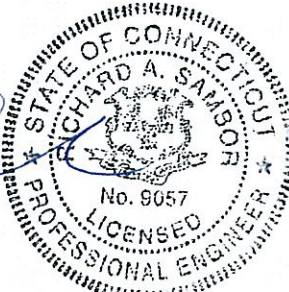
If you should have any questions, please call.

Sincerely,

URS Corporation


Richard A. Sambor, P.E.
Senior Structural Engineer

RAS/kab



2. INTRODUCTION

The subject tower is located at 8 Upper Meadow Road, West Granby, CT. The structure is an existing 149' steel tapered monopole structure, designed by Paul J. Ford and Company and manufactured by PennSummit Tubular, LLC.

The inventory is summarized in the table below:

Antenna Type	Carrier	Mount	Antenna Centerline Elevation	Cable
(2) LPA80080-6CF-EDIN (Gamma Sector)	Verizon (existing)	(3) T-Arm Mounts	137'	(12) 1-5/8"
(3) Amphenol BXA-70063-6CF-EDIN (4) Amphenol LPA-80063-6CF-EDIN (2 per Alpha & Beta Sectors) (6) Amphenol LPA-171080-12CF-EDIN (6) Diplexers	Verizon (proposed)	Shared with Above	137'	(6) 1-5/8"

Notes: 1. All existing and proposed coax shall be located within the monopole.
2. Verizon only carrier on pole per email with Verizon Wireless (tower owner) on December 6, 2011.

This structural analysis of the communications tower was performed by URS Corporation (URS) for Verizon Wireless. The purpose of this analysis was to investigate the structural integrity of the existing tower with its existing and proposed antenna loads. This analysis was conducted to evaluate stress on the tower and the effect of forces to the foundation of the tower resulting from existing and proposed antenna arrangements.

3. ANALYSIS METHODOLOGY AND LOADING CONDITIONS

The structural analysis was conducted in accordance with the 2005 Connecticut State Building Code, TIA/EIA-222-F - Structural Standard for Steel Antenna Towers and Antenna Supporting Structures, and the American Institute of Steel Construction (AISC) Manual of Steel Construction - Allowable Stress Design (ASD).

The analysis was conducted using trn Tower 6.0. Two load conditions were evaluated as shown below which were compared to allowable stresses according to AISC and TIA/EIA.

Load Condition 1 = 80 mph (fastest mile) Wind Load (without ice) + Tower Dead Load

Load Condition 2 = 69 mph (fastest mile) Wind Load (with ice) + Ice Load + Tower Dead Load

Please note that wind pressure is a function of velocity squared. Under Load Condition 2, a 25 percent reduction in wind pressure is allowed by code to account for the unlikelihood of the full wind pressure and ice load occurring at the same time. The same results may be achieved by utilizing a lower wind pressure without taking the 25 percent reduction, as shown above.

The TIA/EIA standard permits a one-third increase in allowable stresses for towers and monopoles less than 700 feet tall. For the purposes of this analysis, in computing the load capacity the allowable stresses of the tower members were increased by one-third.

4. FINDINGS AND EVALUATION

Combined axial and bending stresses on the monopole structure were evaluated to compare with allowable stresses in accordance with AISC. The calculated stresses under the proposed loading were below the allowable stresses (see table below). Detailed analysis and calculations for the proposed load condition are provided in section 6 of this report. Additionally, the anchor bolts, base plate and foundation were found to be within the allowable limits.

Tower Reactions:

For detailed proposed tower reactions, see drawing no. E-1 in section 6 of this report.

Proposed Tower Base Reactions vs. Original Design Reactions

Base Reactions	Original Design Reactions	Proposed Reactions
Axial Load (kips)	25	24
Shear (kips)	25	14
O.T. Moment (ft-kips)	2675	1355

Tower Component Stress vs. Capacity Summary

Component (Section No.)	Controlling Component / Elevation	Stress Ratio (% capacity)	Pass/Fail	Notes:
Pole Shaft (L2)	75.75'-117.5'	58.5%	Pass	
Anchor Bolts	Compression	53.3%	Pass	
Base Plate	Bending	58%	Pass	

Foundation Summary

Foundation	Component	Stress (% capacity/FOS)	Pass/Fail	Comments:
Reinf. Concrete Pad and Pier	OTM	77.2%/2.59	Pass	Min. F.O.S of 2.0 req'd per IBC 2003 Section 3108.4.2

5. CONCLUSIONS AND RECOMMENDATIONS

The results of the analysis indicate that the tower structure has the capacity to support the proposed loading conditions. **The tower and its foundation are considered structurally adequate with the wind load classification specified above and the proposed antenna loading.**

Limitations/Assumptions:

This report is based on the following:

1. Tower inventory as listed in this report.
2. Tower is properly installed and maintained.
3. All members are as specified in the original design documents and are in good condition.
4. All required members are in place.
5. All bolts are in place and are properly tightened.
6. Tower is in plumb condition.
7. All member protective coatings are in good condition.
8. All tower members were properly designed, detailed, fabricated, and installed and have been properly maintained since erection.
9. Foundations were properly constructed to support original design loads as specified in the original design documents.
10. All coaxial cable is installed within the monopole unless specified otherwise.

URS is not responsible for any modifications completed prior to or hereafter in which URS is not or was not directly involved. Modifications include but are not limited to:

- A. Adding antennas
- B. Removing/replacing antennas
- C. Adding coaxial cables

URS hereby states that this document represents the entire report and that it assumes no liability for any factual changes that may occur after the date of this report. All representations, recommendations, and conclusions are based upon information contained and set forth herein. If you are aware of any information which conflicts with that which is contained herein, or you are aware of any defects arising from original design, material, fabrication, or erection deficiencies, you should disregard this report and immediately contact URS. URS disclaims all liability for any representation, recommendation, or conclusion not expressly stated herein.

Ongoing and Periodic Inspection and Maintenance:

After the Contractor has successfully completed the installation and the work has been accepted, the owner will be responsible for the ongoing and periodic inspection and maintenance of the tower.

The owner shall refer to TIA/EIA-222-F for recommendations for maintenance and inspection. The frequency of the inspection and maintenance intervals is to be determined by the owner based upon actual site and environmental conditions. It is recommended that a complete and thorough inspection of the entire tower structural system be performed at least yearly and more frequently as conditions warrant. According to TIA/EIA-222-F section 14.1, Note 1: It is recommended that the structure be inspected after severe wind and/or ice storms or other extreme loading conditions.

6. DRAWINGS AND DATA

TNX TOWER INPUT/OUTPUT SUMMARY

Section	1	2	3	4		149.0 ft
	Length (ft)	45.00	40.00	45.00		
	Number of Sides	18	18	18		
	Thickness (in)	0.2188	0.3125	0.3750		
	Socket Length (ft)	4.25	5.00	37.8040		
	Top Dia (in)	24.8517	31.9540	37.8040		
	Bot Dia (in)	33.1780	39.3540	46.1300		
	Grade	A607-55				
	Weight (K)	3.1	4.8	7.6		
					0.0 ft	
					40.0 ft	
					75.8 ft	
					117.5 ft	

DESIGNED APPURTENANCE LOADING

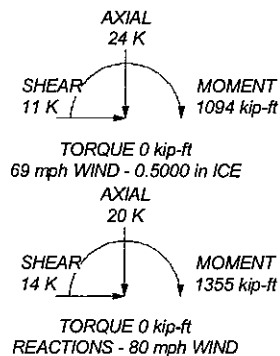
TYPE	ELEVATION	TYPE	ELEVATION
BXA-70063-6CF-EDIN (Verizon)	137	(2) LPA-171080-12CF-EDIN (Verizon)	137
BXA-70063-6CF-EDIN (Verizon)	137	(2) LPA-171080-12CF-EDIN (Verizon)	137
BXA-70063-6CF-EDIN (Verizon)	137	(2) Diplexer (Verizon)	137
(2) LPA-80063-6CF-EDIN (Verizon)	137	(2) Diplexer (Verizon)	137
(2) LPA-80063-6CF-EDIN (Verizon)	137	(2) Diplexer (Verizon)	137
(2) LPA-80080-6CF-EDIN (Verizon)	137	Generic T-Arm Mount	137
(2) LPA-171080-12CF-EDIN (Verizon)	137	Generic T-Arm Mount	137
		Generic T-Arm Mount	137

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A607-55	65 ksi	80 ksi			

TOWER DESIGN NOTES

1. Tower designed for a 80 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 69 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. TOWER RATING: 58.5%



URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job: 149'-0" Summit Monopole		
	Project: 8 Upper Meadow Road, W. Granby, CT		
	Client: Verizon Wireless	Drawn by: kevin_barker	App'd:
	Code: TIA/EIA-222-F	Date: 12/14/11	Scale: NTS
	Path: P:\08\ERI Files\149 Monopole - W. Granby.en	Dwg No. E-1	

TNX TOWER DETAILED OUTPUT

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	1 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Tower Input Data

There is a pole section.

This tower is designed using the TIA/EIA-222-F standard.

The following design criteria apply:

Basic wind speed of 80 mph.

Nominal ice thickness of 0.5000 in.

Ice density of 56 pcf.

A wind speed of 69 mph is used in combination with ice.

Temperature drop of 50 °F.

Deflections calculated using a wind speed of 50 mph.

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	Section Length	Splice Length	Number of Sides	Top Diameter	Bottom Diameter	Wall Thickness	Bend Radius	Pole Grade
	ft	ft	ft		in	in	in	in	
L1	149.00-117.50	31.50	3.25	18	20.0000	25.8280	0.1875	0.7500	A607-65 (65 ksi)
L2	117.50-75.75	45.00	4.25	18	24.8517	33.1780	0.2188	0.8752	A607-65 (65 ksi)
L3	75.75-40.00	40.00	5.00	18	31.9540	39.3540	0.3125	1.2500	A607-65 (65 ksi)
L4	40.00-0.00	45.00		18	37.8040	46.1300	0.3750	1.5000	A607-65 (65 ksi)

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	2 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

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	20.3085	11.7909	584.7409	7.0334	10.1600	57.5532	1170.2512	5.8966	3.1900	17.013
	26.2264	15.2593	1267.4333	9.1024	13.1206	96.5986	2536.5343	7.6311	4.2157	22.484
L2	25.8457	17.1068	1311.4092	8.7447	12.6247	103.8768	2624.5439	8.5550	3.9888	18.23
	33.6898	22.8892	3141.3887	11.7005	16.8544	186.3836	6286.9109	11.4468	5.4542	24.928
L3	33.2453	31.3844	3969.7824	11.2327	16.2326	244.5555	7944.7882	15.6952	5.0739	16.237
	39.9611	38.7243	7457.1672	13.8597	19.9918	373.0107	14924.1467	19.3658	6.3763	20.404
L4	39.3266	44.5499	7884.9768	13.2873	19.2044	410.5811	15780.3288	22.2792	5.9935	15.983
	46.8416	54.4599	14404.2722	16.2430	23.4340	614.6730	28827.4979	27.2351	7.4589	19.89

Tower Elevation	Gusset Area (per face)	Gusset Thickness	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
ft	ft ²	in						
L1 149.00-117.50				1	1	1		
L2 117.50-75.75				1	1	1		
L3 75.75-40.00				1	1	1		
L4 40.00-0.00				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number	C _A A _A ft ² /ft	Weight plf
1 5/8 (Verizon)	C	No	Inside Pole	137.00 - 0.00	18	No Ice 1/2" Ice	0.00 1.04

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A _R ft ²	A _F ft ²	C _A A _A In Face ft ²	C _A A _A Out Face ft ²	Weight K
L1	149.00-117.50	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	0.37
L2	117.50-75.75	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	0.78
L3	75.75-40.00	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	0.67
L4	40.00-0.00	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	0.75

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page 3 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date 15:09:12 12/14/11
	Client	Verizon Wireless	Designed by kevin_barker

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} In Face ft ²	C_{AA} Out Face ft ²	Weight K
L1	149.00-117.50	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	0.37
L2	117.50-75.75	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	0.78
L3	75.75-40.00	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	0.67
L4	40.00-0.00	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	0.75

Feed Line Center of Pressure

Section	Elevation ft	CP_x in	CP_z in	CP_x Ice in	CP_z Ice in
L1	149.00-117.50	0.0000	0.0000	0.0000	0.0000
L2	117.50-75.75	0.0000	0.0000	0.0000	0.0000
L3	75.75-40.00	0.0000	0.0000	0.0000	0.0000
L4	40.00-0.00	0.0000	0.0000	0.0000	0.0000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft	C_{AA} Front ft ²	C_{AA} Side ft ²	Weight K
BXA-70063-6CF-EDIN (Verizon)	A	From Leg	3.00	0.0000	137.00	No Ice	7.73	0.02
			0.00			1/2" Ice	8.27	0.06
			0.00					
BXA-70063-6CF-EDIN (Verizon)	B	From Leg	3.00	0.0000	137.00	No Ice	7.73	0.02
			0.00			1/2" Ice	8.27	0.06
			0.00					
BXA-70063-6CF-EDIN (Verizon)	C	From Leg	3.00	0.0000	137.00	No Ice	7.73	0.02
			0.00			1/2" Ice	8.27	0.06
			0.00					
(2) LPA-80063-6CF-EDIN (Verizon)	A	From Leg	3.00	0.0000	137.00	No Ice	10.51	0.05
			0.00			1/2" Ice	11.07	0.13
			0.00					
(2) LPA-80063-6CF-EDIN (Verizon)	B	From Leg	3.00	0.0000	137.00	No Ice	10.51	0.05
			0.00			1/2" Ice	11.07	0.13
			0.00					
(2) LPA-80080-6CF-EDIN (Verizon)	C	From Leg	3.00	0.0000	137.00	No Ice	4.32	0.05
			0.00			1/2" Ice	4.76	0.09

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	4 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C _A A _A Front ft ²	C _A A _A Side ft ²	Weight K
(2) LPA-171080-12CF-EDIN (Verizon)	A	From Leg	0.00 3.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	3.72 4.17	5.40 5.86	0.02 0.05
(2) LPA-171080-12CF-EDIN (Verizon)	B	From Leg	0.00 3.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	3.72 4.17	5.40 5.86	0.02 0.05
(2) LPA-171080-12CF-EDIN (Verizon)	C	From Leg	0.00 3.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	3.72 4.17	5.40 5.86	0.02 0.05
(2) Diplexer (Verizon)	A	From Leg	0.00 2.50 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	0.47 0.56	0.12 0.17	0.01 0.01
(2) Diplexer (Verizon)	B	From Leg	0.00 2.50 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	0.47 0.56	0.12 0.17	0.01 0.01
(2) Diplexer (Verizon)	C	From Leg	0.00 2.50 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	0.47 0.56	0.12 0.17	0.01 0.01
Generic T-Arm Mount	A	From Leg	0.00 2.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	5.50 6.90	5.50 6.90	0.13 0.17
Generic T-Arm Mount	B	From Leg	0.00 2.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	5.50 6.90	5.50 6.90	0.13 0.17
Generic T-Arm Mount	C	From Leg	0.00 2.00 0.00 0.00	0.0000	137.00	No Ice 1/2" Ice	5.50 6.90	5.50 6.90	0.13 0.17

Tower Pressures - No Ice

$$G_H = 1.690$$

Section Elevation ft	z ft	K _Z	q _z psf	A _G ft ²	F a c e	A _F ft ²	A _R ft ²	A _{leg} ft ²	Leg %	C _A A _A In Face ft ²	C _A A _A Out Face ft ²
L1 149.00-117.50	132.71	1.488	24	60.149	A	0.000	60.149	60.149	100.00	0.000	0.000
					B	0.000	60.149		100.00	0.000	0.000
					C	0.000	60.149		100.00	0.000	0.000
L2 117.50-75.75	96.03	1.357	22	101.994	A	0.000	101.994	101.994	100.00	0.000	0.000
					B	0.000	101.994		100.00	0.000	0.000
					C	0.000	101.994		100.00	0.000	0.000
L3 75.75-40.00	57.73	1.173	19	107.390	A	0.000	107.390	107.390	100.00	0.000	0.000
					B	0.000	107.390		100.00	0.000	0.000
					C	0.000	107.390		100.00	0.000	0.000
L4 40.00-0.00	19.42	1	16	141.432	A	0.000	141.432	141.432	100.00	0.000	0.000
					B	0.000	141.432		100.00	0.000	0.000
					C	0.000	141.432		100.00	0.000	0.000

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	5 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Tower Pressure - With Ice

$$G_H = 1.690$$

Section Elevation	z	K _z	q _z	t _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face	C _A A _A Out Face
ft	ft		psf	in	ft ²		ft ²	ft ²	ft ²		ft ²	ft ²
L1 149.00-117.50	132.71	1.488	18	0.5000	62.774	A	0.000	62.774	62.774	100.00	0.000	0.000
						B	0.000	62.774		100.00	0.000	0.000
						C	0.000	62.774		100.00	0.000	0.000
L2 117.50-75.75	96.03	1.357	17	0.5000	105.473	A	0.000	105.473	105.473	100.00	0.000	0.000
						B	0.000	105.473		100.00	0.000	0.000
						C	0.000	105.473		100.00	0.000	0.000
L3 75.75-40.00	57.73	1.173	14	0.5000	110.370	A	0.000	110.370	110.370	100.00	0.000	0.000
						B	0.000	110.370		100.00	0.000	0.000
						C	0.000	110.370		100.00	0.000	0.000
L4 40.00-0.00	19.42	1	12	0.5000	144.765	A	0.000	144.765	144.765	100.00	0.000	0.000
						B	0.000	144.765		100.00	0.000	0.000
						C	0.000	144.765		100.00	0.000	0.000

Tower Pressure - Service

$$G_H = 1.690$$

Section Elevation	z	K _z	q _z	A _G	F a c e	A _F	A _R	A _{leg}	Leg %	C _A A _A In Face	C _A A _A Out Face
ft	ft		psf	ft ²		ft ²	ft ²	ft ²		ft ²	ft ²
L1 149.00-117.50	132.71	1.488	10	60.149	A	0.000	60.149	60.149	100.00	0.000	0.000
					B	0.000	60.149		100.00	0.000	0.000
					C	0.000	60.149		100.00	0.000	0.000
L2 117.50-75.75	96.03	1.357	9	101.994	A	0.000	101.994	101.994	100.00	0.000	0.000
					B	0.000	101.994		100.00	0.000	0.000
					C	0.000	101.994		100.00	0.000	0.000
L3 75.75-40.00	57.73	1.173	7	107.390	A	0.000	107.390	107.390	100.00	0.000	0.000
					B	0.000	107.390		100.00	0.000	0.000
					C	0.000	107.390		100.00	0.000	0.000
L4 40.00-0.00	19.42	1	6	141.432	A	0.000	141.432	141.432	100.00	0.000	0.000
					B	0.000	141.432		100.00	0.000	0.000
					C	0.000	141.432		100.00	0.000	0.000

Tower Forces - No Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	1.61	51.11	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	2.49	59.53	C
			B	1	0.65	1	1	1	101.994			

inxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	6 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L3 75.75-40.00	0.67	4.77	C	1	0.65	1	1	1	101.994			
			A	1	0.65	1	1	1	107.390	2.26	63.15	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	2.55	63.64	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	632.11 kip-ft	8.90		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	1.61	51.11	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	2.49	59.53	C
			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3 75.75-40.00	0.67	4.77	A	1	0.65	1	1	1	107.390	2.26	63.15	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	2.55	63.64	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	632.11 kip-ft	8.90		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	1.61	51.11	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	2.49	59.53	C
			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3 75.75-40.00	0.67	4.77	A	1	0.65	1	1	1	107.390	2.26	63.15	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	2.55	63.64	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	632.11 kip-ft	8.90		

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	7 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Tower Forces - No Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	1.61	51.11	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	2.49	59.53	C
			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3 75.75-40.00	0.67	4.77	A	1	0.65	1	1	1	107.390	2.26	63.15	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	2.55	63.64	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	632.11 kip-ft	8.90		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.90	A	1	0.65	1	1	1	62.774	1.26	40.03	C
			B	1	0.65	1	1	1	62.774			
			C	1	0.65	1	1	1	62.774			
L2 117.50-75.75	0.78	3.83	A	1	0.65	1	1	1	105.473	1.93	46.19	C
			B	1	0.65	1	1	1	105.473			
			C	1	0.65	1	1	1	105.473			
L3 75.75-40.00	0.67	5.58	A	1	0.65	1	1	1	110.370	1.74	48.70	C
			B	1	0.65	1	1	1	110.370			
			C	1	0.65	1	1	1	110.370			
L4 40.00-0.00	0.75	8.64	A	1	0.65	1	1	1	144.765	1.96	48.88	C
			B	1	0.65	1	1	1	144.765			
			C	1	0.65	1	1	1	144.765			
Sum Weight:	2.56	19.95						OTM	491.02 kip-ft	6.89		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.90	A	1	0.65	1	1	1	62.774	1.26	40.03	C
			B	1	0.65	1	1	1	62.774			
			C	1	0.65	1	1	1	62.774			

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	8 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L2 117.50-75.75	0.78	3.83	A	1	0.65	1	1	1	105.473	1.93	46.19	C
			B	1	0.65	1	1	1	105.473			
			C	1	0.65	1	1	1	105.473			
L3 75.75-40.00	0.67	5.58	A	1	0.65	1	1	1	110.370	1.74	48.70	C
			B	1	0.65	1	1	1	110.370			
			C	1	0.65	1	1	1	110.370			
L4 40.00-0.00	0.75	8.64	A	1	0.65	1	1	1	144.765	1.96	48.88	C
			B	1	0.65	1	1	1	144.765			
			C	1	0.65	1	1	1	144.765			
Sum Weight:	2.56	19.95						OTM	491.02 kip-ft	6.89		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L1 149.00-117.50	0.37	1.90	A	1	0.65	1	1	1	62.774	1.26	40.03	C
			B	1	0.65	1	1	1	62.774			
			C	1	0.65	1	1	1	62.774			
L2 117.50-75.75	0.78	3.83	A	1	0.65	1	1	1	105.473	1.93	46.19	C
			B	1	0.65	1	1	1	105.473			
			C	1	0.65	1	1	1	105.473			
L3 75.75-40.00	0.67	5.58	A	1	0.65	1	1	1	110.370	1.74	48.70	C
			B	1	0.65	1	1	1	110.370			
			C	1	0.65	1	1	1	110.370			
L4 40.00-0.00	0.75	8.64	A	1	0.65	1	1	1	144.765	1.96	48.88	C
			B	1	0.65	1	1	1	144.765			
			C	1	0.65	1	1	1	144.765			
Sum Weight:	2.56	19.95						OTM	491.02 kip-ft	6.89		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	F a c e	e	C _F	R _R	D _F	D _R	A _E ft ²	F K	w plf	Ctrl. Face
L1 149.00-117.50	0.37	1.90	A	1	0.65	1	1	1	62.774	1.26	40.03	C
			B	1	0.65	1	1	1	62.774			
			C	1	0.65	1	1	1	62.774			
L2 117.50-75.75	0.78	3.83	A	1	0.65	1	1	1	105.473	1.93	46.19	C
			B	1	0.65	1	1	1	105.473			
			C	1	0.65	1	1	1	105.473			
L3 75.75-40.00	0.67	5.58	A	1	0.65	1	1	1	110.370	1.74	48.70	C
			B	1	0.65	1	1	1	110.370			
			C	1	0.65	1	1	1	110.370			
L4 40.00-0.00	0.75	8.64	A	1	0.65	1	1	1	144.765	1.96	48.88	C
			B	1	0.65	1	1	1	144.765			
			C	1	0.65	1	1	1	144.765			

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	9 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
Sum Weight:	2.56	19.95						OTM	491.02 kip-ft	6.89		

Tower Forces - Service - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	0.63	19.97	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	0.97	23.25	C
			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3 75.75-40.00	0.67	4.77	A	1	0.65	1	1	1	107.390	0.88	24.67	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	0.99	24.86	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	246.92 kip-ft	3.48		

Tower Forces - Service - Wind 45 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1 149.00-117.50	0.37	1.45	A	1	0.65	1	1	1	60.149	0.63	19.97	C
			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2 117.50-75.75	0.78	3.06	A	1	0.65	1	1	1	101.994	0.97	23.25	C
			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3 75.75-40.00	0.67	4.77	A	1	0.65	1	1	1	107.390	0.88	24.67	C
			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	0.99	24.86	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	246.92 kip-ft	3.48		

Tower Forces - Service - Wind 60 To Face

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	10 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1	0.37	1.45	A	1	0.65	1	1	1	60.149	0.63	19.97	C
149.00-117.50			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2	0.78	3.06	A	1	0.65	1	1	1	101.994	0.97	23.25	C
117.50-75.75			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3	0.67	4.77	A	1	0.65	1	1	1	107.390	0.88	24.67	C
75.75-40.00			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	0.99	24.86	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	246.92	3.48		
									kip-ft			

Tower Forces - Service - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	R _R	D _F	D _R	A _E	F	w	Ctrl. Face
ft	K	K							ft ²	K	plf	
L1	0.37	1.45	A	1	0.65	1	1	1	60.149	0.63	19.97	C
149.00-117.50			B	1	0.65	1	1	1	60.149			
			C	1	0.65	1	1	1	60.149			
L2	0.78	3.06	A	1	0.65	1	1	1	101.994	0.97	23.25	C
117.50-75.75			B	1	0.65	1	1	1	101.994			
			C	1	0.65	1	1	1	101.994			
L3	0.67	4.77	A	1	0.65	1	1	1	107.390	0.88	24.67	C
75.75-40.00			B	1	0.65	1	1	1	107.390			
			C	1	0.65	1	1	1	107.390			
L4 40.00-0.00	0.75	7.58	A	1	0.65	1	1	1	141.432	0.99	24.86	C
			B	1	0.65	1	1	1	141.432			
			C	1	0.65	1	1	1	141.432			
Sum Weight:	2.56	16.86						OTM	246.92	3.48		
									kip-ft			

Force Totals

Load Case	Vertical Forces	Sum of Forces X	Sum of Forces Z	Sum of Overturning Moments, M _x	Sum of Overturning Moments, M _z	Sum of Torques
	K	K	K	kip-ft	kip-ft	kip-ft
Leg Weight	16.86					
Bracing Weight	0.00					
Total Member Self-Weight	16.86			0.00	0.00	
Total Weight	20.33			0.00	0.00	
Wind 0 deg - No Ice		-0.22	-13.85	-1310.57	30.73	-0.01
Wind 30 deg - No Ice		6.60	-11.88	-1119.62	-610.93	-0.01
Wind 45 deg - No Ice		9.45	-9.64	-904.98	-879.90	-0.00
Wind 60 deg - No Ice		11.66	-6.73	-628.67	-1088.90	0.00
Wind 90 deg - No Ice		13.59	0.22	30.73	-1275.09	0.01

Job	149'-0" Summit Monopole	Page	11 of 18
Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
Client	Verizon Wireless	Designed by	kevin_barker

Load Case	Vertical Forces K	Sum of Forces X K	Sum of Forces Z K	Sum of Overturning Moments, M_x kip-ft	Sum of Overturning Moments, M_z kip-ft	Sum of Torques kip-ft
Wind 120 deg - No Ice		11.88	7.12	681.89	-1119.62	0.01
Wind 135 deg - No Ice		9.77	9.95	948.44	-923.35	0.01
Wind 150 deg - No Ice		6.99	12.11	1150.35	-664.15	0.01
Wind 180 deg - No Ice		0.22	13.85	1310.57	-30.73	0.01
Wind 210 deg - No Ice		-6.60	11.88	1119.62	610.93	0.01
Wind 225 deg - No Ice		-9.45	9.64	904.98	879.90	0.00
Wind 240 deg - No Ice		-11.66	6.73	628.67	1088.90	0.00
Wind 270 deg - No Ice		-13.59	-0.22	-30.73	1275.09	-0.01
Wind 300 deg - No Ice		-11.88	-7.12	-681.89	1119.62	-0.01
Wind 315 deg - No Ice		-9.77	-9.95	-948.44	923.35	-0.01
Wind 330 deg - No Ice		-6.99	-12.11	-1150.35	664.15	-0.01
Member Ice	3.09					
Total Weight Ice	24.24			-0.13	-0.22	
Wind 0 deg - Ice		-0.17	-10.98	-1052.09	23.30	-0.01
Wind 30 deg - Ice		5.24	-9.42	-899.40	-492.26	-0.01
Wind 45 deg - Ice		7.50	-7.64	-727.35	-708.24	-0.00
Wind 60 deg - Ice		9.25	-5.34	-505.74	-875.97	0.00
Wind 90 deg - Ice		10.78	0.17	23.39	-1025.03	0.01
Wind 120 deg - Ice		9.42	5.64	546.22	-899.49	0.01
Wind 135 deg - Ice		7.75	7.89	760.35	-741.50	0.01
Wind 150 deg - Ice		5.54	9.59	922.66	-532.99	0.01
Wind 180 deg - Ice		0.17	10.98	1051.84	-23.74	0.01
Wind 210 deg - Ice		-5.24	9.42	899.14	491.81	0.01
Wind 225 deg - Ice		-7.50	7.64	727.09	707.80	0.00
Wind 240 deg - Ice		-9.25	5.34	505.49	875.53	0.00
Wind 270 deg - Ice		-10.78	-0.17	-23.65	1024.59	-0.01
Wind 300 deg - Ice		-9.42	-5.64	-546.48	899.05	-0.01
Wind 315 deg - Ice		-7.75	-7.89	-760.61	741.06	-0.01
Wind 330 deg - Ice		-5.54	-9.59	-922.92	532.55	-0.01
Total Weight	20.33			0.00	0.00	
Wind 0 deg - Service		-0.09	-5.41	-511.94	12.00	-0.00
Wind 30 deg - Service		2.58	-4.64	-437.35	-238.65	-0.00
Wind 45 deg - Service		3.69	-3.76	-353.51	-343.71	-0.00
Wind 60 deg - Service		4.55	-2.63	-245.58	-425.35	0.00
Wind 90 deg - Service		5.31	0.09	12.00	-498.08	0.00
Wind 120 deg - Service		4.64	2.78	266.36	-437.35	0.00
Wind 135 deg - Service		3.82	3.89	370.48	-360.68	0.01
Wind 150 deg - Service		2.73	4.73	449.35	-259.44	0.01
Wind 180 deg - Service		0.09	5.41	511.94	-12.00	0.00
Wind 210 deg - Service		-2.58	4.64	437.35	238.65	0.00
Wind 225 deg - Service		-3.69	3.76	353.51	343.71	0.00
Wind 240 deg - Service		-4.55	2.63	245.58	425.35	0.00
Wind 270 deg - Service		-5.31	-0.09	-12.00	498.08	-0.00
Wind 300 deg - Service		-4.64	-2.78	-266.36	437.35	-0.00
Wind 315 deg - Service		-3.82	-3.89	-370.48	360.68	-0.01
Wind 330 deg - Service		-2.73	-4.73	-449.35	259.44	-0.01

Load Combinations

Comb. No.	Description
1	Dead Only
2	Dead+Wind 0 deg - No Ice
3	Dead+Wind 30 deg - No Ice
4	Dead+Wind 45 deg - No Ice
5	Dead+Wind 60 deg - No Ice

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	12 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Comb. No.	Description
6	Dead+Wind 90 deg - No Ice
7	Dead+Wind 120 deg - No Ice
8	Dead+Wind 135 deg - No Ice
9	Dead+Wind 150 deg - No Ice
10	Dead+Wind 180 deg - No Ice
11	Dead+Wind 210 deg - No Ice
12	Dead+Wind 225 deg - No Ice
13	Dead+Wind 240 deg - No Ice
14	Dead+Wind 270 deg - No Ice
15	Dead+Wind 300 deg - No Ice
16	Dead+Wind 315 deg - No Ice
17	Dead+Wind 330 deg - No Ice
18	Dead+Ice+Temp
19	Dead+Wind 0 deg+Ice+Temp
20	Dead+Wind 30 deg+Ice+Temp
21	Dead+Wind 45 deg+Ice+Temp
22	Dead+Wind 60 deg+Ice+Temp
23	Dead+Wind 90 deg+Ice+Temp
24	Dead+Wind 120 deg+Ice+Temp
25	Dead+Wind 135 deg+Ice+Temp
26	Dead+Wind 150 deg+Ice+Temp
27	Dead+Wind 180 deg+Ice+Temp
28	Dead+Wind 210 deg+Ice+Temp
29	Dead+Wind 225 deg+Ice+Temp
30	Dead+Wind 240 deg+Ice+Temp
31	Dead+Wind 270 deg+Ice+Temp
32	Dead+Wind 300 deg+Ice+Temp
33	Dead+Wind 315 deg+Ice+Temp
34	Dead+Wind 330 deg+Ice+Temp
35	Dead+Wind 0 deg - Service
36	Dead+Wind 30 deg - Service
37	Dead+Wind 45 deg - Service
38	Dead+Wind 60 deg - Service
39	Dead+Wind 90 deg - Service
40	Dead+Wind 120 deg - Service
41	Dead+Wind 135 deg - Service
42	Dead+Wind 150 deg - Service
43	Dead+Wind 180 deg - Service
44	Dead+Wind 210 deg - Service
45	Dead+Wind 225 deg - Service
46	Dead+Wind 240 deg - Service
47	Dead+Wind 270 deg - Service
48	Dead+Wind 300 deg - Service
49	Dead+Wind 315 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L1	149 - 117.5	Pole	Max Tension	10	0.00	0.00	0.00
			Max. Compression	18	-3.73	-0.22	0.13
			Max. Mx	6	-2.14	-97.90	-3.71
			Max. My	2	-2.11	3.71	102.16
			Max. Vy	14	-6.26	97.90	3.71
			Max. Vx	10	6.52	-3.71	-102.16
			Max. Torque	17			0.01
			Max Tension	1	0.00	0.00	0.00
L2	117.5 - 75.75	Pole					

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	13 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Force K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
L3	75.75 - 40	Pole	Max. Compression	18	-8.11	-0.22	0.13
			Max. M _x	6	-5.82	-402.97	-13.08
			Max. M _y	2	-5.80	13.08	418.03
			Max. V _y	14	-8.74	402.97	13.08
			Max. V _x	10	9.01	-13.08	-418.03
			Max. Torque	17			0.01
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-13.98	-0.22	0.13
			Max. M _x	6	-11.03	-747.96	-21.16
			Max. M _y	2	-11.02	21.16	772.34
L4	40 - 0	Pole	Max. V _y	14	-10.95	747.96	21.16
			Max. V _x	10	11.21	-21.16	-772.34
			Max. Torque	17			0.01
			Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-24.24	-0.22	0.13
			Max. M _x	6	-20.32	-1300.24	-31.42
			Max. M _y	2	-20.32	31.42	1336.47
			Max. V _y	14	-13.60	1300.24	31.42
			Max. V _x	10	13.86	-31.42	-1336.47
			Max. Torque	17			0.01

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	18	24.24	-0.00	0.00
	Max. H _x	14	20.33	13.59	0.22
	Max. H _z	2	20.33	0.22	13.85
	Max. M _x	2	1336.47	0.22	13.85
	Max. M _z	6	1300.24	-13.59	-0.22
	Max. Torsion	17	0.01	6.99	12.11
	Min. Vert	2	20.33	0.22	13.85
	Min. H _x	6	20.33	-13.59	-0.22
	Min. H _z	10	20.33	-0.22	-13.85
	Min. M _x	10	-1336.47	-0.22	-13.85
	Min. M _z	14	-1300.24	13.59	0.22
	Min. Torsion	9	-0.01	-6.99	-12.11

Tower Mast Reaction Summary

Load Combination	Vertical K	Shear _x K	Shear _z K	Overturning Moment, M _x kip-ft	Overturning Moment, M _z kip-ft	Torque kip-ft
Dead Only	20.33	0.00	0.00	0.00	0.00	0.00
Dead+ Wind 0 deg - No Ice	20.33	-0.22	-13.85	-1336.47	31.42	-0.01
Dead+ Wind 30 deg - No Ice	20.33	6.60	-11.88	-1141.93	-623.00	-0.01
Dead+ Wind 45 deg - No Ice	20.33	9.45	-9.64	-923.00	-897.34	-0.00
Dead+ Wind 60 deg - No Ice	20.33	11.66	-6.73	-641.16	-1110.52	-0.00
Dead+ Wind 90 deg - No Ice	20.33	13.59	0.22	31.42	-1300.24	0.01
Dead+ Wind 120 deg - No Ice	20.33	11.88	7.12	695.55	-1141.88	0.01
Dead+ Wind 135 deg - No Ice	20.33	9.77	9.95	967.38	-941.72	0.01
Dead+ Wind 150 deg - No Ice	20.33	6.99	12.11	1173.28	-677.39	0.01

tnxTower

URS Corporation
 500 Enterprise Drive, Suite 3B
 Rocky Hill, CT 06067
 Phone: (860) 529-8882
 FAX: (860) 529-3991

Job

149'-0" Summit Monopole

Page

14 of 18

Project

8 Upper Meadow Road, W. Granby, CT

Date

15:09:12 12/14/11

Client

Verizon Wireless

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Load Combination	Vertical K	Shear _x K	Shear _y K	Overturning Moment, M _x kip-ft	Overturning Moment, M _y kip-ft	Torque kip-ft
Dead+Wind 180 deg - No Ice	20.33	0.22	13.85	1336.47	-31.42	0.01
Dead+Wind 210 deg - No Ice	20.33	-6.60	11.88	1141.93	623.00	0.01
Dead+Wind 225 deg - No Ice	20.33	-9.45	9.64	923.00	897.34	0.00
Dead+Wind 240 deg - No Ice	20.33	-11.66	6.73	641.16	1110.52	-0.00
Dead+Wind 270 deg - No Ice	20.33	-13.59	-0.22	-31.42	1300.24	-0.01
Dead+Wind 300 deg - No Ice	20.33	-11.88	-7.12	-695.55	1141.88	-0.01
Dead+Wind 315 deg - No Ice	20.33	-9.77	-9.95	-967.38	941.72	-0.01
Dead+Wind 330 deg - No Ice	20.33	-6.99	-12.11	-1173.28	677.39	-0.01
Dead+Ice+Temp	24.24	0.00	-0.00	-0.13	-0.22	0.00
Dead+Wind 0 deg+Ice+Temp	24.24	-0.17	-10.98	-1080.25	24.00	-0.00
Dead+Wind 30 deg+Ice+Temp	24.24	5.24	-9.42	-923.53	-505.37	-0.00
Dead+Wind 45 deg+Ice+Temp	24.24	7.50	-7.64	-746.85	-727.15	-0.00
Dead+Wind 60 deg+Ice+Temp	24.24	9.25	-5.34	-519.27	-899.40	-0.00
Dead+Wind 90 deg+Ice+Temp	24.24	10.78	0.17	24.10	-1052.38	0.00
Dead+Wind 120 deg+Ice+Temp	24.24	9.42	5.64	560.97	-923.61	0.00
Dead+Wind 135 deg+Ice+Temp	24.24	7.75	7.89	780.83	-761.40	0.00
Dead+Wind 150 deg+Ice+Temp	24.24	5.54	9.59	947.47	-547.33	0.00
Dead+Wind 180 deg+Ice+Temp	24.24	0.17	10.98	1079.98	-24.47	0.00
Dead+Wind 210 deg+Ice+Temp	24.24	-5.24	9.42	923.26	504.90	0.00
Dead+Wind 225 deg+Ice+Temp	24.24	-7.50	7.64	746.58	726.69	0.00
Dead+Wind 240 deg+Ice+Temp	24.24	-9.25	5.34	519.00	898.94	-0.00
Dead+Wind 270 deg+Ice+Temp	24.24	-10.78	-0.17	-24.37	1051.92	-0.00
Dead+Wind 300 deg+Ice+Temp	24.24	-9.42	-5.64	-561.24	923.14	-0.00
Dead+Wind 315 deg+Ice+Temp	24.24	-7.75	-7.89	-781.10	760.94	-0.00
Dead+Wind 330 deg+Ice+Temp	24.24	-5.54	-9.59	-947.74	546.86	-0.00
Dead+Wind 0 deg - Service	20.33	-0.09	-5.41	-522.33	12.28	-0.00
Dead+Wind 30 deg - Service	20.33	2.58	-4.64	-446.22	-243.44	-0.00
Dead+Wind 45 deg - Service	20.33	3.69	-3.76	-360.67	-350.64	-0.00
Dead+Wind 60 deg - Service	20.33	4.55	-2.63	-250.53	-433.94	-0.00
Dead+Wind 90 deg - Service	20.33	5.31	0.09	12.28	-508.16	0.00
Dead+Wind 120 deg - Service	20.33	4.64	2.78	271.80	-446.21	0.00
Dead+Wind 135 deg - Service	20.33	3.82	3.89	378.03	-368.00	0.01
Dead+Wind 150 deg - Service	20.33	2.73	4.73	458.49	-264.71	0.01
Dead+Wind 180 deg - Service	20.33	0.09	5.41	522.33	-12.28	0.00
Dead+Wind 210 deg - Service	20.33	-2.58	4.64	446.22	243.44	0.00
Dead+Wind 225 deg - Service	20.33	-3.69	3.76	360.67	350.64	0.00
Dead+Wind 240 deg - Service	20.33	-4.55	2.63	250.53	433.94	-0.00
Dead+Wind 270 deg - Service	20.33	-5.31	-0.09	-12.28	508.16	-0.00
Dead+Wind 300 deg - Service	20.33	-4.64	-2.78	-271.80	446.21	-0.00
Dead+Wind 315 deg - Service	20.33	-3.82	-3.89	-378.03	368.00	-0.01
Dead+Wind 330 deg - Service	20.33	-2.73	-4.73	-458.49	264.71	-0.01

Solution Summary

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX K	PY K	PZ K	PX K	PY K	PZ K	
1	0.00	-20.33	0.00	0.00	20.33	0.00	0.000%
2	-0.22	-20.33	-13.85	0.22	20.33	13.85	0.008%
3	6.60	-20.33	-11.88	-6.60	20.33	11.88	0.001%
4	9.45	-20.33	-9.64	-9.45	20.33	9.64	0.001%
5	11.66	-20.33	-6.73	-11.66	20.33	6.73	0.001%
6	13.59	-20.33	0.22	-13.59	20.33	-0.22	0.008%
7	11.88	-20.33	7.12	-11.88	20.33	-7.12	0.001%
8	9.77	-20.33	9.95	-9.77	20.33	-9.95	0.001%
9	6.99	-20.33	12.11	-6.99	20.33	-12.11	0.001%
10	0.22	-20.33	13.85	-0.22	20.33	-13.85	0.008%
11	-6.60	-20.33	11.88	6.60	20.33	-11.88	0.001%

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	15 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX K	PY K	PZ K	PX K	PY K	PZ K	
12	-9.45	-20.33	9.64	9.45	20.33	-9.64	0.001%
13	-11.66	-20.33	6.73	11.66	20.33	-6.73	0.001%
14	-13.59	-20.33	-0.22	13.59	20.33	0.22	0.008%
15	-11.88	-20.33	-7.12	11.88	20.33	7.12	0.001%
16	-9.77	-20.33	-9.95	9.77	20.33	9.95	0.001%
17	-6.99	-20.33	-12.11	6.99	20.33	12.11	0.001%
18	0.00	-24.24	0.00	-0.00	24.24	0.00	0.000%
19	-0.17	-24.24	-10.98	0.17	24.24	10.98	0.004%
20	5.24	-24.24	-9.42	-5.24	24.24	9.42	0.001%
21	7.50	-24.24	-7.64	-7.50	24.24	7.64	0.001%
22	9.25	-24.24	-5.34	-9.25	24.24	5.34	0.001%
23	10.78	-24.24	0.17	-10.78	24.24	-0.17	0.004%
24	9.42	-24.24	5.64	-9.42	24.24	-5.64	0.001%
25	7.75	-24.24	7.89	-7.75	24.24	-7.89	0.001%
26	5.54	-24.24	9.59	-5.54	24.24	-9.59	0.001%
27	0.17	-24.24	10.98	-0.17	24.24	-10.98	0.004%
28	-5.24	-24.24	9.42	5.24	24.24	-9.42	0.001%
29	-7.50	-24.24	7.64	7.50	24.24	-7.64	0.001%
30	-9.25	-24.24	5.34	9.25	24.24	-5.34	0.001%
31	-10.78	-24.24	-0.17	10.78	24.24	0.17	0.004%
32	-9.42	-24.24	-5.64	9.42	24.24	5.64	0.001%
33	-7.75	-24.24	-7.89	7.75	24.24	7.89	0.001%
34	-5.54	-24.24	-9.59	5.54	24.24	9.59	0.001%
35	-0.09	-20.33	-5.41	0.09	20.33	5.41	0.004%
36	2.58	-20.33	-4.64	-2.58	20.33	4.64	0.004%
37	3.69	-20.33	-3.76	-3.69	20.33	3.76	0.004%
38	4.55	-20.33	-2.63	-4.55	20.33	2.63	0.003%
39	5.31	-20.33	0.09	-5.31	20.33	-0.09	0.004%
40	4.64	-20.33	2.78	-4.64	20.33	-2.78	0.004%
41	3.82	-20.33	3.89	-3.82	20.33	-3.89	0.004%
42	2.73	-20.33	4.73	-2.73	20.33	-4.73	0.004%
43	0.09	-20.33	5.41	-0.09	20.33	-5.41	0.004%
44	-2.58	-20.33	4.64	2.58	20.33	-4.64	0.004%
45	-3.69	-20.33	3.76	3.69	20.33	-3.76	0.004%
46	-4.55	-20.33	2.63	4.55	20.33	-2.63	0.003%
47	-5.31	-20.33	-0.09	5.31	20.33	0.09	0.004%
48	-4.64	-20.33	-2.78	4.64	20.33	2.78	0.004%
49	-3.82	-20.33	-3.89	3.82	20.33	3.89	0.004%
50	-2.73	-20.33	-4.73	2.73	20.33	4.73	0.004%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	6	0.00000001	0.00000001
2	Yes	15	0.00008976	0.00011334
3	Yes	18	0.00000001	0.00009722
4	Yes	18	0.00000001	0.00011111
5	Yes	18	0.00000001	0.00009584
6	Yes	15	0.00008996	0.00011036
7	Yes	18	0.00000001	0.00011300
8	Yes	18	0.00000001	0.00012965
9	Yes	18	0.00000001	0.00011444
10	Yes	15	0.00008976	0.00011236
11	Yes	18	0.00000001	0.00009735
12	Yes	18	0.00000001	0.00011111

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	Page
	149'-0" Summit Monopole	16 of 18
	Project	Date
	8 Upper Meadow Road, W. Granby, CT	15:09:12 12/14/11
	Client	Designed by
	Verizon Wireless	kevin_barker

13	Yes	18	0.00000001	0.00009584
14	Yes	15	0.00008996	0.00010982
15	Yes	18	0.00000001	0.00011282
16	Yes	18	0.00000001	0.00012967
17	Yes	18	0.00000001	0.00011467
18	Yes	6	0.00000001	0.00000001
19	Yes	16	0.00006677	0.00012351
20	Yes	18	0.00000001	0.00010315
21	Yes	18	0.00000001	0.00011743
22	Yes	18	0.00000001	0.00010240
23	Yes	16	0.00006684	0.00012065
24	Yes	18	0.00000001	0.00011656
25	Yes	18	0.00000001	0.00013254
26	Yes	18	0.00000001	0.00011751
27	Yes	16	0.00006677	0.00012356
28	Yes	18	0.00000001	0.00010279
29	Yes	18	0.00000001	0.00011702
30	Yes	18	0.00000001	0.00010204
31	Yes	16	0.00006684	0.00012059
32	Yes	18	0.00000001	0.00011645
33	Yes	18	0.00000001	0.00013242
34	Yes	18	0.00000001	0.00011741
35	Yes	15	0.00009230	0.00005362
36	Yes	15	0.00000001	0.00005195
37	Yes	15	0.00000001	0.00005035
38	Yes	15	0.00000001	0.00005020
39	Yes	15	0.00000001	0.00005206
40	Yes	15	0.00009208	0.00005582
41	Yes	15	0.00009201	0.00005790
42	Yes	15	0.00009208	0.00005742
43	Yes	15	0.00009230	0.00005359
44	Yes	15	0.00000001	0.00005209
45	Yes	15	0.00000001	0.00005036
46	Yes	15	0.00000001	0.00005020
47	Yes	15	0.00000001	0.00005204
48	Yes	15	0.00009208	0.00005558
49	Yes	15	0.00009201	0.00005792
50	Yes	15	0.00009208	0.00005772

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	149 - 117.5	25.997	50	1.5031	0.0002
L2	120.75 - 75.75	17.229	50	1.4087	0.0001
L3	80 - 40	7.231	50	0.8730	0.0000
L4	45 - 0	2.259	50	0.4609	0.0000

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
137.00	BXA-70063-6CF-EDIN	50	22.181	1.4852	0.0002	14366

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	17 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	149 - 117.5	66.446	17	3.8437	0.0008
L2	120.75 - 75.75	44.046	17	3.6025	0.0006
L3	80 - 40	18.495	17	2.2330	0.0002
L4	45 - 0	5.779	17	1.1792	0.0000

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
137.00	BXA-70063-6CF-EDIN	17	56.699	3.7980	0.0007	5670

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 K	Allow. P _a K	Ratio P P _a
L1	149 - 117.5 (1)	TP25.828x20x0.1875	31.50	149.00	201.1	3.691	14.9015	-2.09	55.00	0.038
L2	117.5 - 75.75 (2)	TP33.178x24.8517x0.2188	45.00	149.00	156.5	6.093	22.3431	-5.79	136.14	0.043
L3	75.75 - 40 (3)	TP39.354x31.954x0.3125	40.00	149.00	132.1	8.553	37.8068	-11.01	323.35	0.034
L4	40 - 0 (4)	TP46.13x37.804x0.375	45.00	149.00	110.1	12.324	54.4599	-20.32	671.16	0.030

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M _x kip-ft	Actual f _{bx} ksi	Allow. F _{bx} ksi	Ratio f _{bx} F _{bx}	Actual M _y kip-ft	Actual f _{by} ksi	Allow. F _{by} ksi	Ratio f _{by} F _{by}
L1	149 - 117.5 (1)	TP25.828x20x0.1875	104.32	-13.591	39.000	0.348	0.00	0.000	39.000	0.000
L2	117.5 - 75.75 (2)	TP33.178x24.8517x0.2188	425.64	-28.765	39.000	0.738	0.00	0.000	39.000	0.000
L3	75.75 - 40 (3)	TP39.354x31.954x0.3125	784.66	-26.488	39.000	0.679	0.00	0.000	39.000	0.000
L4	40 - 0 (4)	TP46.13x37.804x0.375	1354.79	-26.449	39.000	0.678	0.00	0.000	39.000	0.000

tnxTower URS Corporation 500 Enterprise Drive, Suite 3B Rocky Hill, CT 06067 Phone: (860) 529-8882 FAX: (860) 529-3991	Job	149'-0" Summit Monopole	Page	18 of 18
	Project	8 Upper Meadow Road, W. Granby, CT	Date	15:09:12 12/14/11
	Client	Verizon Wireless	Designed by	kevin_barker

Pole Interaction Design Data

Section No.	Elevation ft	Size	Ratio P P_a	Ratio f_{bx} F_{bx}	Ratio f_{by} F_{by}	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	149 - 117.5 (1)	TP25.828x20x0.1875	0.038	0.348	0.000	0.387 ✓	1.333	H1-3 ✓
L2	117.5 - 75.75 (2)	TP33.178x24.8517x0.2188	0.043	0.738	0.000	0.780 ✓	1.333	H1-3 ✓
L3	75.75 - 40 (3)	TP39.354x31.954x0.3125	0.034	0.679	0.000	0.713 ✓	1.333	H1-3 ✓
L4	40 - 0 (4)	TP46.13x37.804x0.375	0.030	0.678	0.000	0.708 ✓	1.333	H1-3 ✓

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	SF* P_{allow} K	% Capacity	Pass Fail
L1	149 - 117.5	Pole	TP25.828x20x0.1875	1	-2.09	73.31	29.0	Pass
L2	117.5 - 75.75	Pole	TP33.178x24.8517x0.2188	2	-5.79	181.48	58.5	Pass
L3	75.75 - 40	Pole	TP39.354x31.954x0.3125	3	-11.01	431.02	53.5	Pass
L4	40 - 0	Pole	TP46.13x37.804x0.375	4	-20.32	894.66	53.1	Pass
							Summary	
							Pole (L2)	58.5 Pass
							RATING =	58.5 Pass

ANCHOR BOLT AND BASE PLATE ANALYSIS

ANCHOR BOLT AND BASEPLATE ANALYSIS

Input Data

Tower Reactions:

Overturning Moment:	OM := 1355·kips·ft	user input
Shear Force:	Shear := 14·kips	user input
Axial Force:	Axial := 20·kips	user input

Anchor Bolt Data:

Use ASTM 615 Grade 75

Number of Anchor Bolts = N	N := 12	user input
Bolt Ultimate Strength:	F _u := 100·ksi	user input
Bolt Allowable Strength:	F _y := 75·(ksi)	user input
Diameter Of Anchor Bolts	D := 2.25in	user input
Threaded length per inch	n := 4.5	user input
Bolt "Column" Distance:	l _w := 3in	user input
Bolt Modulus:	E := 29000·ksi	user input

Base Plate Data:

Use ASTM 572 Grade 60

Plate Yield Strength:	F _{ybp} := 60·ksi	user input
Base Plate Thickness:	PlateThicknessProvide := 3.0·in	user input

Geometric Layout Data:

Distance from the center of gravity of the group to bolt in question = $d(i)$

Distances for loading condition (see detail):

$$d_1 := 26.5 \cdot \text{in} \quad \text{user input}$$

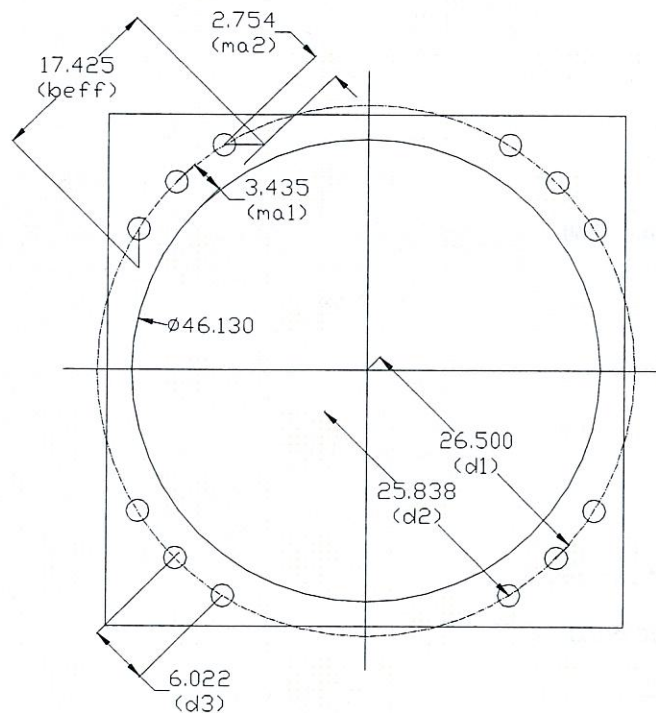
$$d_3 := 6.022 \cdot \text{in} \quad \text{user input}$$

$$\text{MomentArm}_1 := 3.435 \cdot \text{in} \quad \text{user input}$$

$$d_2 := 25.838 \cdot \text{in} \quad \text{user input}$$

$$\text{MomentArm}_2 := 2.754 \cdot \text{in} \quad \text{user input}$$

$$\text{EffectiveWidth} := 17.425 \cdot \text{in} \quad \text{user input}$$



DETAIL - ANCHOR BOLT AND PLATE

Anchor Bolt Section Properties:

Polar Moment of Inertia (J) divided by Area (A) = Σd

$$\Sigma d := (d_1)^2 \cdot 2 + (d_2)^2 \cdot 4 + (d_3)^2 \cdot 4 \quad \Sigma d = 4.22 \times 10^3 \cdot \text{in}^2$$

Gross Area of Bolt:

$$A_g := \frac{\pi}{4} \cdot D^2 \quad A_g = 3.98 \cdot \text{in}^2$$

Net Area of Bolt:

$$A_{\text{net}} := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot \text{in}}{n} \right)^2 \quad A_{\text{net}} = 3.25 \cdot \text{in}^2$$

Net Diameter:

$$D_n := \frac{2 \cdot \sqrt{A_{\text{net}}}}{\sqrt{\pi}} \quad D_n = 2.03 \cdot \text{in}$$

Radius of Gyration of Bolt:

$$r := \frac{D_n}{4} \quad r = 0.51 \cdot \text{in}$$

Section Modulus of Bolt:

$$S_x := \frac{\pi \cdot D_n^3}{32} \quad S_x = 0.83 \cdot \text{in}^3$$

Anchor Bolt Bending Stress:

Maximum Applied Bending:

$$M_x := \left(\frac{\text{Shear}}{N} \right) \cdot l \quad M_x = 0.29 \cdot \text{kips} \cdot \text{ft}$$

$$f_{bx} := \frac{M_x}{S_x} \quad f_{bx} = 4.24 \cdot \text{ksi}$$

Allowable Bending

$$F_{bx} := 1.333 \cdot 0.60 \cdot F_y \quad F_{bx} = 59.98 \cdot \text{ksi}$$

Note: 1.333 increase allowed per TIA/EIA

Anchor Bolt Tensile Stress Check:

Maximum Tensile Force (Gross Area):

$$\text{AllowableTension} := 1.333 \cdot (0.33 \cdot A_g \cdot F_u) \quad \text{AllowableTension} = 174.9 \cdot \text{kips}$$

Note: 1.333 increase allowed per TIA/EIA

Maximum Tensile Force (Net Area):

$$F_{\text{net.area}} := 1.333 \cdot (0.60 \cdot A_{\text{net}} \cdot F_y) \quad F_{\text{net.area}} = 194.81 \cdot \text{kips}$$

Note: 1.333 increase allowed per TIA/EIA

Maximum Applied Tension:

$$\text{MaxTension} := \frac{\text{OM} \cdot d_1}{\Sigma d} - \frac{\text{Axial}}{N} \quad \text{MaxTension} = 100.44 \cdot \text{kips}$$

Check Stresses:

Note: Bolts supplied are "upset bolts." Use net area for checking per AISC.

$$\text{AnchorBoltStress} := \text{if}(F_{\text{net.area}} > \text{MaxTension}, \text{"Not Overstressed"}, \text{"Overstressed"})$$

AnchorBoltStress = "Not Overstressed"

$$\text{PercentStressed} := 100 \cdot \frac{\text{MaxTension}}{F_{\text{net.area}}}$$

PercentStressed = 51.56

Note: Shear Stress is negligible

Check Compression & Combined Stresses (if required):

Check to see if a complete combined stress analysis is required:

Per ASCE Manual 72: "If the clearance between the base plate and concrete does not exceed two times the bolt diameter a bending stress analysis of the bolts is NOT normally required."

Set the clear space between the plate and bolt to zero if a combined stress analysis is not required and set the bending stress to zero:

$$l := \begin{cases} 1 & \text{if } l > 2 \cdot D_n \\ 0.0 \text{ in} & \text{otherwise} \end{cases} \quad l = 0 \quad f_{bx} := \begin{cases} f_{bx} & \text{if } l > 2 \cdot D_n \\ 0.0 \text{ ksi} & \text{otherwise} \end{cases} \quad f_{bx} = 0 \cdot \text{ksi}$$

Allowable Compressive Force:

$$K := 0.65$$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} \quad C_c = 87.36$$

$$F_a := \begin{cases} \frac{\left[1 - \frac{\left(\frac{K \cdot l}{r} \right)^2}{2 \cdot C_c^2} \right] \cdot F_y}{\frac{5}{3} + \frac{3 \cdot \left(\frac{K \cdot l}{r} \right)}{8 \cdot C_c} - \frac{\left(\frac{K \cdot l}{r} \right)^3}{8 \cdot C_c^3}} & \text{if } \frac{K \cdot l}{r} \leq C_c \\ \frac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(\frac{K \cdot l}{r} \right)^2} & \text{if } \frac{K \cdot l}{r} > C_c \end{cases} \quad F_a = 45 \cdot \text{ksi}$$

$$F_a := 1.333 \cdot F_a \quad \text{Note: 1.333 increase allowed per TIA/EIA} \quad F_a = 59.98 \cdot \text{ksi}$$

Applied Compressive Force:

$$\text{MaxCompression} := \frac{OM \cdot d_1}{\Sigma d} + \frac{\text{Axial}}{N} \quad \text{MaxCompression} = 103.77 \cdot \text{kips}$$

$$f_a := \frac{\text{MaxCompression}}{A_{net}} \quad f_a = 31.95 \cdot \text{ksi}$$

Check Combined Stresses:

$$\text{StressRatio} := \frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} \quad \text{StressRatio} = 0.533$$

Condition := if(StressRatio ≤ 1.0, "Not Overstressed", "Overstressed")

Condition = "Not Overstressed"

Base Plate Analysis:

Force From Bolt(s):

$$C_1 := \frac{OM \cdot d_1}{\sum d} + \frac{Axial}{N} \quad C_1 = 103.77 \times 10^3 \cdot lb$$

$$C_2 := \frac{OM \cdot d_2}{\sum d} + \frac{Axial}{N} \quad C_2 = 101.22 \times 10^3 \cdot lb$$

Bending Stress In Plate:

$$f_{bp} := \frac{6 \cdot (1 \cdot C_1 \cdot MomentArm_1 + 2 \cdot C_2 \cdot MomentArm_2)}{EffectiveWidth \cdot PlateThicknessProvide^2} \quad f_{bp} = 34.97 \cdot ksi$$

Check Stresses:

$$BasePlateRatio := \frac{f_{bp}}{1.333 \cdot 0.75 F_{y_{bp}}} \quad BasePlateRatio = 0.58$$

BasePlateStress := if(BasePlateRatio < 1, "Not Over Stress", "Is Over Stress")

BasePlateStress = "Not Over Stress"

FOUNDATION ANALYSIS

MONOPOLE FOUNDATION ANALYSIS

TOWER FORCES:

Moment Caused by Tower $M_t := 1355 \cdot \text{ft} \cdot \text{kips}$
 Shear at Base of Tower $S_t := 14 \text{ kip}$
 Max Compressive Force $C_t := 20 \cdot \text{kip}$
 Height of Tower $H_t := 149 \cdot \text{ft}$
 Base Plate Bolt Circle $MP := 53 \text{ in}$

PROPERTIES:

Compressive Strength of Concrete $f_c := 3000 \text{ psi}$
 Yield Strength of Steel Reinforcement $f_y := 60000 \cdot \text{psi}$
 Yield Strength of Anchor Bolt $f_{ya} := 75000 \cdot \text{psi}$
 Internal Friction Angle of Soil $\phi_s := 0.001 \cdot \text{deg}$

FOOTING DIMENSIONS:

Overall Depth of Footing $D_f := 7 \text{ ft}$
 Length of Pier $L_p := 4.5 \cdot \text{ft}$
 Extension of Pier Above Grade $L_{pag} := 0.5 \cdot \text{ft}$
 Diameter of Pier $d_p := 7 \cdot \text{ft}$
 Thickness of Footing $T_f := 3.0 \cdot \text{ft}$
 Width of Footing: $W_f := 25 \text{ ft}$
 Length of Anchor Bolts: $L_{st} := 84 \text{ in}$

Allowable Bearing Capacity $q_s := 8000 \cdot \text{psf}$
 Unit Weight of Soil $\gamma_{\text{soil}} := 120 \cdot \text{pcf}$
 Unit Weight of Concrete $\gamma_{\text{conc}} := 150 \cdot \text{pcf}$

Is foundation subject to buoyancy (Yes=1/N=0):

Depth to Neglect $n := 1.0 \text{ ft}$
 Cohesion of Clay Type Soil $c_u := 0 \cdot \text{ksf}$
 Note: Use 0 for Sandy Soil
 Seismic Zone Factor: $Z := 2$

Projection of anchor bolts above pier $A_{BP} := 12.0 \cdot \text{in}$
 Anchor Bolt Diameter $d_{\text{anchor}} := 2.25 \text{ in}$
 Anchor bolt area $A_{\text{anchor}} := 3.97 \cdot \text{in}^2$

IBC Fig 23-2
 Coefficient of Friction between Concrete: $\mu := 0.45$
 Clear Cover of Reinforcement Pier: $C_{vr \text{ pier}} := 3 \cdot \text{in}$
 Clear Cover of Reinforcement Pad: $C_{vr \text{ pad}} := 3 \cdot \text{in}$

PIER REINFORCEMENT:

Bar Size $BS_{\text{pier}} := 11$ Bar Diameter $d_{b \text{ pier}} := 1.41 \cdot \text{in}$
 Number of Bars $NB_{\text{pier}} := 24$ Bar Area $A_{b \text{ pier}} := 1.56 \cdot \text{in}^2$

PAD REINFORCEMENT:

TOP:	Bar Size	$BS_{\text{top}} := 10$	Bar Diameter	$d_{b \text{ top}} := 1.27 \cdot \text{in}$
	Number of Bars	$NB_{\text{top}} := 25$	Bar Area	$A_{b \text{ top}} := 1.27 \cdot \text{in}^2$
BOTTOM:	Bar Size	$BS_{\text{bot}} := 10$	Bar Diameter	$d_{b \text{ bot}} := 1.27 \cdot \text{in}$
	Number of Bars	$NB_{\text{bot}} := 25$	Bar Area	$A_{b \text{ bot}} := 1.27 \cdot \text{in}^2$

Coefficient of Lateral Soil Pressure: $K_p := \frac{1 + \sin(\phi_s)}{1 - \sin(\phi_s)} \quad K_p = 1$

Load Factor (EIA 3.1.1): $LF := \text{if } H_t \leq 700 \cdot \text{ft}, 1.333, \text{if } H_t \geq 1200, 1.7, 1.333 + \left(\frac{H_t - 700}{1200 - 700} \right) \cdot 0.4 \quad LF = 1.333$

STABILITY OF FOOTING

Adjusted Unit Weights: $\gamma_c := \text{if}(\text{Bouyancy} = 1, \gamma_{\text{conc}} - 62.4\text{pcf}, \gamma_{\text{conc}})$ $\gamma_c = 87.6\text{pcf}$

$\gamma_s := \text{if}(\text{Bouyancy} = 1, \gamma_{\text{soil}} - 62.4\text{pcf}, \gamma_{\text{soil}})$ $\gamma_s = 57.6\text{pcf}$

Passive Pressure: $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pn} = 0.0576\text{ksf}$

$P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p}$ $P_{pt} = 0.2304\text{ksf}$

$P_{top} := \text{if}[n < (D_f - T_f), P_{pt}, P_{pn}]$ $P_{top} = 0.2304\text{ksf}$

$P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p}$ $P_{bot} = 0.4032\text{ksf}$

$P_{ave} := \frac{P_{top} + P_{bot}}{2}$ $P_{ave} = 0.3168\text{ksf}$

$T_p := \text{if}[n < (D_f - T_f), T_f, (D_f - n)]$ $T_p = 3\text{ft}$

$A_p := W_f \cdot T_p$ $A_p = 75\text{ft}^2$

Ultimate Shear: $S_u := P_{ave} \cdot A_p$ $S_u = 23.7608\text{kip}$

Weight of Concrete Pad: $WT_c := \left[(W_f^2 \cdot T_f) + \frac{d_p^2 \cdot \pi}{4} L_p \right] \cdot \gamma_c$ $WT_c = 179.4206\text{kip}$

Weight of Soil above Footing: $WT_{s1} := \left[W_f^2 \cdot (|L_p - L_{pag} - n|) - \frac{d_p^2 \cdot \pi}{4} \cdot (|L_p - L_{pag} - n|) \right] \cdot \gamma_s$ $WT_{s1} = 101.3499\text{kip}$

Weight of Soil Wedge at back face: $WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\phi_s)}{2} \cdot W_f \right) \cdot \gamma_s$ $WT_{s2} = 0.0006\text{kip}$

Total Weight: $WT_{tot} := WT_c + WT_{s1} + C_t$ $WT_{tot} = 300.7705\text{kip}$

Resisting Moment: $M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + WT_{s2} \cdot \left(W_f + \frac{D_f \tan(\phi_s)}{3} \right)$ $M_r = 3783.4071\text{kip} \cdot \text{ft}$

Overturning Moment: $M_{ot} := M_t + S_t \cdot (L_p + T_f)$ $M_{ot} = 1460\text{kip} \cdot \text{ft}$

Factor of Safety: $FS := \frac{M_r}{M_{ot}}$ $FS_{req} := 2$ $FS = 2.59$

SafetyCheck := $\text{if}(FS > FS_{req}, \text{"Okay"}, \text{"No Good"})$ $\text{SafetyCheck} = \text{"Okay"}$

SHEAR CAPACITY IN PIER

$$S_p := \frac{P_{ave} \cdot A_p + \mu \cdot W_{T_{tot}}}{FS_{req}}$$

$$S_p = 79.5538 \cdot \text{kips}$$

$$\text{ShearCheck} := \text{if}(S_p > S_t, \text{"Okay"}, \text{"No Good"})$$

$$\text{ShearCheck} = \text{"Okay"}$$

BEARING PRESSURE CAUSED BY FOOTING

$$A_{mat} := W_f^2$$

$$A_{mat} = 625 \cdot \text{ft}^2$$

$$S := \frac{W_f^3}{6}$$

$$S = 2604.1667 \cdot \text{ft}^3$$

$$P_{max} := \frac{W_{T_{tot}}}{A_{mat}} + \frac{M_{ot}}{S}$$

$$P_{max} = 1.0419 \cdot \text{ksf}$$

$$P_{min} := \frac{W_{T_{tot}}}{A_{mat}} - \frac{M_{ot}}{S}$$

$$P_{min} = -0.0794 \cdot \text{ksf}$$

$$\text{MaxPressure} := \text{if}(P_{max} < q_s, \text{"Okay"}, \text{"No Good"})$$

$$\text{MaxPressure} = \text{"Okay"}$$

$$\text{MinPressure} := \text{if}[(P_{min} \geq 0) \cdot (P_{min} < q_s), \text{"Okay"}, \text{"No Good"}]$$

$$\text{MinPressure} = \text{"No Good"}$$

Distance to Resultant of Pressure Distribution:

$$X_p := \frac{\frac{P_{max}}{P_{max} - P_{min}} \cdot \frac{1}{3}}{W_f}$$

$$X_p = 7.7432 \cdot \text{ft}$$

Distance to Kern:

$$X_k := \frac{W_f}{6}$$

$$X_k = 4.1667 \cdot \text{ft}$$

Since Resultant Force is Not in Kern, Area to which Pressure is Applied Must be Reduced.

Eccentricity:
$$e := \frac{M_{ot}}{W_{T_{tot}}}$$

$$e = 4.8542$$

Adjusted Soil Pressure:
$$P_a := \frac{2 \cdot W_{T_{tot}}}{3 \cdot W_f \left(\frac{W_f}{2} - e \right)}$$

$$P_a = 1.049 \cdot \text{ksf}$$

$$q_{adj} := \text{if} \left(P_{min} < 0, P_a, \frac{P_{max}}{\text{ft}^2} \right)$$

$$q_{adj} = 1.049 \cdot \text{ksf}$$

$$\text{PressureCheck} := \text{if}(q_{adj} < q_s, \text{"Okay"}, \text{"No Good"})$$

$$\text{PressureCheck} = \text{"Okay"}$$

CONCRETE BEARING CAPACITY (ACI 10.17)

(ACI 9.3.2.2) $\phi_c := 0.75$

$$P_b := \phi_c \cdot 0.85 \cdot f_c \cdot \frac{d_p^2 \cdot \pi}{4}$$

$$P_b = 10598.6341 \cdot \text{kip}$$

$$\text{BearingCheck} := \text{if}(P_b > LF \cdot C_t, \text{"Okay"}, \text{"No Good"})$$

$$\text{BearingCheck} = \text{"Okay"}$$

SHEAR STRENGTH OF CONCRETE

Beam Shear: (Critical section located at a distance d from the face of Pier) (ACI 11.3.1.1)

(ACI 9.3.2.3) $\phi_{s\&A} := .85$

$$d := T_f - C_{vr_{pad}} - d_{bbot}$$

$$d = 31.73 \cdot \text{in}$$

$$d_1 := \frac{W_f}{2} - \frac{d_p}{2}$$

$$d_1 = 9 \cdot \text{ft}$$

$$d_2 := d_1 - d$$

$$d_2 = 6.3558 \cdot \text{ft}$$

$$L := \left(\frac{W_f}{2} - e \right) \cdot 3$$

$$L = 22.9374 \cdot \text{ft}$$

$$\text{Slope} := \text{if} \left(L > W_f, \frac{P_{\max} - P_{\min}}{W_f}, \frac{q_{\text{adj}}}{L} \right)$$

$$\text{Slope} = 0.0457 \cdot \text{kcf}$$

$$V_{\text{req}} := LF \cdot \left[(q_{\text{adj}} - \text{Slope} \cdot d_1) + \left(\frac{\text{Slope} \cdot d_1}{2} \right) \right] \cdot W_f \cdot d_1$$

$$V_{\text{req}} = 252.9002 \cdot \text{kip}$$

ACI 11.3.1.1 $V_{\text{Avail}} := \phi_c \cdot 2 \cdot \sqrt{f_c \cdot \text{psi}} \cdot W_f \cdot d$

$$V_{\text{Avail}} = 886.3411 \cdot \text{kip}$$

$$\text{BeamShearCheck} := \text{if}(V_{\text{req}} < V_{\text{Avail}}, \text{"Okay"}, \text{"No Good"})$$

$$\text{BeamShearCheck} = \text{"Okay"}$$

Punching Shear: (Critical Section Located at a distance of d/2 from the face of pier) (ACI 11.12.2.1)

$$b_o := (d_p + d) \cdot \pi$$

$$b_o = 30.298 \cdot \text{ft}$$

Area included inside bo: $A_{bo} := \frac{\pi \cdot (d_p + d)^2}{4}$

$$A_{bo} = 73.0498 \cdot \text{ft}^2$$

Area outside of bo: $A_{\text{out}} := A_{\text{mat}} - A_{bo}$

$$A_{\text{out}} = 551.9502 \cdot \text{ft}^2$$

Guess Value: $v_u := 1 \text{ ksf}$ (From "Foundation Analysis and design",
By Joseph Bowles, Eq. 8-9)

Given $d^2 + d_p \cdot d = \frac{W_{T_{tot}}}{\pi \cdot v_u}$

$v_u := \text{Find}(v_u)$ $v_u = 3.7543 \cdot \text{ksf}$

$V_u := v_u \cdot d \cdot W_f$ $V_u = 248.1765 \cdot \text{kips}$

$V_{req} := LF \cdot V_u$ $V_{req} = 330.8193 \cdot \text{kips}$

$V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot \text{psi}} \cdot b_o \cdot d$ $V_{Avail} = 2148.352 \cdot \text{kips}$

$\text{PunchingShearCheck} := \text{if}(V_{req} < V_{Avail}, \text{"Okay"}, \text{"No Good"})$ $\text{PunchingShearCheck} = \text{"Okay"}$

STEEL REINFORCEMENT IN THE PAD

ACI 9.3.2.2 $\phi_m := .90$

Take Maximum Bending at face of Pier:

$q_b := q_{adj} - d_1 \cdot \text{Slope}$ $q_b = 0.6374 \cdot \text{ksf}$

$M_n := \frac{1}{LF \cdot \phi_m} \cdot \left[(q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f$ $M_n = 769.5338 \cdot \text{kip} \cdot \text{ft}$

ACI 10.2.7.3 $\beta := \text{if} \left[f_c \leq 4000 \cdot \text{psi}, .85, \text{if} \left[f_c \geq 8000 \cdot \text{psi}, .65, .85 - \left(\frac{\frac{f_c}{\text{psi}} - 4000}{1000} \right) \cdot .05 \right] \right]$ $\beta = 0.85$

$R_u := \frac{M_n}{\phi_m \cdot W_f \cdot d^2}$ $R_u = 4891.8 \text{ lbf}$

$\rho := \frac{0.85 \cdot f_c}{f_y} \left(1 - \sqrt{1 - \frac{2 \cdot R_u}{0.85 \cdot f_c}} \right)$ $\rho = 0.0006$

$\rho_{min} := 1.333 \cdot \rho$ $\rho_{min} = 0.00076$

TEMPERATURE AND SHRINKAGE

	$\rho_{sh} := \text{if}(f_y \geq 60000 \cdot \text{psi}, 0.0018, 0.0020)$	$\rho_{sh} = 0.0018$
(ACI 7.12.2.1b)		
FOR BOTTOM BARS:	$A_s := \max(\rho_{min}, \rho_{sh}) \cdot W_f \cdot d$	$A_s = 17.1342 \cdot \text{in}^2$
	$A_{s_{prov}} := A_{bot} \cdot NB_{bot}$	$A_{s_{prov}} = 31.75 \cdot \text{in}^2$
	$\text{PadReinforcement} := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$	$\text{PadReinforcement} = \text{"Okay"}$
FOR TOP BARS:	$A_s := \rho_{sh} \cdot (W_f \cdot d)$	$A_s = 17.1342 \cdot \text{in}^2$
	$A_{s_{prov}} := A_{btop} \cdot NB_{top}$	$A_{s_{prov}} = 31.75 \cdot \text{in}^2$
	$\text{PadReinforcement} := \text{if}(A_{s_{prov}} > A_s, \text{"Okay"}, \text{"No Good"})$	$\text{PadReinforcement} = \text{"Okay"}$

DEVELOPMENT LENGTH OF PAD REINFORCEMENT

TENSION (ACI 12.2.3)

Bar Spacing:	$B_{sPad} := \frac{W_f - 2 \cdot C_{vr_{pad}} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1}$	$B_{sPad} = 10.9271 \cdot \text{in}$
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Development Length Factors:	Reinforcement Location Factor	$\alpha := 1.0$
	Coating Factor	$\beta := 1.0$
	Concrete strength Factor	$\lambda := 1.0$
	Reinforcement Size Factor	$\gamma := 1.0$

Spacing or Cover Dimension:	$c := \text{if}\left(C_{vr_{pad}} < \frac{B_{sPad}}{2}, C_{vr_{pad}}, \frac{B_{sPad}}{2}\right)$	$c = 3 \cdot \text{in}$
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Transverse Reinforcement Index:

As allowed by ACI 12.2.4 $k_{tr} := 0$

$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{c + k_{tr}} \cdot d_{bbot}$	$L_{dbt} = 44.1711 \cdot \text{in}$
	$L_{dbmin} := 12 \cdot \text{in}$

Minimum Development Length: (ACI 12.2.1)	$L_{dbtCheck} := \text{if}(L_{dbt} \geq L_{dbmin}, \text{"Use } L_{dbt}\text{"}, \text{"Use } L_{dbmin}\text{"})$	$L_{dbtCheck} = \text{"Use } L_{dbt}\text{"}$
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Available Length in Pad:	$L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - C_{vr_{pad}}$	$L_{Pad} = 105 \cdot \text{in}$
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$L_{padTension} := \text{if}(L_{Pad} > L_{dbt}, \text{"Okay"}, \text{"No Good"})$	$L_{padTension} = \text{"Okay"}$
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REINFORCEMENT IN PIER

Pier Area:

$$A_p := \frac{\pi \cdot d_p^2}{4}$$

$$A_p = 5541.7694 \cdot \text{in}^2$$

(ACI 10.8.4 and 10.9.1)

$$A_{smin} := 0.01 \cdot 0.05 \cdot A_p$$

$$A_{smin} = 2.7709 \cdot \text{in}^2$$

$$A_{sprov} := N_{Bpier} \cdot A_{bpier}$$

$$A_{sprov} = 37.44 \cdot \text{in}^2$$

$$\text{SteelAreaCheck} := \text{if}(A_{sprov} > A_{smin}, \text{"Okay"}, \text{"No Good"})$$

$$\text{SteelAreaCheck} = \text{"Okay"}$$

NOTE: Anchor Bolts are not accounted for in reinforcement calculation and will provide additional reinforcement to satisfy minimum requirement of steel.

Bar Spacing In Pier:

$$B_{sPier} := \frac{d_p \cdot \pi}{N_{Bpier}} - d_{bpier}$$

$$B_{sPier} = 9.5856 \cdot \text{in}$$

Diameter of Reinforcement Cage:

$$\text{Diam}_{cage} := d_p - 2 \cdot C_{vrpier}$$

$$\text{Diam}_{cage} = 78 \cdot \text{in}$$

$$\text{Maximum Moment in Pier: } M_p := \left[M_t + S_t \left(L_p + \frac{A_{BP}}{2} \right) \right] \cdot LF$$

$$M_p = 22794.3 \cdot \text{in} \cdot \text{kips}$$

Pier Check evaluated from outside program and results are listed below;

(defined variables)

$$(f_c, f_y, c1, \text{Spiral}) = (3, 60, 3, 0)$$

The required input is column diameter in inches, number of reinforcing bars, bar size number, factored axial load in kips and moment in kip inches:

$$(D, N, n, P_u, M_{xu}) := (72, 24, 11, 18, 30685)$$

Clears any previous output:

$$(\phi P_n, \phi M_{xn}, f_{sp}, \rho) := (0, 0, 0, 0)$$

$$(\phi P_n, \phi M_{xn}, f_{sp}, \rho) := \phi P'_n (D, N, n, P_u, M_{xu})^T$$

The Output is given as useable axial load in kips, moment capacity in kip inches, splicing stress in ksi, and reinforcement ratio:

$$(\phi P_n, \phi M_{xn}, f_{sp}, \rho) = (34.1601, 58233.4552, -60, 0.0092)$$

Column size and reinforcement may be changed to match capacity to the applied load.

$$\text{AxialLoadCheck} := \text{if}(\phi P_n \geq P_u, \text{"Okay"}, \text{"No Good"})$$

$$\text{AxialLoadCheck} = \text{"Okay"}$$

$$\text{BendingCheck} := \text{if}(\phi M_{xn} \geq M_{xu}, \text{"Okay"}, \text{"No Good"})$$

$$\text{BendingCheck} = \text{"Okay"}$$

DEVELOPMENT LENGTH OF PIER REINFORCEMENT

TENSION (ACI 12.2.3)

Factors for development:

Reinforcement Location Factor	$\alpha := 1.0$
Coating Factor	$\beta := 1.0$
Concrete strength Factor	$\lambda := 1.0$
Reinforcement Size Factor	$\gamma := 1.0$

Spacing or Cover Dimension: $c := \text{if} \left(C_{vr_pier} < \frac{B_{sPier}}{2}, C_{vr_pier}, \frac{B_{sPier}}{2} \right)$ $c = 3 \cdot \text{in}$

Transverse Reinforcement:

As allowed by ACI 12.2.4 $k_{tr} := 0$

$$L_{dbt} := \frac{3}{40} \cdot \frac{f_y}{\sqrt{f_c \cdot \text{psi}}} \cdot \frac{\alpha \cdot \beta \cdot \gamma \cdot \lambda}{c + k_{tr}} \cdot d_{bpier} \quad L_{dbt} = 54.4464 \cdot \text{in}$$

$$L_{dbmin} := 12 \cdot \text{in}$$

Minimum Development Length: (ACI 12.2.1)

Pier reinforcement bars are standard 90 degree hooks and therefore development in the pad is computed as follows:

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{f_c}} \cdot .7 \quad L_{dh} = 21.6241 \cdot \text{in}$$

$$L_{db} := \max(L_{dbt}, L_{dbmin}) \quad L_{db} = 54.4464 \cdot \text{in}$$

COMPRESSION: (ACI 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot \text{psi}}} \quad L_{dbc1} = 30.8916 \cdot \text{in}$$

$$L_{dbmin} := 0.0003 \cdot \frac{\text{in}^2}{l_b} \cdot (d_{bpier} \cdot f_y) \quad L_{dbmin} = 25.38 \cdot \text{in}$$

$$L_{dbc} := \text{if}(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}) \quad L_{dbc} = 30.8916 \cdot \text{in}$$

Available Length in Foundation:

$$L_{pier} := L_p - C_{vr_pier} \quad L_{pier} = 51 \cdot \text{in}$$

$$L_{pad} := T_f - C_{vr_pad} \quad L_{pad} = 33 \cdot \text{in}$$

$$L_{tension} := \text{if}(L_{pier} + L_{pad} > L_{dbt}, \text{"Okay"}, \text{"No Good"}) = \text{"Okay"} \quad L_{tension} = \text{"Okay"}$$

$$L_{compression} := \text{if}(L_{pier} + L_{pad} > L_{dbc}, \text{"Okay"}, \text{"No Good"}) \quad L_{compression} = \text{"Okay"}$$

NOTE: Anchor bolts and plate provided

TIE SIZE AND SPACING IN COLUMN

Minimum Tie Size:	$Tie_{min} := \text{if}(BS_{pier} \leq 10, 3, 4)$	$Tie_{min} = 4$
	Used #5 Ties	$d_{Tie} := 5$
Seismic factor: (ACI 21.10.5)	$z := \text{if}(Z \leq 2, 1, 0.5)$	$z = 1$
	$s_{lim1} := 16 \cdot d_{bpier} \cdot z$	$s_{lim1} = 22.56 \cdot \text{in}$
	$s_{lim2} := \frac{48 \cdot d_{Tie} \cdot \text{in}}{8} \cdot z$	$s_{lim2} = 30 \cdot \text{in}$
	$s_{lim3} := D_f \cdot z$	$s_{lim3} = 84 \cdot \text{in}$
	$s_{lim4} := 18 \cdot \text{in}$	$s_{lim4} = 18 \cdot \text{in}$
Maximum Spacing:	$s_{tie} := \min \left(\begin{pmatrix} s_{lim1} \\ s_{lim2} \\ s_{lim3} \\ s_{lim4} \end{pmatrix} \right)$	$s_{tie} = 18 \cdot \text{in}$
Number of Ties Required:	$n_{tie} := \frac{L_{pier} - 3 \cdot \text{in}}{s_{tie}} + 1$	$n_{tie} = 3.6667$

CHECK ANCHOR STEEL EMBEDMENT

Depth:	$D_{ab} := L_{st} - A_{BP}$	$D_{ab} = 6 \cdot \text{ft}$	$L_{anchor} := \frac{(0.11 \cdot f_{ya}) \cdot \text{in}}{\sqrt{f_c \cdot \text{psi}}}$	$L_{anchor} = 12.552 \cdot \text{ft}$
	$\text{DepthCheck} := \text{if}(D_{ab} \geq L_{anchor}, \text{"Okay"}, \text{"No Good"})$			
	$\text{DepthCheck} = \text{"No Good"}$			

Note: Anchor plate is provided