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June 16, 2014

Melanie A. Bachman
Acting Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: **Notice of Exempt Modification – Facility Modification**
720 Quinebaug Road, Thompson, Connecticut

Dear Ms. Bachman:

Cellco Partnership d/b/a Verizon Wireless ("Cellco") currently maintains twelve (12) wireless telecommunications antennas at the 120-foot level on an existing 130-foot tower at 720 Quinebaug Road in Thompson, Connecticut (the "Property"). The tower and underlying property are owned by the Quinebaug Volunteer Fire Department. Cellco's use of the tower was approved by the Council in 2007. Cellco now intends to modify its facility by removing six (6) coaxial cable diplexers and installing three (3) remote radio heads ("RRHs") behind its existing 2100 MHz antennas and one (1) HYBRIFLEX™ antenna cable, inside the monopole. Included in Attachment 1 are specifications for Cellco's RRHs and HYBRIFLEX™ cable.

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 Paul A. Lenky, Thompson's First Selectman.

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 installation of RRHs and a new antenna cable will not result in an increase in the height of the existing tower. Cellco's RRHs will be installed behind its existing antennas at the 120-foot level on the tower.

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

3. The proposed modifications will not increase noise levels at the facility by six decibels or more, or to levels that exceed state and local criteria.

4. The operation of the modified facility will not increase radio frequency (RF) emissions at the facility to a level at or above the Federal Communications Commission (FCC) safety standard. A Cumulative General Power Density table for Cellco's modified facility is included in Attachment 2.

5. The proposed modifications will not cause a change or alteration in the physical or environmental characteristics of the site.

6. The tower and its foundation can support Cellco's proposed modifications. (*See* Structural Analysis Report included in Attachment 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:
Paul A. Lenky, Thompson First Selectman
Sandy M. Carter

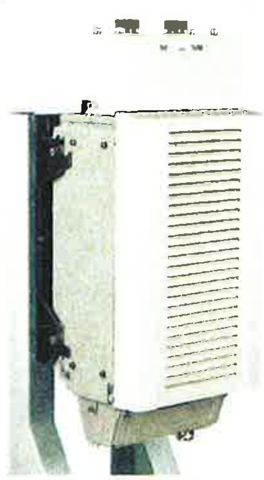
ATTACHMENT 1

Alcatel·Lucent

Alcatel-Lucent RRH2x40-AWS

REMOTE RADIO HEAD

The Alcatel-Lucent RRH2x40-AWS is a high-power, small form-factor Remote Radio Head (RRH) operating in the AWS frequency band (1700/2100MHz - 3GPP Band 4). The Alcatel-Lucent RRH2x40-AWS is designed with an eco-efficient approach, providing operators with the means to achieve high quality and capacity coverage with minimum site requirements.



A distributed eNodeB expands deployment options by using two components, a Base Band Unit (BBU) containing the digital assets and a separate RRH containing the radio-frequency (RF) elements. This modular design optimizes available space and allows the main components of an eNodeB to be installed separately, within the same site or several kilometres apart.

The Alcatel-Lucent RRH2x40-AWS is linked to the BBU by an optical-fiber connection carrying downlink and uplink digital radio signals along with operations, administration and maintenance (OA&M) information. The Alcatel-Lucent RRH2x40-AWS has two transmit RF paths, 40 W RF output power per transmit path, and is designed to manage up to four-way receive diversity. The device is ideally suited to support macro coverage, with multiple-input multiple-output (MIMO) 2x2 operation in up to 20 MHz of bandwidth.

The Alcatel-Lucent RRH2x40-AWS is designed to make available all the benefits of a distributed eNodeB, with excellent RF characteristics, with low capital expenditures (CAPEX) and low operating expenditures (OPEX). The limited space available in some sites may prevent the installation of traditional single-cabinet BTS equipment or require costly cranes to be employed, leaving coverage holes. However, many of these sites can host an Alcatel-Lucent RRH2x40-AWS installation, providing more flexible site selection and improved network quality along with greatly reduced installation time and costs.

Fast, low-cost installation and deployment

The Alcatel-Lucent RRH2x40-AWS is a zero-footprint solution and operates noise-free, simplifying negotiations with site property owners and minimizing environmental impacts. Installation can easily be done by a single person because the Alcatel-Lucent RRH2x40-AWS is compact and weighs less than 20 kg (44 lb), eliminating the need for a crane to hoist the BTS cabinet to the rooftop. A site can be in operation in less than one day — a fraction of the time required for a traditional BTS.

Excellent RF performance

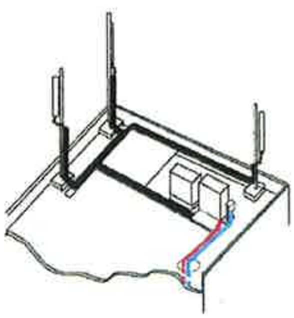
Because of its small size and weight, the Alcatel-Lucent RRH2x40-AWS can be installed close to the antenna. Operators can therefore locate the Alcatel-Lucent RRH2x40-AWS where RF engineering is deemed ideal, minimizing trade-offs between available sites and RF optimum sites. The RF feeder cost and installation costs are reduced or eliminated, and there is no need for a Tower Mounted Amplifier (TMA) because losses introduced by the RF feeder are greatly reduced. The Alcatel-Lucent RRH2x40-AWS provides more RF power while at the same time consuming less electricity.

Features

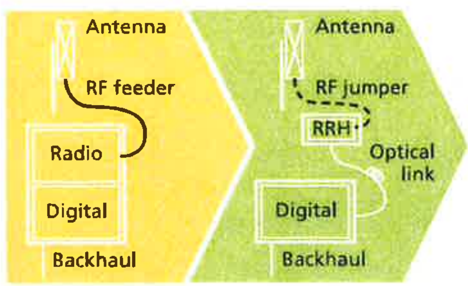
- Zero-footprint deployment
- Easy installation, with a lightweight unit can be carried and set up by one person
- Optimized RF power, with flexible site selection and elimination of a TMA
- Convection-cooled (fanless)
- Noise-free
- Best-in-class power efficiency, with significantly reduced energy consumption

Benefits

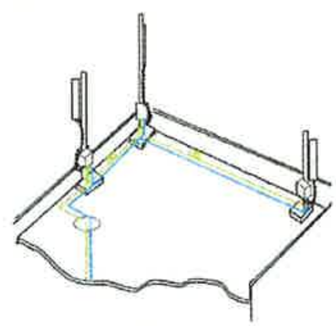
- Leverages existing real estate with lower site costs
- Reduces installation costs, with fewer installation materials and simplified logistics
- Decreases power costs and minimizes environmental impacts, with the potential for eco-sustainable power options
- Improves RF performance and adds flexibility to network planning



Macro



RRH for space-constrained cell sites



Distributed

Technical specifications

Physical dimensions

- Height: 620 mm (24.4 in.)
- Width: 270 mm (10.63 in.)
- Depth: 170m (6.7 in.)
- Weight (without mounting kit): less than 20 kg (44 lb)

Power

- Power supply: -48VDC

Operating environment

- Outdoor temperature range:
  - With solar load: -40°C to +50°C (-40°F to +122°F)
  - Without solar load: -40°C to +55°C (-40°F to +131°F)
- Passive convection cooling (no fans)
- Enclosure protection
  - IP65 (International Protection rating)

RF characteristics

- Frequency band: 1700/2100 MHz (AWS); 3GPP Band 4
- Bandwidth: up to 20 MHz
- RF output power at antenna port: 40 W nominal RF power for each Tx port
- Rx diversity: 2-way or 4-way with optional Rx Diversity module
- Noise figure: below 2.0 dB typical
- Antenna Line Device features
  - TMA and Remote electrical tilt (RET) support via AISG v2.0

Optical characteristics

Type/number of fibers

- Single-mode variant
  - One Single Mode Single Fiber per RRH2x, carrying UL and DL using CWDM
  - Single mode dual fiber (SM/DF)
- Multi-mode variant
  - Two Multi-mode fibers per RRH2x: one carrying UL, the other carrying DL

Optical fiber length

- Up to 500 m (0.31 mi), using MM fiber
- Up to 20 km (12.43 mi), using SM fiber

Digital Ports and Alarms

- Two optical ports to support daisy-chaining
- Six external alarms

Alcatel·Lucent

Product Data Sheet HB158-1-08U8-S8J18

HYBRIFLEX™ RRH Hybrid Feeder Cabling Solution, 1-5/8", Single-Mode Fiber

Product Description

RFS' HYBRIFLEX Remote Radio Head (RRH) hybrid feeder cabling solution combines optical fiber and DC power for RRHs in a single lightweight aluminum corrugated cable, making it the world's most innovative solution for RRH deployments.

It was developed to reduce installation complexity and costs at Cellular sites. HYBRIFLEX allows mobile operators deploying an RRH architecture to standardize the RRH installation process and eliminate the need for and cost of cable grounding. HYBRIFLEX combines optical fiber (multi-mode or single-mode) and power in a single corrugated cable. It eliminates the need for junction boxes and can connect multiple RRHs with a single feeder. Standard RFS CELLFLEX® accessories can be used with HYBRIFLEX cable. Both pre-connectorized and on-site options are available.

Features/Benefits

- Aluminum corrugated armor with outstanding bending characteristics – minimizes installation time and enables mechanical protection and shielding
- Same accessories as 1 5/8" coaxial cable
- Outer conductor grounding – Eliminates typical grounding requirements and saves on installation costs
- Lightweight solution and compact design – Decreases tower loading
- Robust cabling – Eliminates need for expensive cable trays and ducts
- Installation of tight bundled fiber optic cable pairs directly to the RRH – Reduces CAPEX and wind load by eliminating need for interconnection
- Optical fiber and power cables housed in single corrugated cable – Saves CAPEX by standardizing RRH cable installation and reducing installation requirements
- Outdoor polyethylene jacket – Ensures long-lasting cable protection

Figure 1: HYBRIFLEX Series

Technical Specifications

Outer Conductor Armor	Corrugated Aluminum	[mm (in)]	46.5 (1.83)
Jacket	Polyethylene, PE	[mm (in)]	50.3 (1.98)
UV-Protection	Individual and External Jacket		Yes
Weight, Approximate		[kg/m (lb/ft)]	1.9 (1.30)
Minimum Bending Radius, Single Bending		[mm (in)]	200 (8)
Minimum Bending Radius, Repeated Bending		[mm (in)]	500 (20)
Recommended/Maximum Clamp Spacing		[m (ft)]	1.0 / 1.2 (3.25 / 4.0)
DC-Resistance Outer Conductor Armor		[Ω/km (Ω/1000ft)]	.068 (0.205)
DC-Resistance Power Cable, 8.4mm² (8AWG)		[Ω/km (Ω/1000ft)]	2.1 (0.307)
Version			Single-mode OM3
Quantity, Fiber Count			16 (8 pairs)
Core/Clad		[μm]	50/125
Primary Coating (Acrylate)		[μm]	245
Buffer Diameter, Nominal		[μm]	900
Secondary Protection, Jacket, Nominal		[mm (in)]	2.0 (0.08)
Minimum Bending Radius		[mm (in)]	104 (4.1)
Insertion Loss @ wavelength 850nm		dB/km	3.0
Insertion Loss @ wavelength 1310nm		dB/km	1.0
Standards (Meets or exceeds)			UL94-V0, UL1666 RoHS Compliant
Size (Power)		[mm (AWG)]	8.4 (8)
Quantity, Wire Count (Power)			16 (8 pairs)
Size (Alarm)		[mm (AWG)]	0.8 (18)
Quantity, Wire Count (Alarm)			4 (2 pairs)
Type			UV protected
Strands			19
Primary Jacket Diameter, Nominal		[mm (in)]	6.8 (0.27)
Standards (Meets or exceeds)			NFPA 130, ICEA S-95-658 UL Type XHHW-2, UL 44 UL-LS Limited Smoke, UL VW-1 IEEE-383 (1974), IEEE1202/FT4 RoHS Compliant
Installation Temperature		[°C (°F)]	-40 to +65 (-40 to149)
Operation Temperature		[°C (°F)]	-40 to +65 (-40 to149)

* This data is provisional and subject to change

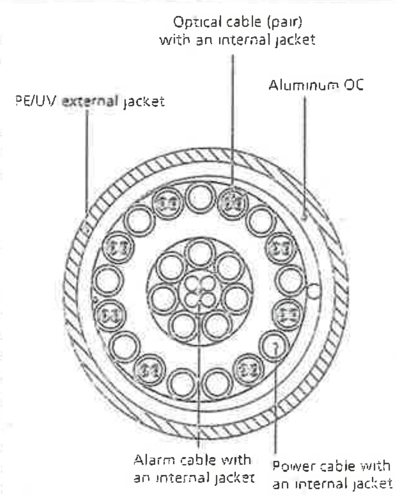


Figure 2: Construction Detail

ATTACHMENT 2

	General	Power	Density					
Site Name: Quinebaug (Thompson)								
Tower Height: 130Ft								
CARRIER	**# OF CHAN.**	**WATTS ERP**	**HEIGHT**	**CALC. POWER DENS**	**FREQ.**	**MAX. PERMISS. EXP.**	**FRACTION MPE**	**Total**
*Quinebaug FD	1	100	133	0.0020	155	0.2000	1.02%	
*Quinebaug FD	1	100	90	0.0044	465	0.3100	1.43%	
*Quinebaug FD	1	100	70	0.0073	33.9	0.2000	3.67%	
*AT&T UMTS	2	565	130	0.0240	880	0.5867	4.10%	
*AT&T UMTS	2	875	130	0.0372	1900	1.0000	3.72%	
*AT&T GSM	1	283	130	0.0060	880	0.5867	1.03%	
*AT&T GSM	4	525	130	0.0447	1900	1.0000	4.47%	
*AT&T LTE	1	1771	130	0.0377	734	0.4893	7.70%	
Verizon	**11**	**447**	**120**	**0.1228**	**1970**	**1.0000**	**12.28%**	
Verizon	**9**	**408**	**120**	**0.0917**	**869**	**0.5793**	**15.83%**	
Verizon	**1**	**1750**	**120**	**0.0437**	**2145**	**1.0000**	**4.37%**	
Verizon	**1**	**1050**	**120**	**0.0262**	**698**	**0.4973**	**5.27%**	
								64.88%
* Source: Siting Council								

ATTACHMENT 3

CENTEK engineering

Centered on Solutions℠

Structural Analysis Report

130-ft Existing Valmont Monopole

Proposed Verizon Wireless
Antenna Upgrade

Verizon Site Ref: Quinebaug

720 Quinebaug Road
Quinebaug, CT

Centek Project No. 14001.046

Date: April 24, 2014

STATE OF CONNECTICUT
LICENSED PROFESSIONAL ENGINEER
No. 16694

Prepared for:

Verizon Wireless
99 East River Road, 9th Floor
East Hartford, CT 06108

63-2 North Branford Road, Branford, CT 06405 203.488.0580 Fax 203.488.8587 www.CentekEng.com

Table of Contents

Introduction

The purpose of this report is to summarize the results of the non-linear, P-Δ structural analysis of the antenna upgrade proposed by Verizon Wireless on the existing monopole (tower) located in Quinebaug, CT.

The host tower is a 130-ft tall, three-section, twelve sided, tapered monopole, originally designed and manufactured by Valmont; job no; 18435-65, dated August 4, 2005. The tower geometry, structure member sizes and foundation system information were obtained from the aforementioned Valmont design documents. Antenna and appurtenance information were obtained from a previous structural analysis report prepared by Hudson Design Group, dated October 8, 2012, and a Verizon RF data sheet.

The tower is made up of three (3) tapered vertical sections consisting of A572-65 pole sections. The vertical tower sections are slip joint connected. The diameter of the pole (flat-flat) is 19.94-in at the top and 47.60-in at the base.

Verizon proposes the installation of three (3) RRH's and one (1) distribution box mounted to the existing low profile platform. Refer to the Antenna and Appurtenance Summary below for a detailed description of the proposed antenna and appurtenance configuration.

Antenna and Appurtenance Summary

The existing, proposed and future loads considered in this analysis consist of the following:

- TOWN (EXISTING):
  Antennas: One (1) 4-bay dipole antenna, one (1) 20-ft Omni-directional whip antenna and one (1) 10-ft Omni-directional whip antenna mounted on the existing AT&T low profile platform with an elevation of 130-ft above grade.
  Coax Cables: Three (3) 7/8" ∅ coax cables running on the inside of the existing tower.
- AT&T (EXISTING):
  Antennas: Six (6) Powerwave 7770.00 panel antennas, one (1) Kathrein 800-10764 panel antenna, one (1) Kathrein 800-10766 panel antenna, one (1) KMW AM-X-CD-17-65-00T panel antenna, six (6) Powerwave LGP21401 TMA's, six (6) Powerwave LGP21901 diplexers, six (6) Ericsson RRUS-11 and one (1) Raycap DC6-48-60-18-8F surge arrestor mounted on an existing low profile platform with a RAD center elevation of 130-ft above grade.
  Coax Cables: Twelve (12) 1-5/8" ∅ coax cables, one (1) 5/8" ∅ fiber cable and two (2) #8 DC control cables running on the inside of the existing tower.
- VERIZON (EXISTING TO REMAIN):
  Antennas: Six (6) Antel LPA-80080-6CF, three (3) Antel BXA-70063-6CF and three (3) Antel BXA-171085-12CF panel antennas mounted on an existing low profile platform with a RAD center elevation of 120-ft above grade.
  Coax Cables: Twelve (12) 1-5/8" ∅ coax cables running on the inside of the existing tower.

- VERIZON (EXISTING TO REMOVE):
  Antennas: Six (6) RFS FD9R6004/2C-3L Diplexers mounted on an existing low profile platform with a RAD center elevation of 120-ft above grade.
- **VERIZON (PROPOSED):**
  Misc. Equipment: Three (3) Alcatel-Lucent RRH2x40-AWS Remote Radio Heads and one (1) RFS DB-T1-6Z-8AB-0Z main distribution box mounted on an existing low profile platform with a RAD center elevation of 120-ft above grade.
  Coax Cables: One (1) 1-5/8" Ø Hybriflex fiber line running on the interior of the monopole.

Primary Assumptions Used in the Analysis

- The tower structure's theoretical capacity not including any assessment of the condition of the tower.
- The tower carries the horizontal and vertical loads due to the weight of antennas, ice load and wind.
- Tower is properly installed and maintained.
- Tower is in plumb condition.
- Tower loading for antennas and mounts as listed in this report.
- All bolts are appropriately tightened providing the necessary connection continuity.
- All welds are fabricated with ER-70S-6 electrodes.
- All members are assumed to be as specified in the original tower design documents or reinforcement drawings.
- All members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
- All member protective coatings are in good condition.
- All tower members were properly designed, detailed, fabricated, installed and have been properly maintained since erection.
- Any deviation from the analyzed antenna loading will require a new analysis for verification of structural adequacy.
- All existing coax cables to be installed as indicated in this report.

Analysis

The existing tower was analyzed using a comprehensive computer program entitled tnxTower. The program analyzes the tower, considering the worst case loading condition. The tower is considered as loaded by concentric forces along the tower shaft, and the model assumes that the shaft members are subjected to bending, axial, and shear forces.

The existing tower was analyzed for the controlling basic wind speed (fastest mile) with no ice and a 75% reduction of wind force with ½ inch accumulative ice to determine stresses in members as per guidelines of TIA/EIA-222-F-96 entitled "Structural Standards for Steel Antenna Towers and Antenna Supporting Structures", the American Institute of Steel Construction (AISC) and the Manual of Steel Construction; Allowable Stress Design (ASD).

The controlling wind speed is determined by evaluating the local available wind speed data as provided in Appendix K of the CSBC[1] and the wind speed data available in the TIA/EIA-222-F-96 Standard. The higher of the two wind speeds is utilized in preparation on the tower analysis.

Tower Loading

Tower loading was determined by the basic wind speed as applied to projected surface areas with modification factors per TIA/EIA-222-F, gravity loads of the tower structure and its components, and the application of ½" radial ice on the tower structure and its components.

Basic Wind Speed:	Windham; v = 85 mph (fastest mile)	*[Section 16 of TIA/EIA-222-F-96]*
	Quinebaug (Thompson); v = 100 mph (3 second gust) equivalent to v = 80 mph (fastest mile)	*[Appendix K of the 2005 CT Building Code Supplement]*
	TIA/EIA-222-F wind speed controls.	
Load Cases:	Load Case 1; 85 mph wind speed w/ no ice plus gravity load – used in calculation of tower stresses and rotation.	*[Section 2.3.16 of TIA/EIA-222-F-96]*
	Load Case 2; 74 mph wind speed w/ ½" radial ice plus gravity load – used in calculation of tower stresses. The 74 mph wind speed velocity represents 75% of the wind pressure generated by the 85 mph wind speed.	*[Section 2.3.16 of TIA/EIA-222-F-96]*
	Load Case 3; Seismic – not checked	*[Section 1614.5 of State Bldg. Code 2005] does not control in the design of this structure type*

---

[1] The 2005 Connecticut State Building Code as amended by the 2005 CT State Supplement. (CSBC)

Tower Capacity

Tower stresses were calculated utilizing the structural analysis software tnxTower. Allowable stresses were determined based on Table 5 of the TIA/EIA code with a 1/3 increase per Section 3.1.1.1 of the same code.

- Calculated stresses were found to be within allowable limits. In Load Case 1, per tnxTower "Section Capacity Table", this tower was found to be at **95.3%** of its total capacity.

Tower Section	Elevation	Stress Ratio (percentage of capacity)	Result
Pole Shaft (L3)	0.00'-39.42'	95.3%	**PASS**

Foundation and Anchors

The existing foundation consists of a 7.0-ft square x 5-ft long reinforced concrete pier on a 20.0-ft square x 3.5-ft thick reinforced concrete pad. The sub-grade conditions used in the analysis of the existing foundation were obtained from the aforementioned Valmont design documents; job no; 18435-65, dated August 4, 2005. The base of the tower is connected to the foundation by means of (12) 2.25"∅, ASTM A615-75 anchor bolts embedded approximately 7-ft into the concrete foundation structure.

Review of the foundation and anchor design consisted of verification of applied loads obtained from the tower design calculations and code checks of allowable stresses:

- The tower base reactions developed from the governing Load Case 1 were used in the verification of the foundation and its anchors:

Location	Vector	Proposed Reactions
Base	Shear	22 kips
	Compression	22 kips
	Moment	1968 kip-ft

- The foundation was found to be within allowable limits.

Foundation	Design Limit	IBC 2003/2005 CT State Building Code Section 3108.4.2 (FS)(1)	Proposed Loading (FS)(1)	Result
Reinforced Concrete Pad and Pier	OTM(2)	2.0	2.62	**PASS**

Note 1: FS denotes Factor of Safety.

Note 2: OTM denotes Overturning Moment

- The anchor bolts and base plate were found to be within allowable limits.

Tower Component	Design Limit	Stress Ratio (percentage of capacity)	Result
Anchor Bolts	Combined Compression and Bending	74.4%	**PASS**
Base Plate	Bending	35.3%	**PASS**

Conclusion

This analysis shows that the subject tower **is adequate** to support the proposed modified antenna configuration.

The analysis is based, in part, on the information provided to this office by Verizon Wireless. If the existing conditions are different than the information in this report, Centek Engineering, Inc. must be contacted for resolution of any potential issues.

Please feel free to call with any questions or comments.

Respectfully Submitted by:

Carlo F. Centore, PE
Principal ~ Structural Engineer

STATE OF CONNECTICUT
CARLO F. CENTORE
No. 16884
LICENSED
PROFESSIONAL ENGINEER

Standard Conditions for Furnishing of Professional Engineering Services on Existing Structures

All engineering services are performed on the basis that the information used is current and correct. This information may consist of, but is not necessarily limited to:

- Information supplied by the client regarding the structure itself, its foundations, the soil conditions, the antenna and feed line loading on the structure and its components, or other relevant information.
- Information from the field and/or drawings in the possession of Centek Engineering, Inc. or generated by field inspections or measurements of the structure.
- It is the responsibility of the client to ensure that the information provided to Centek Engineering, Inc. and used in the performance of our engineering services is correct and complete. In the absence of information to the contrary, we assume that all structures were constructed in accordance with the drawings and specifications and are in an un-corroded condition and have not deteriorated. It is therefore assumed that its capacity has not significantly changed from the “as new” condition.
- All services will be performed to the codes specified by the client, and we do not imply to meet any other codes or requirements unless explicitly agreed in writing. If wind and ice loads or other relevant parameters are to be different from the minimum values recommended by the codes, the client shall specify the exact requirement. In the absence of information to the contrary, all work will be performed in accordance with the latest revision of ANSI/ASCE10 & ANSI/EIA-222
- All services performed, results obtained, and recommendations made are in accordance with generally accepted engineering principles and practices. Centek Engineering, Inc. is not responsible for the conclusions, opinions and recommendations made by others based on the information we supply.

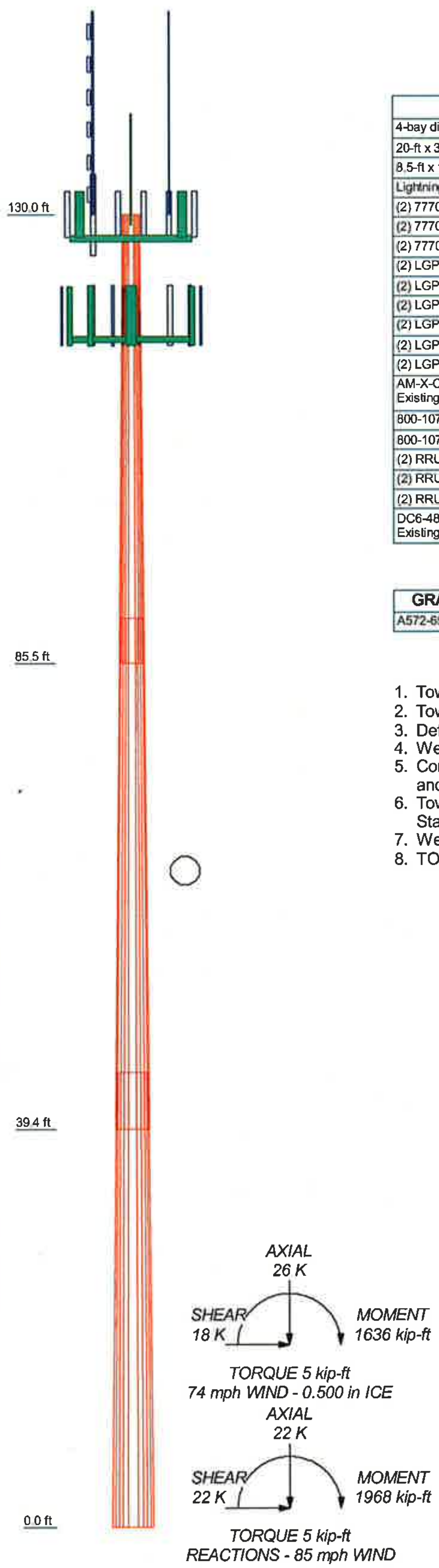
GENERAL DESCRIPTION OF STRUCTURAL ANALYSIS PROGRAM

tnxTower, is an integrated structural analysis and design software package for Designed specifically for the telecommunications industry, tnxTower, formerly ERITower and RISATower, automates much of the tower analysis and design required by the TIA/EIA 222 Standard.

tnxTower Features:

- tnxTower can analyze and design 3- and 4-sided guyed towers, 3- and 4-sided self-supporting towers and either round or tapered ground mounted poles with or without guys.
- The program analyzes towers using the TIA-222-G (2005) standard or any of the previous TIA/EIA standards back to RS-222 (1959). Steel design is checked using the AISC ASD 9th Edition or the AISC LRFD specifications.
- Linear and non-linear (P-delta) analyses can be used in determining displacements and forces in the structure. Wind pressures and forces are automatically calculated.
- Extensive graphics plots include material take-off, shear-moment, leg compression, displacement, twist, feed line, guy anchor and stress plots.
- tnxTower contains unique features such as True Cable behavior, hog rod take-up, foundation stiffness and much more.

Section	Length (ft)	Number of Sides	Thickness (in)	Socket Length (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	44.500	12	0.188	4.500	19.940	29.730	A572-65	2.3
2	50.583	12	0.281	5.583	28.365	39.390	A572-65	5.2
3	45.000	12	0.313		37.611	47.600	A572-65	6.5
								14.0



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
4-bay dipole	130	Andrew 12'-6" Low Profile Platform (ATT - Existing)	128
20-ft x 3" whip	130	LPA-80080-6CF (Verizon - Existing)	120
8.5-ft x 1.5" whip	130	BXA-171085-12BF (Verizon - Existing)	120
Lightning Rod 3/4"x8'	130	BXA-70063/6CF (Verizon - Existing)	120
(2) 7770.00 (ATT - Existing)	130	LPA-80080-6CF (Verizon - Existing)	120
(2) 7770.00 (ATT - Existing)	130	LPA-80080-6CF (Verizon - Existing)	120
(2) 7770.00 (ATT - Existing)	130	BXA-171085-12BF (Verizon - Existing)	120
(2) LGP21401 TMA (ATT - Existing)	130	BXA-70063/6CF (Verizon - Existing)	120
(2) LGP21401 TMA (ATT - Existing)	130	LPA-80080-6CF (Verizon - Existing)	120
(2) LGP21401 TMA (ATT - Existing)	130	LPA-80080-6CF (Verizon - Existing)	120
(2) LGP21901 Diplexer (ATT - Existing)	130	BXA-171085-12BF (Verizon - Existing)	120
(2) LGP21901 Diplexer (ATT - Existing)	130	BXA-70063/6CF (Verizon - Existing)	120
(2) LGP21901 Diplexer (ATT - Existing)	130	LPA-80080-6CF (Verizon - Existing)	120
AM-X-CD-17-65-00T-RET (ATT - Existing)	130	RRH2x40-AWS (Verizon - Proposed)	120
800-10764 (ATT - Existing)	130	RRH2x40-AWS (Verizon - Proposed)	120
800-10766 (ATT - Existing)	130	RRH2x40-AWS (Verizon - Proposed)	120
(2) RRUS-11 (ATT - Existing)	130	DB-T1-6Z-8AB-0Z (Verizon - Proposed)	120
(2) RRUS-11 (ATT - Existing)	130	Valmont 13' Low Profile Platform (Verizon - Existing)	118
(2) RRUS-11 (ATT - Existing)	130		
DC6-48-60-18-8F Surge Arrestor (ATT - Existing)	130		

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower designed for a 85 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 74 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. Weld together tower sections have flange connections.
5. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
6. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
7. Welds are fabricated with ER-70S-6 electrodes.
8. TOWER RATING: 95.3%

Centek Engineering Inc.
63-2 North Branford Rd.
Branford, CT 06405
Phone: (203) 488-0580
FAX: (203) 488-8587

Job: **14001.046 - Quinebaug**		
Project: **130ft Valmont Monopole - 720 Quinebaug Rd, Quinebaug, CT**		
Client: Verizon Wireless	Drawn by: TJL	App'd:
Code: TIA/EIA-222-F	Date: 04/25/14	Scale: NTS
Path:		Dwg No. E-1

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 85 mph.
- Nominal ice thickness of 0.500 in.
- Ice density of 56 pcf.
- A wind speed of 74 mph is used in combination with ice.
- Temperature drop of 50 °F.
- Deflections calculated using a wind speed of 50 mph.
- Weld together tower sections have flange connections..
- Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications..
- Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards..
- Welds are fabricated with ER-70S-6 electrodes..
- 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
Consider Moments - Horizontals
Consider Moments - Diagonals
Use Moment Magnification
√ Use Code Stress Ratios
Use Code Safety Factors - Guys
Escalate Ice
Always Use Max Kz
Use Special Wind Profile
Include Bolts In Member Capacity
Leg Bolts Are At Top Of Section
Secondary Horizontal Braces Leg
Use Diamond Inner Bracing (4 Sided)
Add IBC .6D+W Combination

Distribute Leg Loads As Uniform
Assume Legs Pinned
√ Assume Rigid Index Plate
Use Clear Spans For Wind Area
Use Clear Spans For KL/r
Retension Guys To Initial Tension
√ Bypass Mast Stability Checks
Use Azimuth Dish Coefficients
√ Project Wind Area of Appurt.
Autocalc Torque Arm Areas
SR Members Have Cut Ends
√ Sort Capacity Reports By Component
Triangulate Diamond Inner Bracing

Treat Feedline Bundles As Cylinder
Use ASCE 10 X-Brace Ly Rules
Calculate Redundant Bracing Forces
Ignore Redundant Members in FEA
SR Leg Bolts Resist Compression
All Leg Panels Have Same Allowable
Offset Girt At Foundation
Consider Feedline Torque
Include Angle Block Shear Check

Poles

√ Include Shear-Torsion Interaction
Always Use Sub-Critical Flow
Use Top Mounted Sockets

Tapered Pole Section Geometry

Section	Elevation ft	Section Length ft	Splice Length ft	Number of Sides	Top Diameter in	Bottom Diameter in	Wall Thickness in	Bend Radius in	Pole Grade
L1	130.000-85.500	44.500	4.500	12	19.940	29.730	0.188	0.750	A572-65 (65 ksi)
L2	85.500-39.417	50.583	5.583	12	28.365	39.390	0.281	1.125	A572-65 (65 ksi)
L3	39.417-0.000	45.000		12	37.611	47.600	0.313	1.250	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in^2	I in^4	r in	C in	I/C in^3	J in^4	It/Q in^2	w in	w/t
L1	20.643	11.926	593.895	7.071	10.329	57.498	1203.391	5.869	4.841	25.821
	30.779	17.836	1986.940	10.576	15.400	129.021	4026.080	8.778	7.465	39.814
L2	30.381	25.433	2560.352	10.054	14.693	174.256	5187.967	12.518	6.848	24.349
	40.780	35.418	6914.426	14.001	20.404	338.876	14010.502	17.432	9.803	34.854
L3	40.220	37.531	6664.280	13.353	19.482	342.068	13503.639	18.472	9.242	29.575
	49.279	47.583	13580.974	16.929	24.657	550.800	27518.735	23.419	11.919	38.142

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in
L1 130.000-85.500				1	1	1		
L2 85.500-39.417				1	1	1		
L3 39.417-0.000				1	1	1		

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight klf
7/8	B	No	Inside Pole	130.000 - 3.000	3	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
1 5/8 (AT&T - Existing)	B	No	Inside Pole	130.000 - 3.000	12	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
1 5/8 (Verizon - Existing)	B	No	Inside Pole	120.000 - 3.000	12	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
HYBRIFLEX 1-5/8" (Verizon - Proposed)	B	No	Inside Pole	120.000 - 3.000	1	No Ice	0.000	0.002
						1/2" Ice	0.000	0.002
DC Trunk (AT&T - Existing)	B	No	Inside Pole	130.000 - 3.000	2	No Ice	0.000	0.000
						1/2" Ice	0.000	0.000
Fiber Trunk (AT&T - Existing)	B	No	Inside Pole	130.000 - 3.000	1	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	130.000-85.500	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	1.178
		C	0.000	0.000	0.000	0.000	0.000
L2	85.500-39.417	A	0.000	0.000	0.000	0.000	0.000

Tower Section	Tower Elevation ft	Face	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
		B	0.000	0.000	0.000	0.000	1.369
		C	0.000	0.000	0.000	0.000	0.000
L3	39.417-0.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	1.082
		C	0.000	0.000	0.000	0.000	0.000

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	130.000-85.500	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	1.178
		C		0.000	0.000	0.000	0.000	0.000
L2	85.500-39.417	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	1.369
		C		0.000	0.000	0.000	0.000	0.000
L3	39.417-0.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	1.082
		C		0.000	0.000	0.000	0.000	0.000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft²	C_AA_A Side ft²	Weight K
4-bay dipole	A	From Face	3.500 0.000 10.000	0.000	130.000	No Ice 1/2" Ice	3.150 5.670	3.150 5.670	0.032 0.042
20-ft x 3" whip	B	From Face	3.500 0.000 10.000	0.000	130.000	No Ice 1/2" Ice	0.790 0.910	0.790 0.910	0.010 0.015
8.5-ft x 1.5" whip	C	From Face	3.500 0.000 5.000	0.000	130.000	No Ice 1/2" Ice	1.125 2.004	1.125 2.004	0.004 0.014
Lightning Rod 3/4"x8'	C	From Face	3.500 0.000 4.000	0.000	130.000	No Ice 1/2" Ice	0.600 1.415	0.600 1.415	0.014 0.020
(2) 7770.00 (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	5.882 6.314	2.928 3.273	0.035 0.068
(2) 7770.00 (AT&T - Existing)	B	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	5.882 6.314	2.928 3.273	0.035 0.068
(2) 7770.00 (AT&T - Existing)	C	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	5.882 6.314	2.928 3.273	0.035 0.068
(2) LGP21401 TMA (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.953 1.093	0.367 0.480	0.018 0.023

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert (ft ft ft)	Azimuth Adjustment (°)	Placement (ft)		C_AA_A Front (ft^2)	C_AA_A Side (ft^2)	Weight (K)
(2) LGP21401 TMA (AT&T - Existing)	B	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.953 1.093	0.367 0.480	0.018 0.023
(2) LGP21401 TMA (AT&T - Existing)	C	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.953 1.093	0.367 0.480	0.018 0.023
(2) LGP21901 Diplexer (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.233 0.302	0.117 0.166	0.006 0.008
(2) LGP21901 Diplexer (AT&T - Existing)	B	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.233 0.302	0.117 0.166	0.006 0.008
(2) LGP21901 Diplexer (AT&T - Existing)	C	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	0.233 0.302	0.117 0.166	0.006 0.008
AM-X-CD-17-65-00T-RET (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	11.311 11.927	6.800 7.384	0.060 0.121
800-10764 (AT&T - Existing)	B	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	6.333 6.771	3.389 3.740	0.041 0.078
800-10766 (AT&T - Existing)	C	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	11.311 11.927	6.800 7.384	0.059 0.120
(2) RRUS-11 (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	2.994 3.226	1.246 1.412	0.050 0.070
(2) RRUS-11 (AT&T - Existing)	B	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	2.994 3.226	1.246 1.412	0.050 0.070
(2) RRUS-11 (AT&T - Existing)	C	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	2.994 3.226	1.246 1.412	0.050 0.070
DC6-48-60-18-8F Surge Arrestor (AT&T - Existing)	A	From Face	3.500 0.000 0.000	0.000	130.000	No Ice 1/2" Ice	2.228 2.447	2.228 2.447	0.020 0.039
Andrew 12'-6" Low Profile Platform (AT&T - Existing)	C	From Face	2.000 0.000 0.000	0.000	128.000	No Ice 1/2" Ice	14.450 19.000	14.450 19.000	1.300 1.690
LPA-80080-6CF (Verizon - Existing)	A	From Face	3.500 6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
BXA-171085-12BF (Verizon - Existing)	A	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.734 5.180	3.572 4.007	0.015 0.042
BXA-70063/6CF (Verizon - Existing)	A	From Face	3.500 0.000 0.000	0.000	120.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
LPA-80080-6CF (Verizon - Existing)	A	From Face	3.500 -6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
LPA-80080-6CF (Verizon - Existing)	B	From Face	3.500 6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
BXA-171085-12BF (Verizon - Existing)	B	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.734 5.180	3.572 4.007	0.015 0.042

Description	*Face or Leg*	*Offset Type*	*Offsets: Horz Lateral Vert* ft ft ft	*Azimuth Adjustment* °	*Placement* ft		C_AA_A *Front* ft²	C_AA_A *Side* ft²	*Weight* K
BXA-70063/6CF (Verizon - Existing)	B	From Face	3.500 0.000 0.000	0.000	120.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
LPA-80080-6CF (Verizon - Existing)	B	From Face	3.500 -6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
LPA-80080-6CF (Verizon - Existing)	C	From Face	3.500 6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
BXA-171085-12BF (Verizon - Existing)	C	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.734 5.180	3.572 4.007	0.015 0.042
BXA-70063/6CF (Verizon - Existing)	C	From Face	3.500 0.000 0.000	0.000	120.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
LPA-80080-6CF (Verizon - Existing)	C	From Face	3.500 -6.000 0.000	0.000	120.000	No Ice 1/2" Ice	4.326 4.764	9.088 9.637	0.021 0.069
RRH2x40-AWS (Verizon - Proposed)	A	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	2.522 2.753	1.589 1.795	0.044 0.061
RRH2x40-AWS (Verizon - Proposed)	B	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	2.522 2.753	1.589 1.795	0.044 0.061
RRH2x40-AWS (Verizon - Proposed)	C	From Face	3.500 4.000 0.000	0.000	120.000	No Ice 1/2" Ice	2.522 2.753	1.589 1.795	0.044 0.061
DB-T1-6Z-8AB-0Z (Verizon - Proposed)	C	From Face	3.500 0.000 0.000	0.000	120.000	No Ice 1/2" Ice	5.600 5.915	2.333 2.558	0.044 0.080
Valmont 13' Low Profile Platform (Verizon - Existing)	C	From Face	2.000 0.000 0.000	0.000	118.000	No Ice 1/2" Ice	15.700 20.100	15.700 20.100	1.300 1.765

Tower Pressures - No Ice

$G_H = 1.690$

Section Elevation ft	*z* ft	K_Z	q_z ksf	A_G ft²	*Face*	A_F ft²	A_R ft²	A_{leg} ft²	*Leg %*	C_AA_A *In Face* ft²	C_AA_A *Out Face* ft²
L1 130.000-85.50 0	106.614	1.398	0.026	92.096	A	0.000	92.096	92.096	100.00	0.000	0.000
					B	0.000	92.096		100.00	0.000	0.000
					C	0.000	92.096		100.00	0.000	0.000
L2 85.500-39.417	61.950	1.197	0.022	131.981	A	0.000	131.981	131.981	100.00	0.000	0.000
					B	0.000	131.981		100.00	0.000	0.000
					C	0.000	131.981		100.00	0.000	0.000
L3 39.417-0.000	19.044	1	0.018	141.983	A	0.000	141.983	141.983	100.00	0.000	0.000
					B	0.000	141.983		100.00	0.000	0.000

Section Elevation ft	z ft	K_Z	q_z ksf	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
					C	0.000	141.983		100.00	0.000	0.000

Tower Pressure - With Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z ksf	t_Z in	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 130.000-85.500	106.614	1.398	0.019	0.500	95.805	A	0.000	95.805	95.805	100.00	0.000	0.000
						B	0.000	95.805		100.00	0.000	0.000
						C	0.000	95.805		100.00	0.000	0.000
L2 85.500-39.417	61.950	1.197	0.017	0.500	135.822	A	0.000	135.822	135.822	100.00	0.000	0.000
						B	0.000	135.822		100.00	0.000	0.000
						C	0.000	135.822		100.00	0.000	0.000
L3 39.417-0.000	19.044	1	0.014	0.500	145.268	A	0.000	145.268	145.268	100.00	0.000	0.000
						B	0.000	145.268		100.00	0.000	0.000
						C	0.000	145.268		100.00	0.000	0.000

Tower Pressure - Service

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z ksf	A_G ft²	Face	A_F ft²	A_R ft²	A_{leg} ft²	Leg %	C_AA_A In Face ft²	C_AA_A Out Face ft²
L1 130.000-85.500	106.614	1.398	0.009	92.096	A	0.000	92.096	92.096	100.00	0.000	0.000
					B	0.000	92.096		100.00	0.000	0.000
					C	0.000	92.096		100.00	0.000	0.000
L2 85.500-39.417	61.950	1.197	0.008	131.981	A	0.000	131.981	131.981	100.00	0.000	0.000
					B	0.000	131.981		100.00	0.000	0.000
					C	0.000	131.981		100.00	0.000	0.000
L3 39.417-0.000	19.044	1	0.006	141.983	A	0.000	141.983	141.983	100.00	0.000	0.000
					B	0.000	141.983		100.00	0.000	0.000
					C	0.000	141.983		100.00	0.000	0.000

Tower Forces - No Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft²	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	4.137	0.093	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	5.055	0.110	C
			B	1	1.03	1	1	1	131.981			

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
			C	1	1.03	1	1	1	131.981			
L3	1.082	6.517	A	1	1.03	1	1	1	141.983	4.571	0.116	C
39.417-0.000			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	841.262 kip-ft	13.763		

Tower Forces - No Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1	1.178	2.253	A	1	1.03	1	1	1	92.096	4.137	0.093	C
130.000-85.50			B	1	1.03	1	1	1	92.096			
0			C	1	1.03	1	1	1	92.096			
L2	1.369	5.237	A	1	1.03	1	1	1	131.981	5.055	0.110	C
85.500-39.417			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3	1.082	6.517	A	1	1.03	1	1	1	141.983	4.571	0.116	C
39.417-0.000			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	841.262 kip-ft	13.763		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1	1.178	2.253	A	1	1.03	1	1	1	92.096	4.137	0.093	C
130.000-85.50			B	1	1.03	1	1	1	92.096			
0			C	1	1.03	1	1	1	92.096			
L2	1.369	5.237	A	1	1.03	1	1	1	131.981	5.055	0.110	C
85.500-39.417			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3	1.082	6.517	A	1	1.03	1	1	1	141.983	4.571	0.116	C
39.417-0.000			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	841.262 kip-ft	13.763		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	4.137	0.093	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	5.055	0.110	C
			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3 39.417-0.000	1.082	6.517	A	1	1.03	1	1	1	141.983	4.571	0.116	C
			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	841.262 kip-ft	13.763		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.959	A	1	1.03	1	1	1	95.805	3.228	0.073	C
			B	1	1.03	1	1	1	95.805			
			C	1	1.03	1	1	1	95.805			
L2 85.500-39.417	1.369	6.243	A	1	1.03	1	1	1	135.822	3.901	0.085	C
			B	1	1.03	1	1	1	135.822			
			C	1	1.03	1	1	1	135.822			
L3 39.417-0.000	1.082	7.596	A	1	1.03	1	1	1	145.268	3.508	0.089	C
			B	1	1.03	1	1	1	145.268			
			C	1	1.03	1	1	1	145.268			
Sum Weight:	3.628	16.798						OTM	652.611 kip-ft	10.637		

Tower Forces - With Ice - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.959	A	1	1.03	1	1	1	95.805	3.228	0.073	C
			B	1	1.03	1	1	1	95.805			
			C	1	1.03	1	1	1	95.805			
L2 85.500-39.417	1.369	6.243	A	1	1.03	1	1	1	135.822	3.901	0.085	C
			B	1	1.03	1	1	1	135.822			
			C	1	1.03	1	1	1	135.822			
L3 39.417-0.000	1.082	7.596	A	1	1.03	1	1	1	145.268	3.508	0.089	C
			B	1	1.03	1	1	1	145.268			
			C	1	1.03	1	1	1	145.268			
Sum Weight:	3.628	16.798						OTM	652.611 kip-ft	10.637		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.959	A	1	1.03	1	1	1	95.805	3.228	0.073	C
			B	1	1.03	1	1	1	95.805			
			C	1	1.03	1	1	1	95.805			
L2 85.500-39.417	1.369	6.243	A	1	1.03	1	1	1	135.822	3.901	0.085	C
			B	1	1.03	1	1	1	135.822			
			C	1	1.03	1	1	1	135.822			
L3 39.417-0.000	1.082	7.596	A	1	1.03	1	1	1	145.268	3.508	0.089	C
			B	1	1.03	1	1	1	145.268			
			C	1	1.03	1	1	1	145.268			
Sum Weight:	3.628	16.798						OTM	652.611 kip-ft	10.637		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.959	A	1	1.03	1	1	1	95.805	3.228	0.073	C
			B	1	1.03	1	1	1	95.805			
			C	1	1.03	1	1	1	95.805			
L2 85.500-39.417	1.369	6.243	A	1	1.03	1	1	1	135.822	3.901	0.085	C
			B	1	1.03	1	1	1	135.822			
			C	1	1.03	1	1	1	135.822			
L3 39.417-0.000	1.082	7.596	A	1	1.03	1	1	1	145.268	3.508	0.089	C
			B	1	1.03	1	1	1	145.268			
			C	1	1.03	1	1	1	145.268			
Sum Weight:	3.628	16.798						OTM	652.611 kip-ft	10.637		

Tower Forces - Service - Wind Normal To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	1.432	0.032	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	1.749	0.038	C
			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3 39.417-0.000	1.082	6.517	A	1	1.03	1	1	1	141.983	1.582	0.040	C
			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	291.094 kip-ft	4.762		

Tower Forces - Service - Wind 45 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	1.432	0.032	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	1.749	0.038	C
			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3 39.417-0.000	1.082	6.517	A	1	1.03	1	1	1	141.983	1.582	0.040	C
			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	291.094 kip-ft	4.762		

Tower Forces - Service - Wind 60 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	1.432	0.032	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	1.749	0.038	C
			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3 39.417-0.000	1.082	6.517	A	1	1.03	1	1	1	141.983	1.582	0.040	C
			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	291.094 kip-ft	4.762		

Tower Forces - Service - Wind 90 To Face

Section Elevation ft	Add Weight K	Self Weight K	Face	e	C_F	R_R	D_F	D_R	A_E ft^2	F K	w klf	Ctrl. Face
L1 130.000-85.500	1.178	2.253	A	1	1.03	1	1	1	92.096	1.432	0.032	C
			B	1	1.03	1	1	1	92.096			
			C	1	1.03	1	1	1	92.096			
L2 85.500-39.417	1.369	5.237	A	1	1.03	1	1	1	131.981	1.749	0.038	C
			B	1	1.03	1	1	1	131.981			
			C	1	1.03	1	1	1	131.981			
L3 39.417-0.000	1.082	6.517	A	1	1.03	1	1	1	141.983	1.582	0.040	C
			B	1	1.03	1	1	1	141.983			
			C	1	1.03	1	1	1	141.983			
Sum Weight:	3.628	14.007						OTM	291.094	4.762		

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

Force Totals

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
Leg Weight	14.007					
Bracing Weight	0.000					
Total Member Self-Weight	14.007			7.702	0.229	
Total Weight	21.527			7.702	0.229	
Wind 0 deg - No Ice		-0.031	-22.347	-1904.751	4.309	-1.396
Wind 30 deg - No Ice		11.055	-19.338	-1646.491	-941.249	1.043
Wind 45 deg - No Ice		15.650	-15.780	-1341.721	-1333.334	2.197
Wind 60 deg - No Ice		19.178	-11.146	-944.991	-1634.539	3.202
Wind 90 deg - No Ice		22.163	0.031	11.782	-1889.794	4.504
Wind 120 deg - No Ice		19.210	11.201	967.462	-1638.619	4.598
Wind 135 deg - No Ice		15.694	15.824	1362.895	-1339.104	4.172
Wind 150 deg - No Ice		11.109	19.369	1665.975	-948.316	3.461
Wind 180 deg - No Ice		0.031	22.347	1920.155	-3.851	1.396
Wind 210 deg - No Ice		-11.055	19.338	1661.895	941.707	-1.043
Wind 225 deg - No Ice		-15.650	15.780	1357.126	1333.792	-2.197
Wind 240 deg - No Ice		-19.178	11.146	960.395	1634.997	-3.202
Wind 270 deg - No Ice		-22.163	-0.031	3.622	1890.252	-4.504
Wind 300 deg - No Ice		-19.210	-11.201	-952.057	1639.076	-4.598
Wind 315 deg - No Ice		-15.694	-15.824	-1347.491	1339.562	-4.172
Wind 330 deg - No Ice		-11.109	-19.369	-1650.570	948.773	-3.461
Member Ice	2.791					
Total Weight Ice	26.327			10.388	0.412	
Wind 0 deg - Ice		-0.023	-17.985	-1560.684	3.362	-1.425
Wind 30 deg - Ice		8.903	-15.564	-1348.725	-774.036	0.941
Wind 45 deg - Ice		12.602	-12.701	-1098.441	-1096.351	2.069
Wind 60 deg - Ice		15.442	-8.973	-772.593	-1343.922	3.056
Wind 90 deg - Ice		17.845	0.023	13.339	-1553.595	4.351
Wind 120 deg - Ice		15.465	9.012	798.480	-1346.873	4.480
Wind 135 deg - Ice		12.634	12.733	1123.390	-1100.523	4.084
Wind 150 deg - Ice		8.942	15.586	1372.452	-779.147	3.410
Wind 180 deg - Ice		0.023	17.985	1581.460	-2.539	1.425
Wind 210 deg - Ice		-8.903	15.564	1369.501	774.860	-0.941
Wind 225 deg - Ice		-12.602	12.701	1119.218	1097.174	-2.069
Wind 240 deg - Ice		-15.442	8.973	793.369	1344.746	-3.056
Wind 270 deg - Ice		-17.845	-0.023	7.438	1554.419	-4.351
Wind 300 deg - Ice		-15.465	-9.012	-777.703	1347.697	-4.480
Wind 315 deg - Ice		-12.634	-12.733	-1102.614	1101.347	-4.084
Wind 330 deg - Ice		-8.942	-15.586	-1351.676	779.971	-3.410
Total Weight	21.527			7.702	0.229	
Wind 0 deg - Service		-0.011	-7.733	-654.046	1.640	-0.483
Wind 30 deg - Service		3.825	-6.691	-564.683	-325.542	0.361
Wind 45 deg - Service		5.415	-5.460	-459.226	-461.212	0.760
Wind 60 deg - Service		6.636	-3.857	-321.950	-565.435	1.108
Wind 90 deg - Service		7.669	0.011	9.114	-653.758	1.558
Wind 120 deg - Service		6.647	3.876	339.799	-566.847	1.591
Wind 135 deg - Service		5.430	5.475	476.627	-463.208	1.444
Wind 150 deg - Service		3.844	6.702	581.499	-327.987	1.198
Wind 180 deg - Service		0.011	7.733	669.450	-1.183	0.483

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 210 deg - Service		-3.825	6.691	580.087	326.000	-0.361
Wind 225 deg - Service		-5.415	5.460	474.631	461.669	-0.760
Wind 240 deg - Service		-6.636	3.857	337.354	565.892	-1.108
Wind 270 deg - Service		-7.669	-0.011	6.290	654.216	-1.558
Wind 300 deg - Service		-6.647	-3.876	-324.395	567.304	-1.591
Wind 315 deg - Service		-5.430	-5.475	-461.223	463.666	-1.444
Wind 330 deg - Service		-3.844	-6.702	-566.095	328.445	-1.198

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
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

Comb. No.	*Description*
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	130 - 85.5	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-9.567	0.428	-10.782
			Max. Mx	14	-6.105	376.948	-6.434
			Max. My	10	-6.073	-1.108	-390.603
			Max. Vy	14	-12.502	376.948	-6.434
			Max. Vx	10	12.695	-1.108	-390.603
			Max. Torque	15			4.715
L2	85.5 - 39.417	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-16.684	0.439	-11.063
			Max. Mx	14	-12.543	1048.444	-5.240
			Max. My	10	-12.527	-2.532	-1070.768
			Max. Vy	14	-17.361	1048.444	-5.240
			Max. Vx	10	17.552	-2.532	-1070.768
			Max. Torque	15			4.704
L3	39.417 - 0	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-26.327	0.442	-11.144
			Max. Mx	14	-21.511	1937.117	-3.870
			Max. My	10	-21.510	-3.967	-1967.916
			Max. Vy	14	-22.179	1937.117	-3.870
			Max. Vx	10	22.364	-3.967	-1967.916
			Max. Torque	15			4.690

Maximum Reactions

Location	*Condition*	*Gov. Load Comb.*	*Vertical K*	*Horizontal, X K*	*Horizontal, Z K*
Pole	Max. Vert	27	26.327	-0.023	-17.985
	Max. H_x	14	21.527	22.163	0.031
	Max. H_z	2	21.527	0.031	22.347
	Max. M_x	2	1951.826	0.031	22.347
	Max. M_z	6	1936.637	-22.163	-0.031
	Max. Torsion	15	4.686	19.210	11.201
	Min. Vert	1	21.527	0.000	-0.000
	Min. H_x	6	21.527	-22.163	-0.031
	Min. H_z	10	21.527	-0.031	-22.347
	Min. M_x	10	-1967.916	-0.031	-22.347
	Min. M_z	14	-1937.117	22.163	0.031
	Min. Torsion	7	-4.683	-19.210	-11.201

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	21.527	0.000	0.000	8.098	0.241	0.000
Dead+Wind 0 deg - No Ice	21.527	-0.031	-22.347	-1951.826	4.433	-1.402
Dead+Wind 30 deg - No Ice	21.527	11.055	-19.338	-1687.168	-964.557	1.086
Dead+Wind 45 deg - No Ice	21.527	15.650	-15.780	-1374.840	-1366.370	2.262
Dead+Wind 60 deg - No Ice	21.527	19.178	-11.146	-968.262	-1675.051	3.283
Dead+Wind 90 deg - No Ice	21.527	22.163	0.031	12.269	-1936.637	4.600
Dead+Wind 120 deg - No Ice	21.527	19.210	11.201	991.652	-1679.214	4.683
Dead+Wind 135 deg - No Ice	21.527	15.694	15.824	1396.876	-1372.270	4.243
Dead+Wind 150 deg - No Ice	21.527	11.109	19.369	1707.452	-971.802	3.513
Dead+Wind 180 deg - No Ice	21.527	0.031	22.347	1967.916	-3.967	1.403
Dead+Wind 210 deg - No Ice	21.527	-11.055	19.338	1703.277	965.008	-1.083
Dead+Wind 225 deg - No Ice	21.527	-15.650	15.780	1390.962	1366.821	-2.259
Dead+Wind 240 deg - No Ice	21.527	-19.178	11.146	984.395	1675.509	-3.281
Dead+Wind 270 deg - No Ice	21.527	-22.163	-0.031	3.869	1937.117	-4.601
Dead+Wind 300 deg - No Ice	21.527	-19.210	-11.201	-975.532	1679.709	-4.686
Dead+Wind 315 deg - No Ice	21.527	-15.694	-15.824	-1380.769	1372.765	-4.245
Dead+Wind 330 deg - No Ice	21.527	-11.109	-19.369	-1691.356	972.291	-3.515
Dead+Ice+Temp	26.327	-0.000	0.000	11.144	0.442	0.001
Dead+Wind 0 deg+Ice+Temp	26.327	-0.023	-17.985	-1614.189	3.504	-1.445
Dead+Wind 30 deg+Ice+Temp	26.327	8.903	-15.564	-1394.911	-800.697	0.986
Dead+Wind 45 deg+Ice+Temp	26.327	12.602	-12.701	-1135.987	-1134.129	2.142
Dead+Wind 60 deg+Ice+Temp	26.327	15.442	-8.973	-798.887	-1390.243	3.152
Dead+Wind 90 deg+Ice+Temp	26.327	17.845	0.023	14.182	-1607.147	4.473
Dead+Wind 120 deg+Ice+Temp	26.327	15.465	9.012	826.412	-1393.289	4.595
Dead+Wind 135 deg+Ice+Temp	26.327	12.634	12.733	1162.522	-1138.446	4.184
Dead+Wind 150 deg+Ice+Temp	26.327	8.942	15.586	1420.164	-805.996	3.488
Dead+Wind 180 deg+Ice+Temp	26.327	0.023	17.985	1636.371	-2.639	1.447
Dead+Wind 210 deg+Ice+Temp	26.327	-8.903	15.564	1417.110	801.551	-0.982
Dead+Wind 225 deg+Ice+Temp	26.327	-12.602	12.701	1158.197	1134.985	-2.138
Dead+Wind 240 deg+Ice+Temp	26.327	-15.442	8.973	821.106	1391.105	-3.149
Dead+Wind 270 deg+Ice+Temp	26.327	-17.845	-0.023	8.039	1608.030	-4.473
Dead+Wind 300 deg+Ice+Temp	26.327	-15.465	-9.012	-804.209	1394.183	-4.598
Dead+Wind 315 deg+Ice+Temp	26.327	-12.634	-12.733	-1140.330	1139.337	-4.186
Dead+Wind 330 deg+Ice+Temp	26.327	-8.942	-15.586	-1397.980	806.881	-3.489
Dead+Wind 0 deg - Service	21.527	-0.011	-7.733	-670.759	1.696	-0.490
Dead+Wind 30 deg - Service	21.527	3.825	-6.691	-579.080	-333.942	0.379
Dead+Wind 45 deg - Service	21.527	5.415	-5.460	-470.893	-473.118	0.789
Dead+Wind 60 deg - Service	21.527	6.636	-3.857	-330.062	-580.035	1.146
Dead+Wind 90 deg - Service	21.527	7.669	0.011	9.570	-670.643	1.606
Dead+Wind 120 deg - Service	21.527	6.647	3.876	348.810	-581.488	1.636
Dead+Wind 135 deg - Service	21.527	5.430	5.475	489.177	-475.173	1.482
Dead+Wind 150 deg - Service	21.527	3.844	6.702	596.759	-336.460	1.227
Dead+Wind 180 deg - Service	21.527	0.011	7.733	686.983	-1.215	0.490
Dead+Wind 210 deg - Service	21.527	-3.825	6.691	595.306	334.420	-0.378
Dead+Wind 225 deg - Service	21.527	-5.415	5.460	487.120	473.597	-0.789
Dead+Wind 240 deg - Service	21.527	-6.636	3.857	346.291	580.515	-1.145
Dead+Wind 270 deg - Service	21.527	-7.669	-0.011	6.659	671.126	-1.606
Dead+Wind 300 deg - Service	21.527	-6.647	-3.876	-332.583	581.972	-1.636
Dead+Wind 315 deg - Service	21.527	-5.430	-5.475	-472.951	475.657	-1.482
Dead+Wind 330 deg - Service	21.527	-3.844	-6.702	-580.535	336.943	-1.227

Solution Summary

	Sum of Applied Forces			*Sum of Reactions*			
Load Comb.	*PX K*	*PY K*	*PZ K*	*PX K*	*PY K*	*PZ K*	*% Error*
1	0.000	-21.527	0.000	0.000	21.527	-0.000	0.000%
2	-0.031	-21.527	-22.347	0.031	21.527	22.347	0.000%
3	11.055	-21.527	-19.338	-11.055	21.527	19.338	0.000%
4	15.650	-21.527	-15.780	-15.650	21.527	15.780	0.000%
5	19.178	-21.527	-11.146	-19.178	21.527	11.146	0.000%
6	22.163	-21.527	0.031	-22.163	21.527	-0.031	0.000%
7	19.210	-21.527	11.201	-19.210	21.527	-11.201	0.000%
8	15.694	-21.527	15.824	-15.694	21.527	-15.824	0.000%
9	11.109	-21.527	19.369	-11.109	21.527	-19.369	0.000%
10	0.031	-21.527	22.347	-0.031	21.527	-22.347	0.000%
11	-11.055	-21.527	19.338	11.055	21.527	-19.338	0.000%
12	-15.650	-21.527	15.780	15.650	21.527	-15.780	0.000%
13	-19.178	-21.527	11.146	19.178	21.527	-11.146	0.000%
14	-22.163	-21.527	-0.031	22.163	21.527	0.031	0.000%
15	-19.210	-21.527	-11.201	19.210	21.527	11.201	0.000%
16	-15.694	-21.527	-15.824	15.694	21.527	15.824	0.000%
17	-11.109	-21.527	-19.369	11.109	21.527	19.369	0.000%
18	0.000	-26.327	0.000	0.000	26.327	-0.000	0.000%
19	-0.023	-26.327	-17.985	0.023	26.327	17.985	0.000%
20	8.903	-26.327	-15.564	-8.903	26.327	15.564	0.000%
21	12.602	-26.327	-12.701	-12.602	26.327	12.701	0.000%
22	15.442	-26.327	-8.973	-15.442	26.327	8.973	0.000%
23	17.845	-26.327	0.023	-17.845	26.327	-0.023	0.000%
24	15.465	-26.327	9.012	-15.465	26.327	-9.012	0.000%
25	12.634	-26.327	12.733	-12.634	26.327	-12.733	0.000%
26	8.942	-26.327	15.586	-8.942	26.327	-15.586	0.000%
27	0.023	-26.327	17.985	-0.023	26.327	-17.985	0.000%
28	-8.903	-26.327	15.564	8.903	26.327	-15.564	0.000%
29	-12.602	-26.327	12.701	12.602	26.327	-12.701	0.000%
30	-15.442	-26.327	8.973	15.442	26.327	-8.973	0.000%
31	-17.845	-26.327	-0.023	17.845	26.327	0.023	0.000%
32	-15.465	-26.327	-9.012	15.465	26.327	9.012	0.000%
33	-12.634	-26.327	-12.733	12.634	26.327	12.733	0.000%
34	-8.942	-26.327	-15.586	8.942	26.327	15.586	0.000%
35	-0.011	-21.527	-7.733	0.011	21.527	7.733	0.000%
36	3.825	-21.527	-6.691	-3.825	21.527	6.691	0.000%
37	5.415	-21.527	-5.460	-5.415	21.527	5.460	0.000%
38	6.636	-21.527	-3.857	-6.636	21.527	3.857	0.000%
39	7.669	-21.527	0.011	-7.669	21.527	-0.011	0.000%
40	6.647	-21.527	3.876	-6.647	21.527	-3.876	0.000%
41	5.430	-21.527	5.475	-5.430	21.527	-5.475	0.000%
42	3.844	-21.527	6.702	-3.844	21.527	-6.702	0.000%
43	0.011	-21.527	7.733	-0.011	21.527	-7.733	0.000%
44	-3.825	-21.527	6.691	3.825	21.527	-6.691	0.000%
45	-5.415	-21.527	5.460	5.415	21.527	-5.460	0.000%
46	-6.636	-21.527	3.857	6.636	21.527	-3.857	0.000%
47	-7.669	-21.527	-0.011	7.669	21.527	0.011	0.000%
48	-6.647	-21.527	-3.876	6.647	21.527	3.876	0.000%
49	-5.430	-21.527	-5.475	5.430	21.527	5.475	0.000%
50	-3.844	-21.527	-6.702	3.844	21.527	6.702	0.000%

Non-Linear Convergence Results

Load Combination	*Converged?*	*Number of Cycles*	*Displacement Tolerance*	*Force Tolerance*
1	Yes	4	0.00000001	0.00000001

2	Yes	4	0.00000001	0.00046291
3	Yes	5	0.00000001	0.00013872
4	Yes	5	0.00000001	0.00014759
5	Yes	5	0.00000001	0.00011926
6	Yes	5	0.00000001	0.00004513
7	Yes	5	0.00000001	0.00016640
8	Yes	5	0.00000001	0.00015618
9	Yes	5	0.00000001	0.00012349
10	Yes	4	0.00000001	0.00040913
11	Yes	5	0.00000001	0.00013206
12	Yes	5	0.00000001	0.00015101
13	Yes	5	0.00000001	0.00015573
14	Yes	5	0.00000001	0.00004339
15	Yes	5	0.00000001	0.00011747
16	Yes	5	0.00000001	0.00015376
17	Yes	5	0.00000001	0.00015570
18	Yes	4	0.00000001	0.00004341
19	Yes	5	0.00000001	0.00008634
20	Yes	5	0.00000001	0.00029610
21	Yes	5	0.00000001	0.00032626
22	Yes	5	0.00000001	0.00026538
23	Yes	5	0.00000001	0.00013068
24	Yes	5	0.00000001	0.00035716
25	Yes	5	0.00000001	0.00035374
26	Yes	5	0.00000001	0.00028175
27	Yes	5	0.00000001	0.00008729
28	Yes	5	0.00000001	0.00029466
29	Yes	5	0.00000001	0.00034283
30	Yes	5	0.00000001	0.00033595
31	Yes	5	0.00000001	0.00012881
32	Yes	5	0.00000001	0.00026541
33	Yes	5	0.00000001	0.00033973
34	Yes	5	0.00000001	0.00032902
35	Yes	4	0.00000001	0.00008839
36	Yes	4	0.00000001	0.00036417
37	Yes	4	0.00000001	0.00039833
38	Yes	4	0.00000001	0.00027915
39	Yes	4	0.00000001	0.00029491
40	Yes	4	0.00000001	0.00056769
41	Yes	4	0.00000001	0.00049986
42	Yes	4	0.00000001	0.00032894
43	Yes	4	0.00000001	0.00008958
44	Yes	4	0.00000001	0.00035083
45	Yes	4	0.00000001	0.00044934
46	Yes	4	0.00000001	0.00049730
47	Yes	4	0.00000001	0.00029137
48	Yes	4	0.00000001	0.00030368
49	Yes	4	0.00000001	0.00045581
50	Yes	4	0.00000001	0.00047251

Maximum Tower Deflections - Service Wind

Section No.	*Elevation* *ft*	*Horz. Deflection* *in*	*Gov. Load Comb.*	*Tilt* *°*	*Twist* *°*
L1	130 - 85.5	27.283	43	1.929	0.026
L2	90 - 39.417	12.828	43	1.373	0.009
L3	45 - 0	3.155	43	0.644	0.003

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
130.000	4-bay dipole	43	27.283	1.929	0.026	23077
128.000	Andrew 12'-6" Low Profile Platform	43	26.505	1.903	0.025	23077
120.000	LPA-80080-6CF	43	23.409	1.796	0.021	11538
118.000	Valmont 13' Low Profile Platform	43	22.643	1.770	0.020	9615

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	130 - 85.5	77.119	10	5.375	0.074
L2	90 - 39.417	36.541	10	3.895	0.025
L3	45 - 0	9.021	10	1.840	0.007

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
130.000	4-bay dipole	10	77.119	5.375	0.074	8568
128.000	Andrew 12'-6" Low Profile Platform	10	74.940	5.306	0.072	8568
120.000	LPA-80080-6CF	10	66.266	5.028	0.060	4283
118.000	Valmont 13' Low Profile Platform	10	64.120	4.958	0.058	3569

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 $\frac{P}{P_a}$
L1	130 - 85.5 (1)	TP29.73x19.94x0.188	44.500	0.000	0.0	33.966	17.239	-6.073	585.527	0.010
L2	85.5 - 39.417 (2)	TP39.39x28.365x0.281	50.583	0.000	0.0	36.733	34.316	-12.527	1260.520	0.010
L3	39.417 - 0 (3)	TP47.6x37.611x0.313	45.000	0.000	0.0	34.117	47.583	-21.510	1623.410	0.013

Pole Bending Design Data

Section No.	Elevation ft	Size	Actual M_x kip-ft	Actual f_{bx} ksi	Allow. F_{bx} ksi	Ratio $\frac{f_{bx}}{F_{bx}}$	Actual M_y kip-ft	Actual f_{by} ksi	Allow. F_{by} ksi	Ratio $\frac{f_{by}}{F_{by}}$
L1	130 - 85.5 (1)	TP29.73x19.94x0.188	390.605	38.901	33.966	1.145	0.000	0.000	33.966	0.000
L2	85.5 - 39.417 (2)	TP39.39x28.365x0.281	1070.775	40.401	36.733	1.100	0.000	0.000	36.733	0.000
L3	39.417 - 0 (3)	TP47.6x37.611x0.313	1967.917	42.874	34.117	1.257	0.000	0.000	34.117	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V K	Actual f_v ksi	Allow. F_v ksi	Ratio $\frac{f_v}{F_v}$	Actual T kip-ft	Actual f_{vt} ksi	Allow. F_{vt} ksi	Ratio $\frac{f_{vt}}{F_{vt}}$
L1	130 - 85.5 (1)	TP29.73x19.94x0.188	12.695	0.736	26.000	0.059	1.409	0.066	26.000	0.003
L2	85.5 - 39.417 (2)	TP39.39x28.365x0.281	17.552	0.511	26.000	0.040	1.405	0.025	26.000	0.001
L3	39.417 - 0 (3)	TP47.6x37.611x0.313	22.363	0.470	26.000	0.037	1.403	0.014	26.000	0.001

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P}{P_a}$	Ratio $\frac{f_{bx}}{F_{bx}}$	Ratio $\frac{f_{by}}{F_{by}}$	Ratio $\frac{f_v}{F_v}$	Ratio $\frac{f_{vt}}{F_{vt}}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	130 - 85.5 (1)	0.010	1.145	0.000	0.059	0.003	1.157 ✔	1.333	H1-3+VT ✔
L2	85.5 - 39.417 (2)	0.010	1.100	0.000	0.040	0.001	1.110 ✔	1.333	H1-3+VT ✔
L3	39.417 - 0 (3)	0.013	1.257	0.000	0.037	0.001	1.270 ✔	1.333	H1-3+VT ✔

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	SF*P_{allow} K	% Capacity	Pass Fail
L1	130 - 85.5	Pole	TP29.73x19.94x0.188	1	-6.073	780.507	86.8	Pass
L2	85.5 - 39.417	Pole	TP39.39x28.365x0.281	2	-12.527	1680.273	83.3	Pass
L3	39.417 - 0	Pole	TP47.6x37.611x0.313	3	-21.510	2164.005	95.3	Pass
							Summary	
						Pole (L3)	95.3	Pass
						RATING =	**95.3**	**Pass**

Anchor Bolt and Base Plate Analysis:

Input Data:

Tower Reactions:

Overturning Moment =	$OM := 1968 \cdot ft \cdot kips$	(Input From RisaTower)
Shear Force =	$Shear := 22 \cdot kips$	(Input From RisaTower)
Axial Force =	$Axial := 22 \cdot kips$	(Input From RisaTower)

Anchor Bolt Data:

Use ASTM A615 Grade 75

Number of Anchor Bolts =	$N := 12$	(User Input)
Diameter of Bolt Circle =	$D_{bc} := 55.03 \cdot in$	(User Input)
Bolt "Column" Distance =	$l := 3.00 \cdot in$	(User Input)
Bolt Ultimate Strength =	$F_u := 100 \cdot ksi$	(User Input)
Bolt Yield Strength =	$F_y := 75 \cdot ksi$	(User Input)
Bolt Modulus =	$E := 29000 \cdot ksi$	(User Input)
Diameter of Anchor Bolts =	$D := 2.25 \cdot in$	(User Input)
Threads per Inch =	$n := 4.5$	(User Input)

Base Plate Data:

Use ASTM A633-60

Plate Yield Strength =	$Fy_{bp} := 60 \cdot ksi$	(User Input)
Base Plate Thickness =	$t_{bp} := 2.25 \cdot in$	(User Input)
Base Plate Diameter =	$D_{bp} := 61.03 \cdot in$	(User Input)
Outer Pole Diameter =	$D_{pole} := 47.60 \cdot in$	(User Input)

Geometric Layout Data:

Distance from Bolts to Centroid of Pole:

Radius of Bolt Circle =: $R_{bc} := \frac{D_{bc}}{2} = 27.515 \cdot in$

Distance to Bolts = $i := 1..N$

$$d_i := \left| \begin{array}{l} \theta \leftarrow 2 \cdot \pi \cdot \left(\frac{i}{N}\right) \\ d \leftarrow R_{bc} \cdot \sin(\theta) \end{array} \right.$$

$d_1 = 13.76 \cdot in$	$d_7 = -13.76 \cdot in$
$d_2 = 23.83 \cdot in$	$d_8 = -23.83 \cdot in$
$d_3 = 27.52 \cdot in$	$d_9 = -27.52 \cdot in$
$d_4 = 23.83 \cdot in$	$d_{10} = -23.83 \cdot in$
$d_5 = 13.76 \cdot in$	$d_{11} = -13.76 \cdot in$
$d_6 = 0.00 \cdot in$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius = $R_{pole} := \frac{D_{pole}}{2} = 23.8 \cdot in$

Moment Arms of Bolts about Neutral Axis = $MA_i := if\left(d_i \geq R_{pole}, d_i - R_{pole}, 0in\right)$

$MA_1 = 0.00 \cdot in$	$MA_7 = 0.00 \cdot in$
$MA_2 = 0.03 \cdot in$	$MA_8 = 0.00 \cdot in$
$MA_3 = 3.72 \cdot in$	$MA_9 = 0.00 \cdot in$
$MA_4 = 0.03 \cdot in$	$MA_{10} = 0.00 \cdot in$
$MA_5 = 0.00 \cdot in$	$MA_{11} = 0.00 \cdot in$
$MA_6 = 0.00 \cdot in$	etc

Effective Width of Baseplate for Bending = $B_{eff} := .8 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2} = 30.6 \cdot in$

Anchor Bolt Analysis:

Calculated Anchor Bolt Properties:

Polar Moment of Inertia = $I_p := \sum_i (d_i)^2 = 4.542 \times 10^3 \cdot in^2$

Gross Area of Bolt = $A_g := \frac{\pi}{4} \cdot D^2 = 3.976 \cdot in^2$

Net Area of Bolt = $A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n}\right)^2 = 3.248 \cdot in^2$

Net Diameter = $D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} = 2.033 \cdot in$

Radius of Gyration of Bolt = $r := \frac{D_n}{4} = 0.508 \cdot in$

Section Modulus of Bolt = $S_x := \frac{\pi \cdot D_n^{\ 3}}{32} = 0.826 \cdot in^3$

Check Anchor Bolt Tension Force:

Maximum Tensile Force = $T_{Max} := OM \cdot \frac{R_{bc}}{I_p} - \frac{Axial}{N} = 141.2 \cdot kips$

Allowable Tensile Force = $T_{ALL.Gross} := 1.333 \cdot (0.33 \cdot A_g \cdot F_u) = 174.9 \cdot kips$ (1.333 increase allowed per TIA/EIA)

$T_{ALL.Net} := 1.333 \cdot (0.60 \cdot A_n \cdot F_y) = 194.812 \cdot kips$ (1.333 increase allowed per TIA/EIA)

Bolt Tension % of Capacity = $\frac{T_{Max}}{T_{ALL.Net}} = 72.5 \cdot \%$ Bolts are "upset bolts". Use net area per AISC

Condition1 = $Condition1 := if\left(\frac{T_{Max}}{T_{ALL.Net}} \le 1.00, \text{"OK"}, \text{"Overstressed"}\right)$

Condition1 = "OK"

Check Anchor Bolt Bending Stress:

Maximum Bending Moment = $M_x := \left(\frac{Shear}{N}\right) \cdot l = 0.458 \cdot ft \cdot kips$

Maximum Bending Stress = $f_{bx} := \frac{M_x}{S_x} = 6.7 \cdot ksi$

Allowable Bending Stress = $F_{bx} := 1.333 \cdot 0.6 \cdot F_y = 60 \cdot ksi$ (1.333 increase allowed per TIA/EIA)

Check Combined Stress Requirement:

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.

$$l := \begin{cases} l & \text{if } l > 2 \cdot D_n \\ 0 & \text{otherwise} \end{cases} = 0 \cdot in$$

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

Check Anchor Bolt Compression/Combined Stress:

Maximum Compressive Force = $C_{Max} := OM \cdot \frac{R_{bc}}{I_p} + \frac{Axial}{N} = 144.9 \cdot kips$

Maximum Compressive Stress = $f_a := \frac{C_{Max}}{A_n} = 44.6 \cdot ksi$

$K := 0.65$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} = 87.364$$

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

Allowable Compressive Stress = $F_a := 1.333 \cdot F_a = 60 \cdot ksi$ (1.333 increase allowed per TIA/EIA)

Combined Stress % of Capacity = $\left(\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}}\right) = 74.4 \cdot \%$

Condition 2 = $Condition2 := \text{if}\left(\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}} \le 1.00, \text{"OK"}, \text{"Overstressed"}\right)$

Condition2 = "OK"

Base Plate Analysis:

Force from Bolts = $C_i := \frac{OM \cdot d_i}{I_p} + \frac{Axial}{N}$

$C_1 = 73.4 \cdot kips$	$C_7 = -69.7 \cdot kips$
$C_2 = 125.7 \cdot kips$	$C_8 = -122.1 \cdot kips$
$C_3 = 144.9 \cdot kips$	$C_9 = -141.2 \cdot kips$
$C_4 = 125.7 \cdot kips$	$C_{10} = -122.1 \cdot kips$
$C_5 = 73.4 \cdot kips$	$C_{11} = -69.7 \cdot kips$
$C_6 = 1.8 \cdot kips$	etc.

Maximum Bending Stress in Plate = $f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{\left(B_{eff} \cdot t_{bp}^{\,2}\right)} = 21.2 \cdot ksi$

Allowable Bending Stress in Plate = $F_{bp} := 1.33 \cdot 0.75 \cdot Fy_{bp} = 59.9 \cdot ksi$

Plate Bending Stress % of Capacity = $\frac{f_{bp}}{F_{bp}} = 35.3 \cdot \%$

Condition3 = Condition3 := if$\left(\frac{f_{bp}}{F_{bp}} < 1.00, \text{"Ok"}, \text{"Overstressed"}\right)$

Condition3 = "Ok"

Standard Monopole Foundation:

Input Data:

Tower Data

Overturning Moment =	$OM := 1968 \cdot ft \cdot kips$	(User Input from RISATower)
Shear Force =	$Shear := 22 \cdot kip$	(User Input from RISATower)
Axial Force =	$Axial := 22 \cdot kip$	(User Input from RISATower)
Tower Height =	$H_t := 130 \cdot ft$	(User Input)

Footing Data:

Overall Depth of Footing =	$D_f := 8 \cdot ft$	(User Input)
Length of Pier =	$L_p := 5.0 \cdot ft$	(User Input)
Extension of Pier Above Grade =	$L_{pag} := 0.5 \cdot ft$	(User Input)
Width of Pier =	$d_p := 7 \cdot ft$	(User Input)
Thickness of Footing =	$T_f := 3.5 \cdot ft$	(User Input)
Width of Footing =	$W_f := 20.0 \cdot ft$	(User Input)

Anchor Bolt Data:

Length of Anchor Bolts =	$L_{st} := 96 \cdot in$	(User Input)
Projection of Anchor Bolts Above Pier =	$A_{BP} := 9.25 \cdot in$	(User Input)
Anchor Bolt Diameter =	$d_{anchor} := 2.25 \cdot in$	(User Input)
Base Plate Bolt Circle =	$MP := 55.03 \cdot in$	(User Input)

Material Properties:

Concrete Compressive Strength =	$f_c := 3000 \cdot psi$	(User Input)	
Steel Reinforcment Yield Strength =	$f_y := 60000 \cdot psi$	(User Input)	
Anchor Bolt Yield Strength =	$f_{ya} := 75000 \cdot psi$	(User Input)	
Internal Friction Angle of Soil =	$\Phi_s := 30 \cdot deg$	(User Input)	
Allowable Soil Bearing Capacity =	$q_s := 5000 \cdot psf$	(User Input)	
Unit Weight of Soil =	$\gamma_{soil} := 100 \cdot pcf$	(User Input)	
Unit Weight of Concrete =	$\gamma_{conc} := 150 \cdot pcf$	(User Input)	
Foundation Bouyancy =	$Bouyancy := 0$	(User Input)	(Yes=1 / No=0)
Depth to Neglect =	$n := 0 \cdot ft$	(User Input)	
Cohesion of Clay Type Soil =	$c := 0 \cdot ksf$	(User Input)	(Use 0 for Sandy Soil)
Seismic Zone Factor =	$Z := 2$	(User Input)	(UBC-1997 Fig 23-2)
Coefficient of Friction Between Concrete =	$\mu := 0.45$	(User Input)	

Pier Reinforcement:

Bar Size =	$BS_{pier} := 9$	(User Input)	
Bar Diameter =	$d_{bpier} := 1.128 \cdot in$	(User Input)	
Number of Bars =	$NB_{pier} := 36$	(User Input)	
Clear Cover of Reinforcement =	$Cvr_{pier} := 3 \cdot in$	(User Input)	
Reinforcement Location Factor =	$\alpha_{pier} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Coating Factor =	$\beta_{pier} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Concrete Strength Factor =	$\lambda_{pier} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Reinforcement Size Factor =	$\gamma_{pier} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Diameter of Tie =	$d_{Tie} := 3 \cdot in$	(User Input)	

Pad Reinforcement:

Bar Size =	$BS_{top} := 6$	(User Input)	(Top of Pad)
Bar Diameter =	$d_{btop} := 0.75 \cdot in$	(User Input)	(Top of Pad)
Number of Bars =	$NB_{top} := 15$	(User Input)	(Top of Pad)
Bar Size =	$BS_{bot} := 7$	(User Input)	(Bottom of Pad)
Bar Diameter =	$d_{bbot} := 0.875 \cdot in$	(User Input)	(Bottom of Pad)
Number of Bars =	$NB_{bot} := 22$	(User Input)	(Bottom of Pad)
Clear Cover of Reinforcement =	$Cvr_{pad} := 3.0 \cdot in$	(User Input)	
Reinforcement Location Factor =	$\alpha_{pad} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Coating Factor =	$\beta_{pad} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Concrete Strength Factor =	$\lambda_{pad} := 1.0$	(User Input)	(ACI-2008 12.2.4)
Reinforcement Size Factor =	$\gamma_{pad} := 1.0$	(User Input)	(ACI-2008 12.2.4)

Calculated Factors:

Pier Reinforcement Bar Area = $$A_{bpier} := \frac{\pi \cdot d_{bpier}^{2}}{4} = 0.999 \cdot in^{2}$$

Pad Top Reinforcement Bar Area = $$A_{btop} := \frac{\pi \cdot d_{btop}^{2}}{4} = 0.442 \cdot in^{2}$$

Pad Bottom Reinforcement Bar Area = $$A_{bbot} := \frac{\pi \cdot d_{bbot}^{2}}{4} = 0.601 \cdot in^{2}$$

Coefficient of Lateral Soil Pressure = $$K_p := \frac{1 + \sin(\Phi_s)}{1 - \sin(\Phi_s)} = 3$$

Load Factor = $$LF := \begin{cases} 1.333 & \text{if } H_t \le 700 \cdot ft \\ 1.7 & \text{if } H_t \ge 1200 \cdot ft \\ 1.333 + \left(\dfrac{H_t - 700ft}{1200ft - 700ft} \right) \cdot 0.4 & \text{otherwise} \end{cases} = 1.333$$

Stability of Footing:

Adjusted Concrete Unit Weight = $\gamma_c := \text{if}(\text{Bouyancy} = 1, \gamma_{conc} - 62.4\text{pcf}, \gamma_{conc}) = 150 \cdot \text{pcf}$

Adjusted Soil Unit Weight = $\gamma_s := \text{if}(\text{Bouyancy} = 1, \gamma_{soil} - 62.4\text{pcf}, \gamma_{soil}) = 100 \cdot \text{pcf}$

Passive Pressure = $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p} = 0 \cdot \text{ksf}$

$P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p} = 1.35 \cdot \text{ksf}$

$P_{top} := \text{if}\left[n < (D_f - T_f), P_{pt}, P_{pn}\right] = 1.35 \cdot \text{ksf}$

$P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p} = 2.4 \cdot \text{ksf}$

$P_{ave} := \dfrac{P_{top} + P_{bot}}{2} = 1.875 \cdot \text{ksf}$

$T_p := \text{if}\left[n < (D_f - T_f), T_f, (D_f - n)\right] = 3.5$

$A_p := W_f \cdot T_p = 70$

Ultimate Shear = $S_u := P_{ave} \cdot A_p = 131.25 \cdot \text{kip}$

Weight of Concrete Pad = $WT_c := \left[\left(W_f^2 \cdot T_f\right) + d_p^2 \cdot L_p\right] \cdot \gamma_c = 246.75 \cdot \text{kip}$

Weight of Soil Above Footing = $WT_{s1} := \left[\left(W_f^2 - d_p^2\right) \cdot \left(\left|L_p - L_{pag} - n\right|\right)\right] \cdot \gamma_s = 157.95 \cdot \text{kip}$

Weight of Soil Wedge at Back Face = $WT_{s2} := \left(\dfrac{D_f^2 \cdot \tan(\Phi_s)}{2} \cdot W_f\right) \cdot \gamma_s = 36.95 \cdot \text{kip}$

Weight of Soil Wedge at back face Corners = $WT_{s3} := 2 \left[(D_f)^3 \cdot \dfrac{\tan(\Phi_s)}{3}\right] \cdot \gamma_s = 19.707 \cdot \text{kips}$

Total Weight = $WT_{tot} := WT_c + WT_{s1} + \text{Axial} = 426.7 \cdot \text{kip}$

Resisting Moment = $M_r := (WT_{tot}) \cdot \dfrac{W_f}{2} + S_u \cdot \dfrac{T_f}{3} + \left[(WT_{s2} + WT_{s3}) \cdot \left(W_f + \dfrac{D_f \cdot \tan(\Phi_s)}{3}\right)\right] = 5641 \cdot \text{kip} \cdot \text{ft}$

Overturning Moment = $M_{ot} := OM + \text{Shear} \cdot (L_p + T_f) = 2155 \cdot \text{kip} \cdot \text{ft}$

Factor of Safety Actual = $FS := \dfrac{M_r}{M_{ot}} = 2.62$

Factor of Safety Required = $FS_{req} := 2$

OverTurning_Moment_Check := if(FS ≥ FS_{req}, "Okay", "No Good")

OverTurning_Moment_Check = "Okay"

Shear Capacity in Pier:

Shear Resistance of Pier = $S_p := \frac{P_{ave} \cdot A_p + \mu \cdot WT_{tot}}{FS_{req}} = 161.632 \cdot kips$

Shear_Check := if(S_p > Shear, "Okay", "No Good")

Shear_Check = "Okay"

Bearing Pressure Caused by Footing:

Area of the Mat = $A_{mat} := W_f^2 = 400$

Section Modulus of Mat = $S := \frac{W_f^3}{6} = 1333.33 \cdot ft^3$

Maximum Pressure in Mat = $P_{max} := \frac{WT_{tot}}{A_{mat}} + \frac{M_{ot}}{S} = 2.683 \cdot ksf$

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

Max_Pressure_Check = "Okay"

Minimum Pressure in Mat = $P_{min} := \frac{WT_{tot}}{A_{mat}} - \frac{M_{ot}}{S} = -0.55 \cdot ksf$

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

Min_Pressure_Check = "No Good"

Distance to Resultant of Pressure Distribution = $X_p := \frac{P_{max}}{\frac{P_{max} - P_{min}}{W_f}} \cdot \frac{1}{3} = 5.533$

Distance to Kern = $X_k := \frac{W_f}{6} = 3.333$

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

Eccentricity = $e := \frac{M_{ot}}{WT_{tot}} = 5.05$

Adjusted Soil Pressure = $P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \left(\frac{W_f}{2} - e\right)} = 2.874 \cdot ksf$

$q_{adj} :=$ if($P_{min} < 0, P_a, P_{max}$) = 2.874·ksf

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

Pressure_Check = "Okay"

Concrete Bearing Capacity:

Strength Reduction Factor = $\Phi_c := 0.65$ (ACI-2008 9.3.2.2)

Bearing Strength Between Pier and Pad = $P_b := \Phi_c \cdot 0.85 \cdot f_c \cdot d_p^2 = 1.17 \times 10^4 \cdot kips$ (ACI-2008 10.14)

$Bearing\_Check := if(P_b > LF \cdot Axial, "Okay", "No Good")$

$Bearing\_Check = "Okay"$

Shear Strength of Concrete:

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

$\phi_c := 0.85$ (ACI 9.3.2.5)

$d := T_f - Cvr_{pad} - d_{bbot}$

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

$d_2 := d_1 - d$

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

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

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

$V_{Avail} := \phi_c \cdot 2 \cdot \sqrt{f_c \cdot psi} \cdot W_f \cdot d$ (ACI-2008 11.2.1.1)

$Beam\_Shear\_Check := if(V_{req} < V_{Avail}, "Okay", "No Good")$

$Beam\_Shear\_Check = "Okay"$

Punching Shear: (Critical Section Located at a distance of d/2 from the face of pier) (ACI 11.11.1.2)

Critical Perimeter of Punching Shear = $b_o := (d_p + d) \cdot \pi = 32$

Area Included Inside Perimeter = $A_{bo} := \frac{\pi \cdot (d_p + d)^2}{4} = 81.3$

Area Outside of Perimeter = $A_{out} := A_{mat} - A_{bo} = 318.7$

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

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

$v_u := Find(v_u) = 4.2 \cdot ksf$

$V_u := v_u \cdot d \cdot W_f = 266.9 \cdot kips$

Required Shear Strength = $V_{req} := LF \cdot V_u = 355.8 \cdot kips$

Available Shear Strength = $V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot psi} \cdot b_o \cdot d = 2724 \cdot kip$ (ACI-2008 11.11.2.1)

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

$Punching\_Shear\_Check = \text{"Okay"}$

Steel Reinforcement in Pad:

Required Reinforcement for Bending:

Strength Reduction Factor = $\phi_m := .90$ (ACI-2008 9.3.2.1)

$q_b := q_{adj} - d_1 \cdot Slope = 1.616 \cdot ksf$

Maximum Bending at Face of Pier = $M_n := \frac{1}{LF \cdot \phi_m} \cdot \left[(q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f = 864.3 \cdot kip \cdot ft$

$$\beta := \begin{cases} 0.85 & \text{if } 2500 \cdot psi \le f_c \le 4000 \cdot psi \\ 0.65 & \text{if } f_c > 8000 \cdot psi \\ \left[0.85 - \left[\frac{\left(\frac{f_c}{psi} - 4000 \right)}{1000} \right] \cdot 0.5 \right] & \text{otherwise} \end{cases} = 0.85$$

(ACI-200810.2.7.3)

$R_u := \frac{M_n}{\phi_m \cdot W_f \cdot d^2} = 33 \cdot psi$

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

$\rho_{min} := 1.333 \cdot \rho = 0.00074$

Required Reinforcement for Temperature and Shrinkage:

$$\rho_{sh} := \begin{cases} .0018 & \text{if } f_y \geq 60000 \cdot psi \\ .0020 & \text{otherwise} \end{cases}$$ (ACI -2008 7.12.2.1)

Check Bottom Bars:

$$As := \begin{cases} \rho \cdot W_f \cdot d & \text{if } \rho > \frac{\rho_{sh}}{2} \\ \rho_{sh} \cdot W_f \cdot \frac{d}{2} & \text{otherwise} \end{cases} = 8.235 \cdot in^2$$

$$As_{prov} := A_{bbot} \cdot NB_{bot} = 13.2 \cdot in^2$$

Pad_Reinforcement_Bot := if(As_{prov} > As, "Okay", "No Good")

Pad_Reinforcement_Bot = "Okay"

Check top Bars:

$$As := \rho_{sh} \cdot (W_f \cdot d) = 16.5 \cdot in^2$$

$$As_{prov} := A_{btop} \cdot NB_{top} + A_{bbot} \cdot NB_{bot} = 19.9 \cdot in^2$$

Pad_Reinforcement_Top := if(As_{prov} > As, "Okay", "No Good")

Pad_Reinforcement_Top = "Okay"

Developement Length Pad Reinforcement:

Bar Spacing =

$$B_{sPad} := \frac{W_f - 2 \cdot Cvr_{pad} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1} = 10.23 \cdot in$$

Spacing or Cover Dimension =

$$c := if\left(Cvr_{pad} < \frac{B_{sPad}}{2}, Cvr_{pad}, \frac{B_{sPad}}{2}\right) = 3 \cdot in$$

Transverse Reinforcement Index =

$$k_{tr} := 0$$ (ACI-2008 12.2.3)

$$L_{dbt} := \frac{3 \cdot f_y \alpha_{pad} \cdot \beta_{pad} \cdot \gamma_{pad} \cdot \lambda_{pad}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \frac{c + k_{tr}}{d_{bbot}}} \cdot d_{bbot} = 21 \cdot in$$

Minimum Development Length =

$$L_{dbmin} := 12 \cdot in$$ (ACI-2008 12.2.1)

$L_{dbtCheck}$:= if($L_{dbt} \geq L_{dbmin}$, "Use L.dbt", "Use L.dbmin")

Available Length in Pad =

$$L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - Cvr_{pad} = 75 \cdot in$$

Lpad_Check := if($L_{Pad} > L_{dbt}$, "Okay", "No Good")

Lpad_Check = "Okay"

Steel Reinforcement in Pier:

Area of Pier = $A_p := \frac{\pi \cdot d_p^{\,2}}{4} = 5541.77 \cdot in^2$

$A_{smin} := 0.01 \cdot 0.5 \cdot A_p = 27.71 \cdot in^2$ (ACI-2008 10.8.4 & 10.9.1)

$A_{sprov} := NB_{pier} \cdot A_{bpier} = 35.98 \cdot in^2$

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

Steel_Area_Check = "Okay"

Bar Spacing In Pier = $B_{sPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier} = 6.202 \cdot in$

Diameter of Reinforcement Cage = $Diam_{cage} := d_p - 2 \cdot Cvr_{pier} = 78 \cdot in$

Maximum Moment in Pier = $M_p := \left[OM + Shear \cdot \left(L_p + \frac{A_{BP}}{2} \right) \right] \cdot LF = 33375.3 \cdot in \cdot kips$

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

$$\begin{pmatrix} D & N & n & P_u & M_{xu} \end{pmatrix} := \begin{pmatrix} d_p \cdot 12 & NB_{pier} & BS_{pier} & \frac{Axial \cdot 1.333}{kips} & \frac{M_p}{in \cdot kips} \end{pmatrix}$$

$$\begin{pmatrix} D & N & n & P_u & M_{xu} \end{pmatrix} = \begin{pmatrix} 84 & 36 & 9 & 29.3 & 33375.3 \end{pmatrix}$$

$$\begin{pmatrix} \phi P_n & \phi M_{xn} & f_{sp} & \rho \end{pmatrix} := \begin{pmatrix} 0 & 0 & 0 & 0 \end{pmatrix}$$

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

$$\begin{pmatrix} \phi P_n & \phi M_{xn} & f_{sp} & \rho \end{pmatrix} = \begin{pmatrix} 60.6 & 68941.9 & -60 & 0 \end{pmatrix}$$

Axial_Load_Check := if$(\phi P_n \geq P_u$, "Okay" , "No Good"$)$

Axial_Load_Check = "Okay"

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

Bending_Check = "Okay"

Development Length Pier Reinforcement:

Available Length in Foundation:

$$L_{pier} := L_p - Cvr_{pier} = 57 \cdot in$$

$$L_{pad} := T_f - Cvr_{pad} = 39 \cdot in$$

Tension: (ACI-2008 12.2.3)

Spacing or Cover Dimension =

$$c := if\left(Cvr_{pier} < \frac{B_{sPier}}{2}, Cvr_{pier}, \frac{B_{sPier}}{2}\right) = 3 \cdot in$$

Transverse Reinforcement =

$$k_{tr} := 0$$ (ACI-2008 12.2.3)

$$L_{dbt} := \frac{3 \cdot f_y \alpha_{pier} \cdot \beta_{pier} \cdot \gamma_{pier} \cdot \lambda_{pier}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \left(\frac{c + k_{tr}}{d_{bpier}}\right)} \cdot d_{bpier} = 34.85 \cdot in$$

Minimum Development Length =

$$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{psi}}} \cdot .7 = 17.299 \cdot in$$ (ACI 12.2.1)

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

$$L_{db} := max(L_{dbt}, L_{dbmin})$$

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

$$L_{tension\_Check} = \text{"Okay"}$$

Compression: (ACI-2008 12.3.2)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot psi}} = 24.713 \cdot in$$

$$L_{dbmin} := 0.0003 \cdot \frac{in^2}{lb} \cdot (d_{bpier} \cdot f_y) = 20.304 \cdot in$$

$$L_{dbc} := if(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}) = 24.713 \cdot in$$

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

$$L_{compression\_Check} = \text{"Okay"}$$

Tie Size and Spacing in Column:

Minimum Tie Size = $Tie_{min} := if(BS_{pier} \le 10, 3, 4) = 3$

Used #3 Ties

Seismic Factor = $z := if(Z \le 2, 1, 0.5) = 1$ (ACI-2008 21.10.5)

$s_{lim1} := 16 \cdot d_{bpier} \cdot z = 18.048 \cdot in$

$s_{lim2} := \frac{48 \cdot d_{Tie}}{8} \cdot z = 18 \cdot in$

$s_{lim3} := D_f \cdot z = 96 \cdot in$

$s_{lim4} := 18in$

Maximum Spacing = $s_{tie} := min\left(\begin{pmatrix} s_{lim1} \\ s_{lim2} \\ s_{lim3} \\ s_{lim4} \end{pmatrix}\right) = 18 \cdot in$

Number of Ties Required = $n_{tie} := \frac{L_{pier} - 3 \cdot in}{s_{tie}} + 1 = 4$

Check Anchor Steel Embedment:

Depth Available = $D_{ab} := L_{st} - A_{BP} = 7.229 \cdot ft$

Length of Anchor Bolt = $L_{anchor} := \frac{(0.11 \cdot f_{ya}) \cdot in}{\sqrt{f_c \cdot psi}} = 12.552 \cdot ft$

Depth_Check := $if(D_{ab} \ge L_{anchor}, "Okay", "No Good")$

Depth_Check = "No Good"

Note: Anchor plate is provided

SITE NAME	QUINEBAUG CT		ECP - CELL #	AWS1	2	20
LATITUDE	42-01-21.90 N		LONGITUDE	71-56-57.48 W		
Additional Comments: AWS RRH and fiber line add, utilize existing unsued PCS antenna for AWS, remove any un-necessary diplexers			SAVE BUTTON			
			STRUCTURE TYPE	MONOPOLE		
AWS - LTE ANTENNA ADD	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	2100 MHz BBU		2100 MHz BBU		2100 MHz BBU	
ANTENNA TYPE	use existing PCS antenna		use existing PCS antenna		use existing PCS antenna	
QTY OF ANTENNAS PER FACE	0		0		0	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	112		112		112	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL						
RRH - QTY/MODEL	1	ALU RH_2X40-AWS	1	ALU RH_2X40-AWS	1	ALU RH_2X40-AWS
SECTOR DISTRIBUTION BOX						
MAIN DISTRIBUTION BOX	1		DB-T1-6Z-8AB-0Z			
700 Mhz - LTE Current Config	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	700 eNodeB		700 eNodeB		700 eNodeB	
ANTENNA TYPE	BXA-70063-6CF-2-750MHZ		BXA-70063-6CF-2-750MHZ		BXA-70063-6CF-2-750MHZ	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	112		112		112	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL						
700 Mhz - LTE Future Config	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	700 eNodeB		700 eNodeB		700 eNodeB	
ANTENNA TYPE	BXA-70063-6CF-2-750MHZ		BXA-70063-6CF-2-750MHZ		BXA-70063-6CF-2-750MHZ	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	112		112		112	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL						
RRH - QTY/MODEL						
850 Celluar - Current Config	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	Cellular Mod 4.0B		Cellular Mod 4.0B		Cellular Mod 4.0B	
ANTENNA TYPE	LPA-80080-6CF		LPA-80080-6CF		LPA-80080-6CF	
QTY OF ANTENNAS PER FACE	2		2		2	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	112		112		112	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL	2	FD9R 6004/2C-3L	2	FD9R 6004/2C-3L	2	FD9R 6004/2C-3L
850 Celluar - Future Config	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	Cellular Mod 4.0B		Cellular Mod 4.0B		Cellular Mod 4.0B	
ANTENNA TYPE	LPA-80080-6CF		LPA-80080-6CF		LPA-80080-6CF	
QTY OF ANTENNAS PER FACE	2		2		2	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	112		112		112	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL	0		0		0	
DIPLEX WITH LTE CABLE						
1900 PCS - Current Config	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	PCS Mod 4.0B		PCS Mod 4.0B		PCS Mod 4.0B	
ANTENNA TYPE	BXA-171085-12BF-EDIN-2		BXA-171085-12BF-EDIN-2		BXA-171085-12BF-EDIN-2	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	0		120		240	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	137		137		137	

TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL		X WITH CELLULAR		PLEX WITH CELLULAR CAB		DIPLEX WITH CELLULAR CABLE

1900 PCS - Future Config	**ALPHA**	**BETA**	**GAMMA**
EQUIPMENT TYPE	PCS Mod 4.0B	PCS Mod 4.0B	PCS Mod 4.0B
ANTENNA TYPE	BXA-171085-12BF-EDIN-2	BXA-171085-12BF-EDIN-2	BXA-171085-12BF-EDIN-2
QTY OF ANTENNAS PER FACE	1	1	1
ORIENTATION (DEG)	0	120	240
DOWN TILT (MECH/DEG)	0	0	0
RAD CTR (FT AGL)	137	137	137
TMA - QTY / MODEL			
DIPLEX WITH CELLULAR CABLE			

NUMBER OF CABLE'S NEEDED						**Fiber Lines Model number**			
TOTAL # FIBER LINES	1	TOTAL # OF MAINLINES			12	FIBER LINE MODEL #			HB158-1-08U8-S8J18
TOTAL # TOP JUMPERS	3	TOTAL # OF TOP JUMPERS			12	FIBER TOP JUMPER MODEL #			HB114-1-08U4-S4J18
Equipment Cable Ordering		**MAIN CABLE**	12	+	0	**TOP JUMPER #**	12	+	

TX / RX FREQUENCIES			**TX POWER OUTPUT**	
Cellular A-Band	**PCS F / AWS-Band**	**700 Mhz C - B**	Cellular (Watts)	20
TX - 869-880,890-891.5 MHz	TX - 1970-1975 / 2145-21	TX - 746-757	PCS (Watts)	16
RX - 824-835,845-846.5 MHz	RX - 1890-1895 / 1745-17	RX - 776-787	LTE/ AWS (Watts)	40

ALPHA				**BETA**				**GAMMA**			
Ant.	Freq.	Func.	Color Code	Ant.	Freq.	Func.	Color Code	Ant.	Freq.	Func.	Color Code
A1-A	800	Tx1/Rx0	RED	A5-A	800	Tx2/Rx0	BLUE	A9-A	800	Tx3/Rx0	GREEN
A1-B	1900	Tx1/Rx0	RED/ WHITE	A5-B	1900	Tx2/Rx0	BLUE/ WHITE	A9-B	1900	Tx3/Rx0	GREEN/WHITE
A2	700	Tx1/Rx0	RED/ ORANGE	A6	700	Tx2/Rx0	BLUE/ ORANGE	A10	700	Tx3/Rx0	GREEN/ORANGE
A3	700	Tx4/Rx1	RED/RED/ ORANGE	A7	700	Tx5/Rx1	BLUE/BLUE/OR ANGE	A11	700	Tx6/Rx1	GREEN/GREEN/ORANGE
A4-B	1900	Tx4/Rx1	RED/RED/ WHITE	A8-B	1900	Tx5/Rx1	BLUE/BLUE/WH ITE	A12-B	1900	Tx6/Rx1	GREEN/GREEN/WHITE
A4-A	800	Tx4/Rx1	RED/RED	A8-A	800	Tx5/Rx1	BLUE/BLUE	A12-A	800	Tx6/Rx1	GREEN/GREEN
F1-A	1700	Tx/Rx	RED/ BROWN	F1-B	1700	Tx/Rx	BLUE/BROWN	F1-C	1700	Tx/Rx	GREEN/BROWN
F1-D	1700	Tx/Rx	RED/RED/ BROWN	F1-E	1700	Tx/Rx	BLUE/BLUE/BR OWN	F1-F	1700	Tx/Rx	GREEN/GREEN/BROWN

RF ENGINEER	**RF MANAGER**	**INITIALS**	**DATE**
Prepared By: Mark Brauer	Robert Hesselbach	MB	11/20/2013

Alcatel·Lucent

Alcatel-Lucent RRH2x40-AWS

REMOTE RADIO HEAD

The Alcatel-Lucent RRH2x40-AWS is a high-power, small form-factor Remote Radio Head (RRH) operating in the AWS frequency band (1700/2100MHz - 3GPP Band 4). The Alcatel-Lucent RRH2x40-AWS is designed with an eco-efficient approach, providing operators with the means to achieve high quality and capacity coverage with minimum site requirements.

A distributed eNodeB expands deployment options by using two components, a Base Band Unit (BBU) containing the digital assets and a separate RRH containing the radio-frequency (RF) elements. This modular design optimizes available space and allows the main components of an eNodeB to be installed separately, within the same site or several kilometres apart.

The Alcatel-Lucent RRH2x40-AWS is linked to the BBU by an optical-fiber connection carrying downlink and uplink digital radio signals along with operations, administration and maintenance (OA&M) information. The Alcatel-Lucent RRH2x40-AWS has two transmit RF paths, 40 W RF output power per transmit path, and is designed to manage up to four-way receive diversity. The device is ideally suited to support macro coverage, with multiple-input multiple-output (MIMO) 2x2 operation in up to 20 MHz of bandwidth.

The Alcatel-Lucent RRH2x40-AWS is designed to make available all the benefits of a distributed eNodeB, with excellent RF characteristics, with low capital expenditures (CAPEX) and low operating expenditures (OPEX). The limited space available in some sites may prevent the installation of traditional single-cabinet BTS equipment or require costly cranes to be employed, leaving coverage holes. However, many of these sites can host an Alcatel-Lucent RRH2x40-AWS installation, providing more flexible site selection and improved network quality along with greatly reduced installation time and costs.

Fast, low-cost installation and deployment

The Alcatel-Lucent RRH2x40-AWS is a zero-footprint solution and operates noise-free, simplifying negotiations with site property owners and minimizing environmental impacts. Installation can easily be done by a single person because the Alcatel-Lucent RRH2x40-AWS is compact and weighs less than 20 kg (44 lb), eliminating the need for a crane to hoist the BTS cabinet to the rooftop. A site can be in operation in less than one day — a fraction of the time required for a traditional BTS.

Excellent RF performance

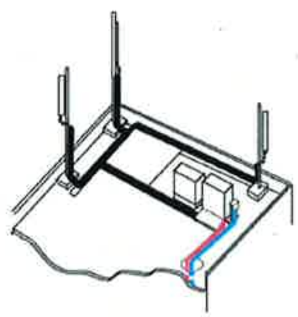
Because of its small size and weight, the Alcatel-Lucent RRH2x40-AWS can be installed close to the antenna. Operators can therefore locate the Alcatel-Lucent RRH2x40-AWS where RF engineering is deemed ideal, minimizing trade-offs between available sites and RF optimum sites. The RF feeder cost and installation costs are reduced or eliminated, and there is no need for a Tower Mounted Amplifier (TMA) because losses introduced by the RF feeder are greatly reduced. The Alcatel-Lucent RRH2x40-AWS provides more RF power while at the same time consuming less electricity.

Features

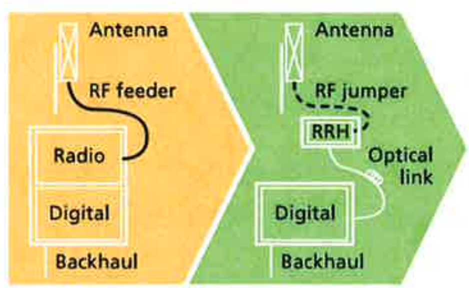
- Zero-footprint deployment
- Easy installation, with a lightweight unit can be carried and set up by one person
- Optimized RF power, with flexible site selection and elimination of a TMA
- Convection-cooled (fanless)
- Noise-free
- Best-in-class power efficiency, with significantly reduced energy consumption

Benefits

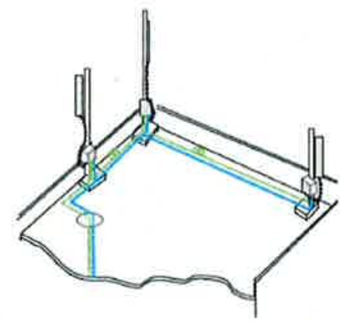
- Leverages existing real estate with lower site costs
- Reduces installation costs, with fewer installation materials and simplified logistics
- Decreases power costs and minimizes environmental impacts, with the potential for eco-sustainable power options
- Improves RF performance and adds flexibility to network planning



Macro



RRH for space-constrained cell sites



Distributed

Technical specifications

Physical dimensions

- Height: 620 mm (24.4 in.)
- Width: 270 mm (10.63 in.)
- Depth: 170m (6.7 in.)
- Weight (without mounting kit): less than 20 kg (44 lb)

Power

- Power supply: -48VDC

Operating environment

- Outdoor temperature range:
  - With solar load: -40°C to +50°C (-40°F to +122°F)
  - Without solar load: -40°C to +55°C (-40°F to +131°F)
- Passive convection cooling (no fans)
- Enclosure protection
  - IP65 (International Protection rating)

RF characteristics

- Frequency band: 1700/2100 MHz (AWS); 3GPP Band 4
- Bandwidth: up to 20 MHz
- RF output power at antenna port: 40 W nominal RF power for each Tx port
- Rx diversity: 2-way or 4-way with optional Rx Diversity module
- Noise figure: below 2.0 dB typical
- Antenna Line Device features
  - TMA and Remote electrical tilt (RET) support via AISG v2.0

Optical characteristics

Type/number of fibers

- Single-mode variant
  - One Single Mode Single Fiber per RRH2x, carrying UL and DL using CWDM
  - Single mode dual fiber (SM/DF)
- Multi-mode variant
  - Two Multi-mode fibers per RRH2x: one carrying UL, the other carrying DL

Optical fiber length

- Up to 500 m (0.31 mi), using MM fiber
- Up to 20 km (12.43 mi), using SM fiber

Digital Ports and Alarms

- Two optical ports to support daisy-chaining
- Six external alarms

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CPG2809100912 (09)

Alcatel·Lucent

Product Data Sheet — DB-B1 and DB-T1 Series

DC and Fiber Management Distribution Boxes for HYBRIFLEX™ Cable

Product Description

The RFS Distribution Box design comes with the option for pluggable over voltage protection (OVP) for up to 6 remote radios and the connection for 6 pairs of optical fiber with LC optical fiber cable management. There is a hybrid cable input with a jumper configuration for power and optical fiber to the remote radio heads (RRHs). A custom wall, a 2-inch pole, and an H-Frame mounting bracket are included. Both the compact and standard design are available with lightening protection.

Features/Benefits

- Designed to accommodate varying diameters of HYBRIFLEX™ (combined power and fiber optic) cables – up to 2 inches
- Supports Single- and Multi-Mode Optical fiber
- NEMA 4x rated enclosure – allows **flexibility for indoor or outdoor installation** on a roof or tower top
- Weatherproof enclosure and ports – **improves system reliability**
- Modular design – makes replacement or addition of OVP easy without removal of other components within the box
- Strikesorb OVP technology – protects equipment from damaging surges up to 60 kA on an 8/20 waveform and up to 5 kA on a 10/350 waveform (certain models only)
- Low residual voltage and high impedance – **ideally suited for RRH technology** – won't shut down the RRH the way spark gap technology does (certain models only)

Technical Specifications

Mechanical Specifications

Model Number	DB-B1-6C-8AB-0Z	DB-T1-6Z-8AB-0Z
Enclosure Design	Standard, 6 OVP's	Standard without OVP
Dimensions - H x W x D, mm (in)	610 x 610 x 254 (24 x 24 x 10)	610 x 610 x 254 (24 x 24 x 10)
Weight, kg (lb)	20 (44)	20 (44)
Suppression Connection Method	Compression lug, #2-#14 AWG Copper, #2-#12 Aluminum	
Fiber Connection Method	LC-LC Single- or Multi-mode duplex	
Environmental Rating	NEMA 4x	
Operating Temperature, °C (°F)	-40 to +80 (-40 to +176)	
UV Protection	ISO 4892-2 Method A Xenon-Arc 2160 hrs	

Electrical Specifications

Nominal Operating Voltage	48 VDC	
Nominal Discharge Current (I_n) per UL 1449 3rd Ed	20 kA 8/20 µs	N/A
Maximum Discharge Current (I_{max}) per NEMA LS-1	60 kA 8/20 µs	N/A
Maximum Impulse (Lightning) Current (I_{imp}) per IEC 61643-1	5 kA 10/350 µs	N/A
Maximum Continuous Operating Voltage (U_c)	75 VDC	N/A
Voltage Protection Rating per UL1449 3rd Ed	400 V	N/A
Protection Class as per IEC 61643-1	Class 1	N/A
Strikesorb OVP Compliance	ANSI/UL 1449-3rd Ed	N/A
	IEEE C62.41	N/A
	NEMA LS-1	N/A
	IEC 61643-1	N/A
	IEC 61643-12	N/A
	EN 61643-11	N/A

* This data is provisional and subject to change.

Product Data Sheet HB158-1-08U8-S8J18

HYBRIFLEX™ RRH Hybrid Feeder Cabling Solution, 1-5/8", Single-Mode Fiber

Product Description

RFS' HYBRIFLEX Remote Radio Head (RRH) hybrid feeder cabling solution combines optical fiber and DC power for RRHs in a single lightweight aluminum corrugated cable, making it the world's most innovative solution for RRH deployments.

It was developed to reduce installation complexity and costs at Cellular sites. HYBRIFLEX allows mobile operators deploying an RRH architecture to standardize the RRH installation process and eliminate the need for and cost of cable grounding. HYBRIFLEX combines optical fiber (multi-mode or single-mode) and power in a single corrugated cable. It eliminates the need for junction boxes and can connect multiple RRHs with a single feeder. Standard RFS CELLFLEX® accessories can be used with HYBRIFLEX cable. Both pre-connectorized and on-site options are available.

Features/Benefits

- Aluminum corrugated armor with outstanding bending characteristics – **minimizes installation time and enables mechanical protection and shielding**
- Same accessories as 1 5/8" coaxial cable
- Outer conductor grounding – **Eliminates typical grounding requirements and saves on installation costs**
- Lightweight solution and compact design – **Decreases tower loading**
- Robust cabling – **Eliminates need for expensive cable trays and ducts**
- Installation of tight bundled fiber optic cable pairs directly to the RRH – **Reduces CAPEX and wind load by eliminating need for interconnection**
- Optical fiber and power cables housed in single corrugated cable – **Saves CAPEX by standardizing RRH cable installation and reducing installation requirements**
- Outdoor polyethylene jacket – **Ensures long-lasting cable protection**

Figure 1: HYBRIFLEX Series

Technical Specifications

Structure

Outer Conductor Armor:	Corrugated Aluminum	[mm (in)]	46.5 (1.83)
Jacket:	Polyethylene, PE	[mm (in)]	50.3 (1.98)
UV-Protection:	Individual and External Jacket		Yes

Mechanical Properties

Weight, Approximate	[kg/m (lb/ft)]	1.9 (1.30)
Minimum Bending Radius, Single Bending	[mm (in)]	200 (8)
Minimum Bending Radius, Repeated Bending	[mm (in)]	500 (20)
Recommended/Maximum Clamp Spacing	[m (ft)]	1.0 / 1.2 (3.25 / 4.0)

Electrical Properties

DC-Resistance Outer Conductor Armor	[Ω/km (Ω/1000ft)]	068 (0.205)
DC-Resistance Power Cable, 8.4mm² (8AWG)	[Ω/km (Ω/1000ft)]	2.1 (0.307)

Fiber Optic Properties

Version		Single-mode OM3
Quantity, Fiber Count		16 (8 pairs)
Core/Clad	[μm]	50/125
Primary Coating (Acrylate)	[μm]	245
Buffer Diameter, Nominal	[μm]	900
Secondary Protection, Jacket, Nominal	[mm (in)]	2.0 (0.08)
Minimum Bending Radius	[mm (in)]	104 (4.1)
Insertion Loss @ wavelength 850nm	dB/km	3.0
Insertion Loss @ wavelength 1310nm	dB/km	1.0
Standards (Meets or exceeds)		UL94-V0, UL1666 RoHS Compliant

DC Power Cable Properties

Size (Power)	[mm² (AWG)]	8.4 (8)
Quantity, Wire Count (Power)		16 (8 pairs)
Size (Alarm)	[mm² (AWG)]	0.8 (18)
Quantity, Wire Count (Alarm)		4 (2 pairs)
Type		UV protected
Strands		19
Primary Jacket Diameter, Nominal	[mm (in)]	6.8 (0.27)
Standards (Meets or exceeds)		NFPA 130, ICEA S-95-658 UL Type XHHW-2, UL 44 UL-LS Limited Smoke, UL VW-1 IEEE-383 (1974), IEEE1202/FT4 RoHS Compliant

Environment

Installation Temperature	[°C (°F)]	-40 to +65 (-40 to149)
Operation Temperature	[°C (°F)]	-40 to +65 (-40 to149)

* This data is provisional and subject to change.

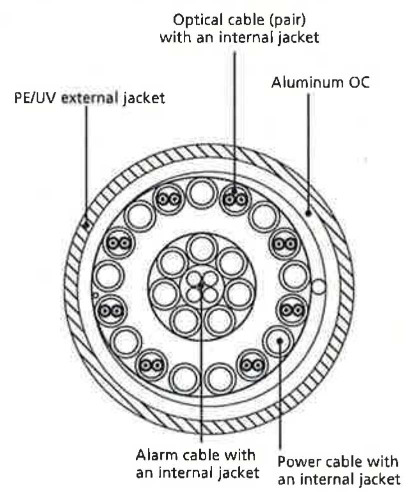

Figure 2: Construction Detail