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May 2, 2014

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

Re: **Notice of Exempt Modification – Facility Modification**
347 Riverside Drive, Thompson, Connecticut

Dear Ms. Bachman:

Cellco Partnership d/b/a Verizon Wireless ("Cellco") currently maintains twelve (12) antennas at the 137-foot level of the existing 140-foot tower at 347 Riverside Drive in Thompson, Connecticut (the "Property"). The tower is owned by MCF Communications. The Council approved Cellco's use of this tower in 2008. Cellco now intends to replace six (6) of its existing antennas with three (3) model BXA-70063-6CF, 850 MHz and three (3) model WBX065X19x050, 2100 MHz antennas, all at the same 137-foot level on the tower. Cellco also intends to install three (3) remote radio heads ("RRHs") behind its 2100 MHz antennas and one (1) HYBRIFLEX™ antenna cable inside the monopole. Included in Attachment 1 are specifications for Cellco's replacement antennas, 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, First Selectman of the Town of Thompson. A copy of this letter is also being sent to Rene B. and Mary V. Santerre, the owners of the Property.

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

1. The proposed modifications will not result in an increase in the height of the existing tower. Cellco's six (6) replacement antennas and RRHs will be located at the 137-foot level on the 140-foot 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 replacement antennas 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 behind 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
Rene B. and Mary V. Santerre
Sandy M. Carter

ATTACHMENT 1

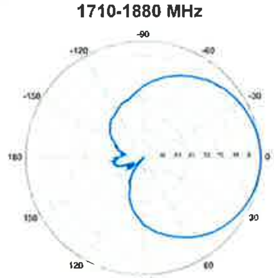
Amphenol ANTENNA SOLUTIONS

WBX065X19x050

X-Pol | VET Panel | 65° | 19.0 dBi

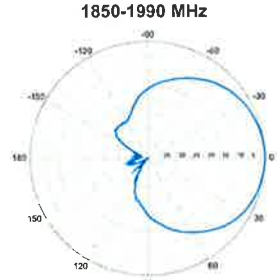
Ordering Options			
When ordering, replace "x" in the model number with the options below.			
WBX065X19M050	Antenna with Manual Electrical Tilt (MET)		
WBX065X19R050	Antenna with Remote Electrical Tilt (RET) for AISG v1.1		
WBX065X19R050G	Antenna with Remote Electrical Tilt (RET) for AISG v2.0/3GPP		
Electrical Characteristics	1710-2170 MHz		
Frequency bands	1710-1880 MHz	1850-1990 MHz	1900-2170 MHz
Polarization	±45°	±45°	±45°
Horizontal beamwidth	69°	66°	63°
Vertical beamwidth	4.9°	4.6°	4.3°
Gain	15.9 dBd / 18.0 dBi	16.4 dBd / 18.5 dBi	16.9 dBd / 19.0 dBi
Electrical downtilt	2-10° Variable Electrical Tilt		
Impedance	50Ω		
VSWR	< 1.35:1		
Upper sidelobe suppression	< -18 dB		
First null	> -20 dB typical		
Front-to-back ratio	> 25 dB		
Inter-port isolation	> 30 dB		
IM3 (2x20W carrier)	< -153 dBc		
Input power	2 x 160W		
Connector(s)	2 Ports / 7/16 DIN / Female / Bottom		
Operating temperature	-40° to +60° C / -40° to +140° F		
Mechanical Characteristics			
Dimensions Length x Width x Depth	1950 x 157 x 69 mm	76.8 x 6.2 x 2.7 in	
Weight without mounting brackets	9.5 kg	20.9 lbs	
Survival wind speed	241 km/hr	150 mph	
Wind load @ 161 km/hr (100 mph)	Front: 405 N Side: 176 N	Front: 91 lbf Side: 40 lbf	
RET type / Part number	Internal / RETU-CA01		
Mounting Options	Part Number	Fits Pipe Diameter	Weight
Pole mounting bracket kit	MKS05P01	40-115 mm 1.6-4.5 in	2.9 kg 6.5 lbs
Scissor tilt bracket kit	MKS05T03	40-115 mm 1.6-4.5 in	4.1 kg 9.1 lbs
Bar tilt bracket kit	MKS05T04	40-115 mm 1.6-4.5 in	4.0 kg 8.8 lbs
Concealment Options			
UNICELL module	UNX14-19	UNX20-19	
Azimuth swivel	±30°	±30°	
Elevation tilt	Fixed	Fixed	
Required mounting kit	UNX14-WBX-AZ	UNX20-WBX-AZ	

1710-1880 MHz



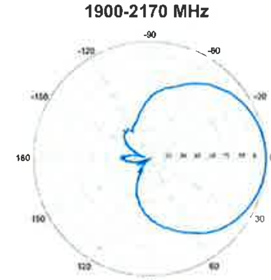
Horizontal

1850-1990 MHz



Horizontal

1900-2170 MHz



Horizontal

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

BXA-70063-6CF-EDIN-X

X-Pol | FET Panel | 63° | 14.5 dBd

Replace "X" with desired electrical downtilt.

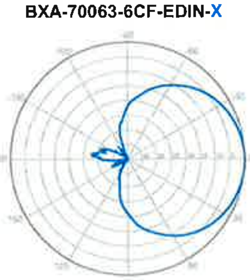
Antenna is also available with NE connector(s). Replace "EDIN" with "NE" in the model number when ordering.

Electrical Characteristics	696-900 MHz	
Frequency bands	696-806 MHz	806-900 MHz
Polarization	±45°	
Horizontal beamwidth	65°	63°
Vertical beamwidth	13°	11°
Gain	14.0 dBd (16.1 dBi)	14.5 dBd (16.6 dBi)
Electrical downtilt (X)	0, 2, 3, 4, 5, 6, 8, 10	
Impedance	50Ω	
VSWR	≤1.35:1	
Upper sidelobe suppression (0°)	-18.3 dB	-18.2 dB
Front-to-back ratio (+/-30°)	-33.4 dB	-36.3 dB
Null fill	5% (-26.02 dB)	
Isolation between ports	< -25 dB	
Input power with EDIN connectors	500 W	
Input power with NE connectors	300 W	
IM3 (2x20W carriers)	< -153 dBc	
Lightning protection	Direct Ground	
Connector(s)	2 Ports / EDIN or NE / Female / Center (Back)	

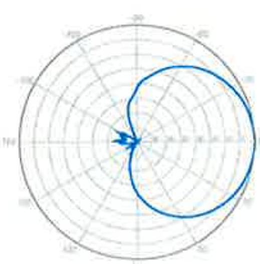
Mechanical Characteristics		
Dimensions Length x Width x Depth	1804 x 285 x 132 mm	71.0 x 11.2 x 5.2 in
Depth with z-brackets	172 mm	6.8 in
Weight without mounting brackets	7.9 kg	17 lbs
Survival wind speed	> 201 km/hr	> 125 mph
Wind area	Front: 0.51 m² Side: 0.24 m²	Front: 5.5 ft² Side: 2.6 ft²
Wind load @ 161 km/hr (100 mph)	Front: 759 N Side: 391 N	Front: 169 lbf Side: 89 lbf

Mounting Options	Part Number	Fits Pipe Diameter	Weight
3-Point Mounting & Downtilt Bracket Kit	36210008	40-115 mm 1.57-4.5 in	6.9 kg 15.2 lbs
Concealment Configurations	For concealment configurations, order BXA-70063-6CF-EDIN-X-FP		

BXA-70063-6CF-EDIN-X

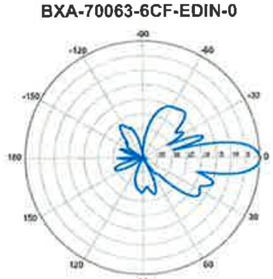


Horizontal | 750 MHz

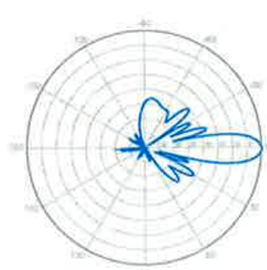


Horizontal | 850 MHz

BXA-70063-6CF-EDIN-0

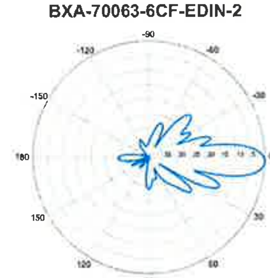


0° | Vertical | 750 MHz

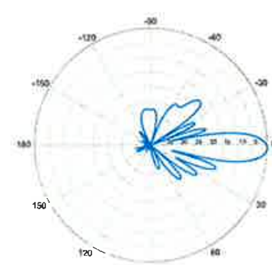


0° | Vertical | 850 MHz

BXA-70063-6CF-EDIN-2



2° | Vertical | 750 MHz



2° | Vertical | 850 MHz

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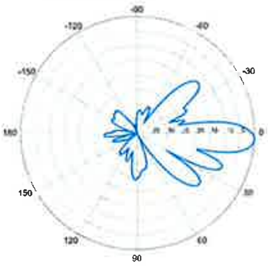
Amphenol ANTENNA SOLUTIONS

BXA-70063-6CF-EDIN-X

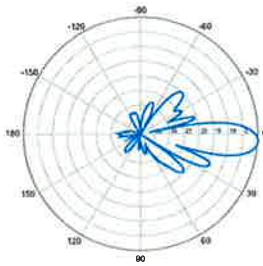
X-Pol | FET Panel | 63° | 14.5 dBd

BXA-70063-6CF-EDIN-3



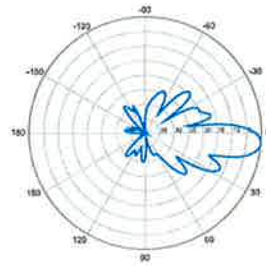
3° | Vertical | 750 MHz

BXA-70063-6CF-EDIN-4

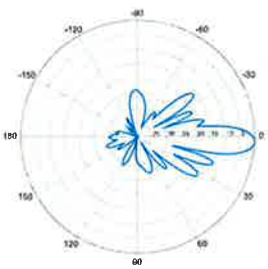


4° | Vertical | 750 MHz

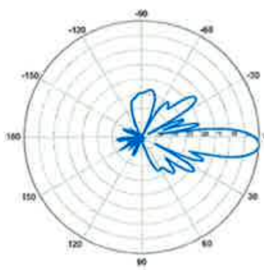
BXA-70063-6CF-EDIN-5



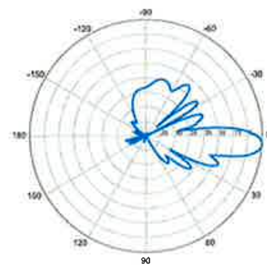
5° | Vertical | 750 MHz



3° | Vertical | 850 MHz

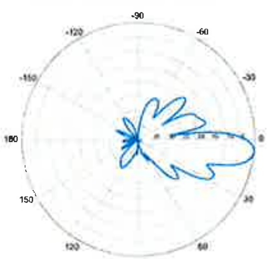


4° | Vertical | 850 MHz



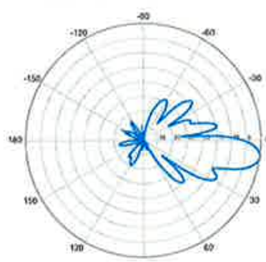
5° | Vertical | 850 MHz

BXA-70063-6CF-EDIN-6



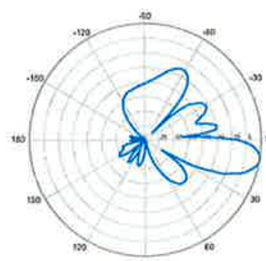
6° | Vertical | 750 MHz

BXA-70063-6CF-EDIN-8

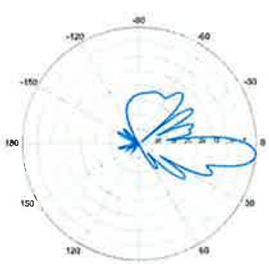


8° | Vertical | 750 MHz

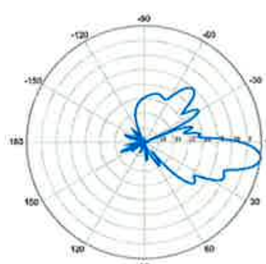
BXA-70063-6CF-EDIN-10



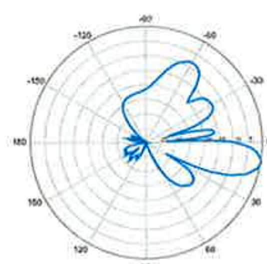
10° | Vertical | 750 MHz



6° | Vertical | 850 MHz



8° | Vertical | 850 MHz



10° | Vertical | 850 MHz

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

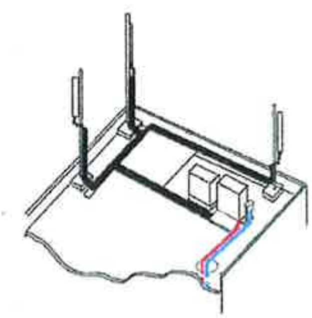
Because of its small size and weight, the Alcatel-Lucent RRH2x40-AWS can be installed close to the antenna. Operators can therefore locate the Alcatel-Lucent RRH2x40-AWS where RF engineering is deemed ideal, minimizing trade-offs between available sites and RF optimum sites. The RF feeder cost and installation 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

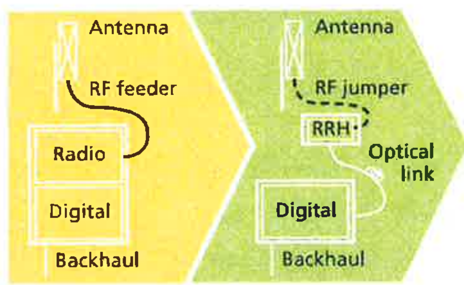
- Zero-footprint deployment
- Easy installation, with a lightweight unit can be carried and set up by one person
- Optimized RF power, with flexible site selection and elimination of a TMA
- Convection-cooled (fanless)
- Noise-free
- Best-in-class power efficiency, with significantly reduced energy consumption

Benefits

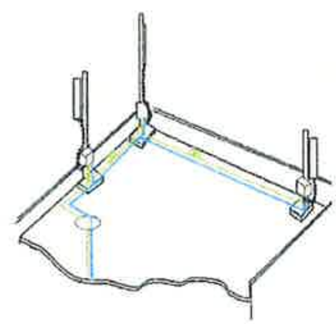
- Leverages existing real estate with lower site costs
- Reduces installation costs, with fewer installation materials and simplified logistics
- Decreases power costs and minimizes environmental impacts, with the potential for eco-sustainable power options
- Improves RF performance and adds flexibility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

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

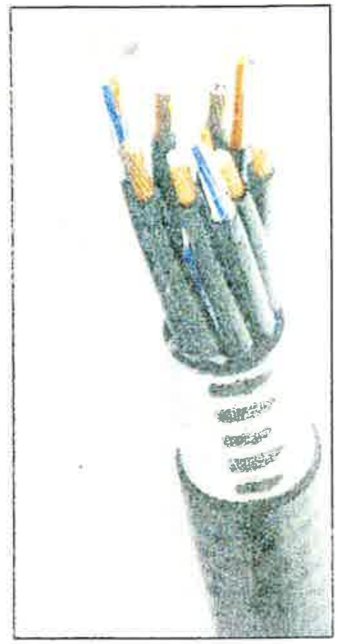


Figure 1: HYBRIFLEX Series

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

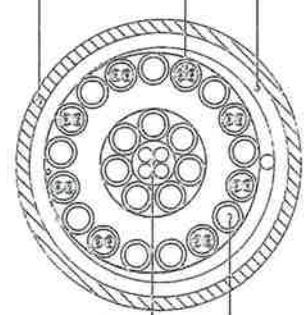


Figure 2: Construction Detail

ATTACHMENT 2

Site Name: Thompson 2, CT
Cumulative Power Density

Operator	Operating Frequency	Number of Trans.	ERP Per Trans.	Total ERP	Distance to Target	Calculated Power Density	Maximum Permissable Exposure*	Fraction of MPE
	(MHz)		(watts)	(watts)	(feet)	(mW/cm^2)	(mW/cm^2)	(%)
VZW PCS	1970	11	421	4632.044	137	0.0888	1.0	8.88%
VZW Cellular	869	9	393	3540.312	137	0.0678	0.579333333	11.71%
VZW AWS	2145	1	1750	1750	137	0.0335	1.0	3.35%
VZW 700	746	1	1050	1050	137	0.0201	0.497333333	4.05%
Total Percentage of Maximum Permissible Exposure								27.98%

*Guidelines adopted by the FCC on August 1, 1996, 47 CFR Part 1 based on NCRP Report 86, 1986 and generally on ANSI/IEEE C95.1-1992

MHz = Megahertz
mW/cm^2 = milliwatts per square centimeter
ERP = Effective Radiated Power

Absolute worst case maximum values used.

ATTACHMENT 3

CENTEK engineering

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Structural Analysis Report

139-ft Existing Nudd Monopole

Proposed Verizon Wireless
Antenna Upgrade

Verizon Site Ref: Thompson 2

347 Riverside Drive
Thompson, CT

Centek Project No. 14001.044

Date: April 24, 2014

Prepared for:

Verizon Wireless
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East Hartford, CT 06108

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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 Thompson, CT.

The host tower is a 139-ft tall, six-section, eighteen sided, tapered monopole, originally designed by DaVinci Engineering Inc. job no; 08243-1920 and manufactured by Fred A. Nudd Corporation.; job no; 208-13265, dated December 30, 2008. The tower geometry, structure member sizes and foundation system information were obtained from the aforementioned design documents.

Antenna and appurtenance information were obtained from a Verizon RF data sheet.

The tower is made up of six (6) tapered vertical sections consisting of A572-65 pole sections. The vertical tower sections are connected by a combination of full pen welds, slip joint connections and flange connections. The diameter of the pole (flat-flat) is 24.00-in at the top and 55.625-in at the base.

Verizon proposes the replacement of six (6) of the existing twelve (12) panel antennas and the installation of three (3) remote radio heads and one (1) main 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:

- VERIZON (EXISTING TO REMAIN):
  Antennas: Three (3) Antel BXA-70063-6CF panel antennas, three (3) Antel BXA-185063/12CF panel antennas, six (6) RFS FD9R6004/2C-3L diplexers mounted on an existing low profile platform with a RAD center elevation of 137-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) Antel LPA-80063-6CF panel antennas mounted on an existing low profile platform with a RAD center elevation of 137-ft above grade.

- **VERIZON (PROPOSED):**
  Antennas: Three (3) Antel WBX065X19 panel antennas, three (3) Antel BXA-70063-6CF panel antennas, 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 137-ft above grade.
  Coax Cables: One (1) 1-5/8" ∅ fiber cables running on the inside of the existing tower.

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]*
	Thompson; v = 100mph (3 second gust) equivalent to v = 85 mph (fastest mile)	*[Appendix K of the 2005 CT Building Code Supplement]*
	TIA/EIA-222-F and Appendix-K wind speeds are equal.	
Load Cases:	<u>Load Case 1</u>; 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]*
	<u>Load Case 2</u>; 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]*
	<u>Load Case 3</u>; 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 2009 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 **30.1%** of its total capacity.

Tower Section	Elevation	Stress Ratio (percentage of capacity)	Result
Pole Shaft (L1)	114.00'-139.00'	22.7%	**PASS**
Pole Shaft (L2)	89.00'-114.00'	26.0%	**PASS**
Pole Shaft (L3)	80.00'-89.00'	25.9%	**PASS**
Pole Shaft (L4)	69.00'-80.00'	24.0%	**PASS**
Pole Shaft (L5)	44.00'-69.00'	27.5%	**PASS**
Pole Shaft (L6)	0.00'-44.00'	30.1%	**PASS**

Foundation and Anchors

The existing foundation consists of a 7.0-ft square x 2.5-ft long reinforced concrete pier on a 28.0-ft square x 3.0-ft thick reinforced concrete pad. The sub-grade conditions used in the analysis of the existing foundation were obtained from the aforementioned design calculations by DaVinci Engineering Inc. job no; 08243-1920. The base of the tower is connected to the foundation by means of (18) 2.00"∅, ASTM F1554 anchor bolts embedded approximately 5-ft into the concrete foundation structure.

- 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	15 kips
	Compression	27 kips
	Moment	1329 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	5.98	**PASS**

Note 1: FS denotes Factor of Safety.

Note 2: OTM denotes Overturning Moment

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

Tower Component	Design Limit	Stress Ratio (percentage of capacity)	Result
Flange Bolts	Tension	35.0%	**PASS**
Flange Plate	Bending	18.2%	**PASS**

- 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	28.0%	**PASS**
Base Plate	Bending	19.3%	**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

Prepared by:

Timothy J. Lynn, PE
Structural 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 provide 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

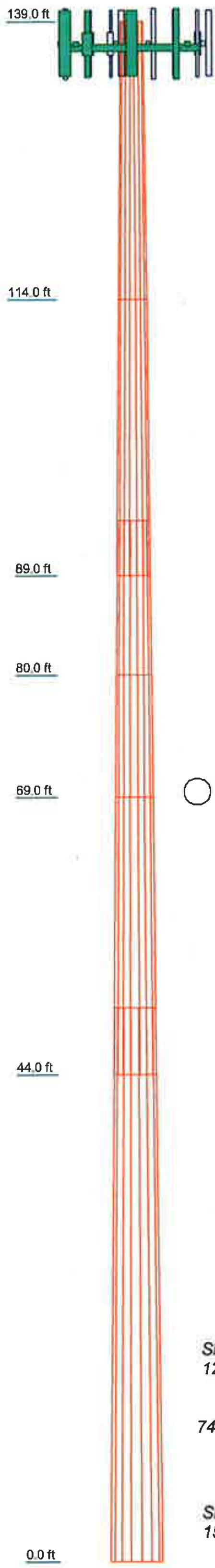
tnxTower, is an integrated structural analysis and design software package for Designed specifically for the telecommunications industry, tnxTower, formerly ERITower, automates much of the tower analysis and design required by the TIA/EIA 222 Standard.

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	6	5	4	3	2	1
Length (ft)	50.000	25.000	11.000	14.000	25.000	25.000
Number of Sides	18	18	18	18	18	18
Thickness (in)	0.438	0.375	0.375	0.313	0.250	0.188
Socket Length (ft)		6.000			5.000	
Top Dia (in)	43.715	40.000	37.375	34.125	29.875	24.000
Bot Dia (in)	55.625	45.875	40.000	37.375	35.813	29.875
Grade	A572-65					
Weight (K)	11.6	4.3	1.7	1.7	2.2	1.4

	Total
Weight (K)	22.9



DESIGNED APPURTENANCE LOADING

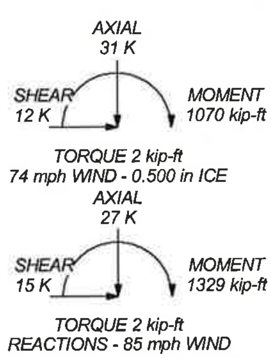
TYPE	ELEVATION
BXA-70063/6CF (Verizon - Proposed)	137
BXA-185063/12CF (Verizon - Existing)	137
BXA-70063/6CF (Verizon - Existing)	137
WBX065X19 (Verizon - Proposed)	137
BXA-70063/6CF (Verizon - Proposed)	137
BXA-185063/12CF (Verizon - Existing)	137
BXA-70063/6CF (Verizon - Existing)	137
WBX065X19 (Verizon - Proposed)	137
BXA-70063/6CF (Verizon - Proposed)	137
BXA-185063/12CF (Verizon - Existing)	137
BXA-70063/6CF (Verizon - Existing)	137
WBX065X19 (Verizon - Proposed)	137
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	137
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	137
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	137
RRH2x40-AWS (Verizon - Proposed)	137
RRH2x40-AWS (Verizon - Proposed)	137
RRH2x40-AWS (Verizon - Proposed)	137
DB-T1-6Z-8AB-0Z (Verizon - Proposed)	137
EEI 14-ft Low Profile Platform (Verizon - Existing)	137

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: 30.1%



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

Job: **14001.044 - Thompson 2**		
Project: **139-ft Nudd Monopole - 347 Riverside Dr., Thompson, CT**		
Client: Verizon Wireless	Drawn by: TJL	App'd:
Code: TIA/EIA-222-F	Date: 04/24/14	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	139.000-114.000	25.000	0.000	18	24.000	29.875	0.188	0.750	A572-65 (65 ksi)
L2	114.000-89.000	25.000	5.000	18	29.875	35.813	0.250	1.000	A572-65 (65 ksi)
L3	89.000-80.000	14.000	0.000	18	34.125	37.375	0.313	1.250	A572-65 (65 ksi)

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
L4	80.000-69.000	11.000	0.000	18	37.375	40.000	0.375	1.500	A572-65 (65 ksi)
L5	69.000-44.000	25.000	6.000	18	40.000	45.875	0.375	1.500	A572-65 (65 ksi)
L6	44.000-0.000	50.000		18	43.715	55.625	0.438	1.750	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in^2	I in^4	r in	C in	I/C in^3	J in^4	It/Q in^2	w in	w/t
L1	24.370	14.171	1015.221	8.453	12.192	83.269	2031.778	7.087	3.894	20.768
	30.336	17.668	1967.282	10.539	15.177	129.627	3937.152	8.836	4.928	26.283
L2	30.336	23.507	2606.510	10.517	15.177	171.746	5216.450	11.756	4.818	19.272
	36.365	28.219	4508.993	12.625	18.193	247.842	9023.919	14.112	5.863	23.452
L3	35.830	33.538	4844.419	12.004	17.336	279.447	9695.211	16.772	5.456	17.459
	37.952	36.761	6379.675	13.157	18.986	336.011	12767.744	18.384	6.028	19.29
L4	37.952	44.039	7616.945	13.135	18.986	401.177	15243.912	22.024	5.918	15.781
	40.617	47.164	9355.855	14.067	20.320	460.426	18724.020	23.586	6.380	17.013
L5	40.617	47.164	9355.855	14.067	20.320	460.426	18724.020	23.586	6.380	17.013
	46.583	54.156	14164.780	16.153	23.305	607.813	28348.198	27.083	7.414	19.771
L6	45.841	60.096	14220.305	15.364	22.207	640.346	28459.322	30.054	6.924	15.826
	56.483	76.635	29487.951	19.592	28.258	1043.544	59014.703	38.325	9.020	20.617

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 139.000-114.000				1	1	1		
L2 114.000-89.000				1	1	1		
L3 89.000-80.000				1	1	1		
L4 80.000-69.000				1	1	1		
L5 69.000-44.000				1	1	1		
L6 44.000-0.000				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
1 5/8 (Verizon - Existing)	B	No	Inside Pole	137.000 - 3.000	12	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
HYBRIFLEX 1-5/8"	B	No	Inside Pole	137.000 - 3.000	1	No Ice	0.000	0.002

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft²/ft	Weight klf
(Verizon - Proposed)						1/2" Ice	0.000	0.002

Feed Line/Linear Appurtenances Section Areas

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
L1	139.000-114.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.331
		C	0.000	0.000	0.000	0.000	0.000
L2	114.000-89.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.359
		C	0.000	0.000	0.000	0.000	0.000
L3	89.000-80.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.129
		C	0.000	0.000	0.000	0.000	0.000
L4	80.000-69.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.158
		C	0.000	0.000	0.000	0.000	0.000
L5	69.000-44.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.359
		C	0.000	0.000	0.000	0.000	0.000
L6	44.000-0.000	A	0.000	0.000	0.000	0.000	0.000
		B	0.000	0.000	0.000	0.000	0.590
		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	139.000-114.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.331
		C		0.000	0.000	0.000	0.000	0.000
L2	114.000-89.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.359
		C		0.000	0.000	0.000	0.000	0.000
L3	89.000-80.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.129
		C		0.000	0.000	0.000	0.000	0.000
L4	80.000-69.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.158
		C		0.000	0.000	0.000	0.000	0.000
L5	69.000-44.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.359
		C		0.000	0.000	0.000	0.000	0.000
L6	44.000-0.000	A	0.500	0.000	0.000	0.000	0.000	0.000
		B		0.000	0.000	0.000	0.000	0.590
		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*
BXA-70063/6CF (Verizon - Proposed)	A	From Face	3.500 6.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
BXA-185063/12CF (Verizon - Existing)	A	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	4.791 5.242	3.618 4.058	0.015 0.042
BXA-70063/6CF (Verizon - Existing)	A	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
WBX065X19 (Verizon - Proposed)	A	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	5.223 5.699	2.880 3.502	0.025 0.051
BXA-70063/6CF (Verizon - Proposed)	B	From Face	3.500 6.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
BXA-185063/12CF (Verizon - Existing)	B	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	4.791 5.242	3.618 4.058	0.015 0.042
BXA-70063/6CF (Verizon - Existing)	B	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
WBX065X19 (Verizon - Proposed)	B	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	5.223 5.699	2.880 3.502	0.025 0.051
BXA-70063/6CF (Verizon - Proposed)	C	From Face	3.500 6.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
BXA-185063/12CF (Verizon - Existing)	C	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	4.791 5.242	3.618 4.058	0.015 0.042
BXA-70063/6CF (Verizon - Existing)	C	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	7.731 8.268	4.158 4.595	0.017 0.059
WBX065X19 (Verizon - Proposed)	C	From Face	3.500 4.000 0.000	0.000	137.000	No Ice 1/2" Ice	5.223 5.699	2.880 3.502	0.025 0.051
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	A	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	0.367 0.451	0.085 0.136	0.003 0.005
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	B	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	0.367 0.451	0.085 0.136	0.003 0.005
(2) FD9R6004/2C-3L Diplexer (Verizon - Existing)	C	From Face	3.500 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	0.367 0.451	0.085 0.136	0.003 0.005
RRH2x40-AWS (Verizon - Proposed)	A	From Face	3.500 4.000 0.000	0.000	137.000	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	137.000	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	137.000	No Ice 1/2" Ice	2.522 2.753	1.589 1.795	0.044 0.061
DB-T1-6Z-8AB-0Z (Verizon - Proposed)	A	From Face	3.500 0.000	0.000	137.000	No Ice 1/2" Ice	5.600 5.915	2.333 2.558	0.044 0.080

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
EEI 14-ft Low Profile Platform (Verizon - Existing)	C	From Face	0.000 2.000 0.000 0.000	0.000	137.000	No Ice 1/2" Ice	16.500 20.000	16.500 20.000	1.550 1.800

Tower Pressures - No Ice

$G_H = 1.690$

Section Elevation ft	z ft	K_Z	q_z ksf	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 139.000-114.000	126.046	1.467	0.027	56.120	A	0.000	56.120	56.120	100.00	0.000	0.000
					B	0.000	56.120		100.00	0.000	0.000
					C	0.000	56.120		100.00	0.000	0.000
L2 114.000-89.000	101.123	1.377	0.025	68.425	A	0.000	68.425	68.425	100.00	0.000	0.000
					B	0.000	68.425		100.00	0.000	0.000
					C	0.000	68.425		100.00	0.000	0.000
L3 89.000-80.000	84.457	1.308	0.024	27.248	A	0.000	27.248	27.248	100.00	0.000	0.000
					B	0.000	27.248		100.00	0.000	0.000
					C	0.000	27.248		100.00	0.000	0.000
L4 80.000-69.000	74.438	1.262	0.023	35.464	A	0.000	35.464	35.464	100.00	0.000	0.000
					B	0.000	35.464		100.00	0.000	0.000
					C	0.000	35.464		100.00	0.000	0.000
L5 69.000-44.000	56.215	1.164	0.022	89.453	A	0.000	89.453	89.453	100.00	0.000	0.000
					B	0.000	89.453		100.00	0.000	0.000
					C	0.000	89.453		100.00	0.000	0.000
L6 44.000-0.000	21.237	1	0.018	184.744	A	0.000	184.744	184.744	100.00	0.000	0.000
					B	0.000	184.744		100.00	0.000	0.000
					C	0.000	184.744		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 ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1 139.000-114.000	126.046	1.467	0.020	0.500	58.203	A	0.000	58.203	58.203	100.00	0.000	0.000
						B	0.000	58.203		100.00	0.000	0.000
						C	0.000	58.203		100.00	0.000	0.000
L2 114.000-89.000	101.123	1.377	0.019	0.500	70.508	A	0.000	70.508	70.508	100.00	0.000	0.000
						B	0.000	70.508		100.00	0.000	0.000
						C	0.000	70.508		100.00	0.000	0.000
L3	84.457	1.308	0.018	0.500	27.998	A	0.000	27.998	27.998	100.00	0.000	0.000

Section Elevation ft	z ft	K_Z	q_z ksf	t_Z in	A_G ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
89.000-80.000						B	0.000	27.998		100.00	0.000	0.000
						C	0.000	27.998		100.00	0.000	0.000
L4	74.438	1.262	0.018	0.500	36.380	A	0.000	36.380	36.380	100.00	0.000	0.000
80.000-69.000						B	0.000	36.380		100.00	0.000	0.000
						C	0.000	36.380		100.00	0.000	0.000
L5	56.215	1.164	0.016	0.500	91.536	A	0.000	91.536	91.536	100.00	0.000	0.000
69.000-44.000						B	0.000	91.536		100.00	0.000	0.000
						C	0.000	91.536		100.00	0.000	0.000
L6 44.000-0.000	21.237	1	0.014	0.500	188.410	A	0.000	188.410	188.410	100.00	0.000	0.000
						B	0.000	188.410		100.00	0.000	0.000
						C	0.000	188.410		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 ft^2	Face	A_F ft^2	A_R ft^2	A_{leg} ft^2	Leg %	C_AA_A In Face ft^2	C_AA_A Out Face ft^2
L1	126.046	1.467	0.009	56.120	A	0.000	56.120	56.120	100.00	0.000	0.000
139.000-114.0					B	0.000	56.120		100.00	0.000	0.000
00					C	0.000	56.120		100.00	0.000	0.000
L2	101.123	1.377	0.009	68.425	A	0.000	68.425	68.425	100.00	0.000	0.000
114.000-89.00					B	0.000	68.425		100.00	0.000	0.000
0					C	0.000	68.425		100.00	0.000	0.000
L3	84.457	1.308	0.008	27.248	A	0.000	27.248	27.248	100.00	0.000	0.000
89.000-80.000					B	0.000	27.248		100.00	0.000	0.000
					C	0.000	27.248		100.00	0.000	0.000
L4	74.438	1.262	0.008	35.464	A	0.000	35.464	35.464	100.00	0.000	0.000
80.000-69.000					B	0.000	35.464		100.00	0.000	0.000
					C	0.000	35.464		100.00	0.000	0.000
L5	56.215	1.164	0.007	89.453	A	0.000	89.453	89.453	100.00	0.000	0.000
69.000-44.000					B	0.000	89.453		100.00	0.000	0.000
					C	0.000	89.453		100.00	0.000	0.000
L6	21.237	1	0.006	184.744	A	0.000	184.744	184.744	100.00	0.000	0.000
44.000-0.000					B	0.000	184.744		100.00	0.000	0.000
					C	0.000	184.744		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 ft^2	F K	w klf	Ctrl. Face
L1	0.331	1.354	A	1	0.65	1	1	1	56.120	1.672	0.067	C
139.000-114.0			B	1	0.65	1	1	1	56.120			
00			C	1	0.65	1	1	1	56.120			
L2	0.359	2.200	A	1	0.65	1	1	1	68.425	1.914	0.077	C
114.000-89.00			B	1	0.65	1	1	1	68.425			
0			C	1	0.65	1	1	1	68.425			
L3	0.129	1.675	A	1	0.65	1	1	1	27.248	0.724	0.080	C

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
89.000-80.000			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4	0.158	1.707	A	1	0.65	1	1	1	35.464	0.909	0.083	C
80.000-69.000			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5	0.359	4.310	A	1	0.65	1	1	1	89.453	2.116	0.085	C
69.000-44.000			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6	0.590	11.632	A	1	0.65	1	1	1	184.744	3.754	0.085	C
44.000-0.000			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	731.876 kip-ft	11.090		

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	0.331	1.354	A	1	0.65	1	1	1	56.120	1.672	0.067	C
139.000-114.0			B	1	0.65	1	1	1	56.120			
00			C	1	0.65	1	1	1	56.120			
L2	0.359	2.200	A	1	0.65	1	1	1	68.425	1.914	0.077	C
114.000-89.00			B	1	0.65	1	1	1	68.425			
0			C	1	0.65	1	1	1	68.425			
L3	0.129	1.675	A	1	0.65	1	1	1	27.248	0.724	0.080	C
89.000-80.000			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4	0.158	1.707	A	1	0.65	1	1	1	35.464	0.909	0.083	C
80.000-69.000			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5	0.359	4.310	A	1	0.65	1	1	1	89.453	2.116	0.085	C
69.000-44.000			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6	0.590	11.632	A	1	0.65	1	1	1	184.744	3.754	0.085	C
44.000-0.000			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	731.876 kip-ft	11.090		

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	0.331	1.354	A	1	0.65	1	1	1	56.120	1.672	0.067	C
139.000-114.0			B	1	0.65	1	1	1	56.120			
00			C	1	0.65	1	1	1	56.120			
L2	0.359	2.200	A	1	0.65	1	1	1	68.425	1.914	0.077	C

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
114.000-89.00			B	1	0.65	1	1	1	68.425			
0			C	1	0.65	1	1	1	68.425			
L3	0.129	1.675	A	1	0.65	1	1	1	27.248	0.724	0.080	C
89.000-80.000			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4	0.158	1.707	A	1	0.65	1	1	1	35.464	0.909	0.083	C
80.000-69.000			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5	0.359	4.310	A	1	0.65	1	1	1	89.453	2.116	0.085	C
69.000-44.000			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6	0.590	11.632	A	1	0.65	1	1	1	184.744	3.754	0.085	C
44.000-0.000			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	731.876 kip-ft	11.090		

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 *ft²*	F *K*	w *klf*	Ctrl. Face
L1	0.331	1.354	A	1	0.65	1	1	1	56.120	1.672	0.067	C
139.000-114.0			B	1	0.65	1	1	1	56.120			
00			C	1	0.65	1	1	1	56.120			
L2	0.359	2.200	A	1	0.65	1	1	1	68.425	1.914	0.077	C
114.000-89.00			B	1	0.65	1	1	1	68.425			
0			C	1	0.65	1	1	1	68.425			
L3	0.129	1.675	A	1	0.65	1	1	1	27.248	0.724	0.080	C
89.000-80.000			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4	0.158	1.707	A	1	0.65	1	1	1	35.464	0.909	0.083	C
80.000-69.000			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5	0.359	4.310	A	1	0.65	1	1	1	89.453	2.116	0.085	C
69.000-44.000			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6	0.590	11.632	A	1	0.65	1	1	1	184.744	3.754	0.085	C
44.000-0.000			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	731.876 kip-ft	11.090		

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 *ft²*	F *K*	w *klf*	Ctrl. Face
L1	0.331	1.778	A	1	0.65	1	1	1	58.203	1.301	0.052	C

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
139.000-114.0			B	1	0.65	1	1	1	58.203			
00			C	1	0.65	1	1	1	58.203			
L2	0.359	2.715	A	1	0.65	1	1	1	70.508	1.480	0.059	C
114.000-89.00			B	1	0.65	1	1	1	70.508			
0			C	1	0.65	1	1	1	70.508			
L3	0.129	1.879	A	1	0.65	1	1	1	27.998	0.558	0.062	C
89.000-80.000			B	1	0.65	1	1	1	27.998			
			C	1	0.65	1	1	1	27.998			
L4	0.158	1.973	A	1	0.65	1	1	1	36.380	0.699	0.064	C
80.000-69.000			B	1	0.65	1	1	1	36.380			
			C	1	0.65	1	1	1	36.380			
L5	0.359	4.980	A	1	0.65	1	1	1	91.536	1.624	0.065	C
69.000-44.000			B	1	0.65	1	1	1	91.536			
			C	1	0.65	1	1	1	91.536			
L6	0.590	13.013	A	1	0.65	1	1	1	188.410	2.871	0.065	C
44.000-0.000			B	1	0.65	1	1	1	188.410			
			C	1	0.65	1	1	1	188.410			
Sum Weight:	1.927	26.338						OTM	565.036 kip-ft	8.533		

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	0.331	1.778	A	1	0.65	1	1	1	58.203	1.301	0.052	C
139.000-114.0			B	1	0.65	1	1	1	58.203			
00			C	1	0.65	1	1	1	58.203			
L2	0.359	2.715	A	1	0.65	1	1	1	70.508	1.480	0.059	C
114.000-89.00			B	1	0.65	1	1	1	70.508			
0			C	1	0.65	1	1	1	70.508			
L3	0.129	1.879	A	1	0.65	1	1	1	27.998	0.558	0.062	C
89.000-80.000			B	1	0.65	1	1	1	27.998			
			C	1	0.65	1	1	1	27.998			
L4	0.158	1.973	A	1	0.65	1	1	1	36.380	0.699	0.064	C
80.000-69.000			B	1	0.65	1	1	1	36.380			
			C	1	0.65	1	1	1	36.380			
L5	0.359	4.980	A	1	0.65	1	1	1	91.536	1.624	0.065	C
69.000-44.000			B	1	0.65	1	1	1	91.536			
			C	1	0.65	1	1	1	91.536			
L6	0.590	13.013	A	1	0.65	1	1	1	188.410	2.871	0.065	C
44.000-0.000			B	1	0.65	1	1	1	188.410			
			C	1	0.65	1	1	1	188.410			
Sum Weight:	1.927	26.338						OTM	565.036 kip-ft	8.533		

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 139.000-114.000	0.331	1.778	A	1	0.65	1	1	1	58.203	1.301	0.052	C
			B	1	0.65	1	1	1	58.203			
			C	1	0.65	1	1	1	58.203			
L2 114.000-89.000	0.359	2.715	A	1	0.65	1	1	1	70.508	1.480	0.059	C
			B	1	0.65	1	1	1	70.508			
			C	1	0.65	1	1	1	70.508			
L3 89.000-80.000	0.129	1.879	A	1	0.65	1	1	1	27.998	0.558	0.062	C
			B	1	0.65	1	1	1	27.998			
			C	1	0.65	1	1	1	27.998			
L4 80.000-69.000	0.158	1.973	A	1	0.65	1	1	1	36.380	0.699	0.064	C
			B	1	0.65	1	1	1	36.380			
			C	1	0.65	1	1	1	36.380			
L5 69.000-44.000	0.359	4.980	A	1	0.65	1	1	1	91.536	1.624	0.065	C
			B	1	0.65	1	1	1	91.536			
			C	1	0.65	1	1	1	91.536			
L6 44.000-0.000	0.590	13.013	A	1	0.65	1	1	1	188.410	2.871	0.065	C
			B	1	0.65	1	1	1	188.410			
			C	1	0.65	1	1	1	188.410			
Sum Weight:	1.927	26.338						OTM	565.036 kip-ft	8.533		

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 139.000-114.000	0.331	1.778	A	1	0.65	1	1	1	58.203	1.301	0.052	C
			B	1	0.65	1	1	1	58.203			
			C	1	0.65	1	1	1	58.203			
L2 114.000-89.000	0.359	2.715	A	1	0.65	1	1	1	70.508	1.480	0.059	C
			B	1	0.65	1	1	1	70.508			
			C	1	0.65	1	1	1	70.508			
L3 89.000-80.000	0.129	1.879	A	1	0.65	1	1	1	27.998	0.558	0.062	C
			B	1	0.65	1	1	1	27.998			
			C	1	0.65	1	1	1	27.998			
L4 80.000-69.000	0.158	1.973	A	1	0.65	1	1	1	36.380	0.699	0.064	C
			B	1	0.65	1	1	1	36.380			
			C	1	0.65	1	1	1	36.380			
L5 69.000-44.000	0.359	4.980	A	1	0.65	1	1	1	91.536	1.624	0.065	C
			B	1	0.65	1	1	1	91.536			
			C	1	0.65	1	1	1	91.536			
L6 44.000-0.000	0.590	13.013	A	1	0.65	1	1	1	188.410	2.871	0.065	C
			B	1	0.65	1	1	1	188.410			
			C	1	0.65	1	1	1	188.410			
Sum Weight:	1.927	26.338						OTM	565.036 kip-ft	8.533		

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 139.000-114.000	0.331	1.354	A	1	0.65	1	1	1	56.120	0.579	0.023	C
			B	1	0.65	1	1	1	56.120			
			C	1	0.65	1	1	1	56.120			
L2 114.000-89.000	0.359	2.200	A	1	0.65	1	1	1	68.425	0.662	0.026	C
			B	1	0.65	1	1	1	68.425			
			C	1	0.65	1	1	1	68.425			
L3 89.000-80.000	0.129	1.675	A	1	0.65	1	1	1	27.248	0.251	0.028	C
			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4 80.000-69.000	0.158	1.707	A	1	0.65	1	1	1	35.464	0.315	0.029	C
			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5 69.000-44.000	0.359	4.310	A	1	0.65	1	1	1	89.453	0.732	0.029	C
			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6 44.000-0.000	0.590	11.632	A	1	0.65	1	1	1	184.744	1.299	0.030	C
			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	253.244 kip-ft	3.837		

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 139.000-114.000	0.331	1.354	A	1	0.65	1	1	1	56.120	0.579	0.023	C
			B	1	0.65	1	1	1	56.120			
			C	1	0.65	1	1	1	56.120			
L2 114.000-89.000	0.359	2.200	A	1	0.65	1	1	1	68.425	0.662	0.026	C
			B	1	0.65	1	1	1	68.425			
			C	1	0.65	1	1	1	68.425			
L3 89.000-80.000	0.129	1.675	A	1	0.65	1	1	1	27.248	0.251	0.028	C
			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4 80.000-69.000	0.158	1.707	A	1	0.65	1	1	1	35.464	0.315	0.029	C
			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5 69.000-44.000	0.359	4.310	A	1	0.65	1	1	1	89.453	0.732	0.029	C
			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6 44.000-0.000	0.590	11.632	A	1	0.65	1	1	1	184.744	1.299	0.030	C
			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	253.244 kip-ft	3.837		

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 139.000-114.000	0.331	1.354	A	1	0.65	1	1	1	56.120	0.579	0.023	C
			B	1	0.65	1	1	1	56.120			
			C	1	0.65	1	1	1	56.120			
L2 114.000-89.000	0.359	2.200	A	1	0.65	1	1	1	68.425	0.662	0.026	C
			B	1	0.65	1	1	1	68.425			
			C	1	0.65	1	1	1	68.425			
L3 89.000-80.000	0.129	1.675	A	1	0.65	1	1	1	27.248	0.251	0.028	C
			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4 80.000-69.000	0.158	1.707	A	1	0.65	1	1	1	35.464	0.315	0.029	C
			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5 69.000-44.000	0.359	4.310	A	1	0.65	1	1	1	89.453	0.732	0.029	C
			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6 44.000-0.000	0.590	11.632	A	1	0.65	1	1	1	184.744	1.299	0.030	C
			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	253.244 kip-ft	3.837		

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 139.000-114.000	0.331	1.354	A	1	0.65	1	1	1	56.120	0.579	0.023	C
			B	1	0.65	1	1	1	56.120			
			C	1	0.65	1	1	1	56.120			
L2 114.000-89.000	0.359	2.200	A	1	0.65	1	1	1	68.425	0.662	0.026	C
			B	1	0.65	1	1	1	68.425			
			C	1	0.65	1	1	1	68.425			
L3 89.000-80.000	0.129	1.675	A	1	0.65	1	1	1	27.248	0.251	0.028	C
			B	1	0.65	1	1	1	27.248			
			C	1	0.65	1	1	1	27.248			
L4 80.000-69.000	0.158	1.707	A	1	0.65	1	1	1	35.464	0.315	0.029	C
			B	1	0.65	1	1	1	35.464			
			C	1	0.65	1	1	1	35.464			
L5 69.000-44.000	0.359	4.310	A	1	0.65	1	1	1	89.453	0.732	0.029	C
			B	1	0.65	1	1	1	89.453			
			C	1	0.65	1	1	1	89.453			
L6 44.000-0.000	0.590	11.632	A	1	0.65	1	1	1	184.744	1.299	0.030	C
			B	1	0.65	1	1	1	184.744			
			C	1	0.65	1	1	1	184.744			
Sum Weight:	1.927	22.877						OTM	253.244 kip-ft	3.837		

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	22.877					
Bracing Weight	0.000					
Total Member Self-Weight	22.877			4.581	0.172	
Total Weight	26.770			4.581	0.172	
Wind 0 deg - No Ice		-0.066	-15.202	-1290.744	9.270	-0.429
Wind 30 deg - No Ice		7.582	-13.133	-1112.654	-644.864	0.674
Wind 45 deg - No Ice		10.757	-10.703	-904.919	-916.756	1.176
Wind 60 deg - No Ice		13.199	-7.544	-635.203	-1126.161	1.597
Wind 90 deg - No Ice		15.279	0.066	13.678	-1305.657	2.091
Wind 120 deg - No Ice		13.265	7.659	660.122	-1135.258	2.026
Wind 135 deg - No Ice		10.851	10.797	926.947	-929.622	1.782
Wind 150 deg - No Ice		7.697	13.199	1130.914	-660.621	1.417
Wind 180 deg - No Ice		0.066	15.202	1299.906	-8.925	0.429
Wind 210 deg - No Ice		-7.582	13.133	1121.816	645.208	-0.674
Wind 225 deg - No Ice		-10.757	10.703	914.081	917.100	-1.176
Wind 240 deg - No Ice		-13.199	7.544	644.365	1126.505	-1.597
Wind 270 deg - No Ice		-15.279	-0.066	-4.517	1306.002	-2.091
Wind 300 deg - No Ice		-13.265	-7.659	-650.960	1135.602	-2.026
Wind 315 deg - No Ice		-10.851	-10.797	-917.785	929.966	-1.782
Wind 330 deg - No Ice		-7.697	-13.199	-1121.752	660.966	-1.417
Member Ice	3.460					
Total Weight Ice	30.996			5.254	0.314	
Wind 0 deg - Ice		-0.051	-11.995	-1034.049	7.326	-0.353
Wind 30 deg - Ice		5.983	-10.362	-891.302	-517.313	0.656
Wind 45 deg - Ice		8.487	-8.445	-724.685	-735.352	1.110
Wind 60 deg - Ice		10.413	-5.953	-508.324	-903.255	1.489
Wind 90 deg - Ice		12.054	0.051	12.267	-1047.087	1.923
Wind 120 deg - Ice		10.465	6.042	530.979	-910.268	1.841
Wind 135 deg - Ice		8.560	8.518	745.111	-745.269	1.609
Wind 150 deg - Ice		6.071	10.413	908.823	-529.460	1.267
Wind 180 deg - Ice		0.051	11.995	1044.557	-6.699	0.353
Wind 210 deg - Ice		-5.983	10.362	901.811	517.941	-0.656
Wind 225 deg - Ice		-8.487	8.445	735.194	735.979	-1.110
Wind 240 deg - Ice		-10.413	5.953	518.833	903.883	-1.489
Wind 270 deg - Ice		-12.054	-0.051	-1.758	1047.714	-1.923
Wind 300 deg - Ice		-10.465	-6.042	-520.470	910.895	-1.841
Wind 315 deg - Ice		-8.560	-8.518	-734.603	745.896	-1.609
Wind 330 deg - Ice		-6.071	-10.413	-898.315	530.087	-1.267
Total Weight	26.770			4.581	0.172	
Wind 0 deg - Service		-0.023	-5.260	-443.628	3.320	-0.148
Wind 30 deg - Service		2.624	-4.544	-382.006	-223.024	0.233
Wind 45 deg - Service		3.722	-3.703	-310.125	-317.104	0.407
Wind 60 deg - Service		4.567	-2.610	-216.798	-389.562	0.553
Wind 90 deg - Service		5.287	0.023	7.729	-451.672	0.724
Wind 120 deg - Service		4.590	2.650	231.412	-392.710	0.701
Wind 135 deg - Service		3.755	3.736	323.739	-321.556	0.617
Wind 150 deg - Service		2.663	4.567	394.315	-228.476	0.490
Wind 180 deg - Service		0.023	5.260	452.790	-2.976	0.148
Wind 210 deg - Service		-2.624	4.544	391.168	223.368	-0.233
Wind 225 deg - Service		-3.722	3.703	319.287	317.448	-0.407
Wind 240 deg - Service		-4.567	2.610	225.959	389.907	-0.553
Wind 270 deg - Service		-5.287	-0.023	1.433	452.016	-0.724
Wind 300 deg - Service		-4.590	-2.650	-222.250	393.055	-0.701
Wind 315 deg - Service		-3.755	-3.736	-314.577	321.900	-0.617
Wind 330 deg - Service		-2.663	-4.567	-385.154	228.820	-0.490

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
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

Section No.	*Elevation ft*	*Component Type*	*Condition*	*Gov. Load Comb.*	*Force K*	*Major Axis Moment kip-ft*	*Minor Axis Moment kip-ft*
L1	139 - 114	Pole	Max Tension	18	0.000	-0.000	0.000
			Max. Compression	18	-4.840	0.316	-5.301
			Max. Mx	14	-3.491	118.542	-3.029
			Max. My	10	-3.493	-1.380	-121.191
			Max. Vy	14	-5.958	118.542	-3.029
			Max. Vx	10	5.882	-1.380	-121.191
			Max. Torque	6			-2.028
L2	114 - 89	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-7.260	0.318	-5.333
			Max. Mx	14	-5.506	252.640	-1.716
			Max. My	10	-5.508	-2.724	-253.753
			Max. Vy	14	-7.486	252.640	-1.716
			Max. Vx	10	7.409	-2.724	-253.753
			Max. Torque	6			-2.028
L3	89 - 80	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-9.923	0.320	-5.354
			Max. Mx	14	-7.857	365.629	-0.790
			Max. My	10	-7.859	-3.669	-365.664
			Max. Vy	14	-8.646	365.629	-0.790
			Max. Vx	10	8.569	-3.669	-365.664
			Max. Torque	6			-2.028
L4	80 - 69	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-12.054	0.320	-5.369
			Max. Mx	14	-9.731	465.717	-0.061
			Max. My	10	-9.733	-4.412	-464.902
			Max. Vy	14	-9.563	465.717	-0.061
			Max. Vx	10	9.486	-4.412	-464.902
			Max. Torque	6			-2.027
L5	69 - 44	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-16.049	0.321	-5.371
			Max. Mx	14	-13.254	662.116	1.203
			Max. My	10	-13.255	-5.695	-659.832
			Max. Vy	14	-11.136	662.116	1.203
			Max. Vx	10	11.059	-5.695	-659.832
			Max. Torque	6			-2.027
L6	44 - 0	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	18	-30.996	0.321	-5.371
			Max. Mx	14	-26.766	1321.620	4.538
			Max. My	10	-26.766	-9.052	-1315.480
			Max. Vy	14	-15.286	1321.620	4.538
			Max. Vx	10	15.209	-9.052	-1315.480
			Max. Torque	6			-2.027

Maximum Reactions

Location	*Condition*	*Gov. Load Comb.*	*Vertical K*	*Horizontal, X K*	*Horizontal, Z K*
Pole	Max. Vert	23	30.996	-12.054	-0.051
	Max. H_x	14	26.770	15.279	0.066
	Max. H_z	2	26.770	0.066	15.202
	Max. M_x	2	1306.102	0.066	15.202
	Max. M_z	6	1321.267	-15.279	-0.066
	Max. Torsion	14	2.027	15.279	0.066
	Min. Vert	41	26.770	-3.755	-3.736
	Min. H_x	6	26.770	-15.279	-0.066
	Min. H_z	10	26.770	-0.066	-15.202

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
	Min. M_x	10	-1315.480	-0.066	-15.202
	Min. M_z	14	-1321.620	15.279	0.066
	Min. Torsion	6	-2.027	-15.279	-0.066

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	26.770	0.000	0.000	4.655	0.175	0.000
Dead+Wind 0 deg - No Ice	26.770	-0.066	-15.202	-1306.102	9.404	-0.425
Dead+Wind 30 deg - No Ice	26.770	7.582	-13.133	-1125.876	-652.557	0.645
Dead+Wind 45 deg - No Ice	26.770	10.757	-10.703	-915.654	-927.704	1.132
Dead+Wind 60 deg - No Ice	26.770	13.199	-7.544	-642.713	-1139.617	1.543
Dead+Wind 90 deg - No Ice	26.770	15.279	0.066	13.919	-1321.267	2.027
Dead+Wind 120 deg - No Ice	26.770	13.265	7.659	668.075	-1148.840	1.968
Dead+Wind 135 deg - No Ice	26.770	10.851	10.797	938.081	-940.749	1.734
Dead+Wind 150 deg - No Ice	26.770	7.697	13.199	1144.479	-668.537	1.382
Dead+Wind 180 deg - No Ice	26.770	0.066	15.202	1315.480	-9.052	0.425
Dead+Wind 210 deg - No Ice	26.770	-7.582	13.133	1135.255	652.908	-0.645
Dead+Wind 225 deg - No Ice	26.770	-10.757	10.703	925.035	928.055	-1.132
Dead+Wind 240 deg - No Ice	26.770	-13.199	7.544	652.094	1139.968	-1.542
Dead+Wind 270 deg - No Ice	26.770	-15.279	-0.066	-4.538	1321.620	-2.027
Dead+Wind 300 deg - No Ice	26.770	-13.265	-7.659	-658.695	1149.193	-1.968
Dead+Wind 315 deg - No Ice	26.770	-10.851	-10.797	-928.702	941.103	-1.734
Dead+Wind 330 deg - No Ice	26.770	-7.697	-13.199	-1135.100	668.891	-1.382
Dead+Ice+Temp	30.996	0.000	0.000	5.371	0.321	0.000
Dead+Wind 0 deg+Ice+Temp	30.996	-0.051	-11.995	-1049.470	7.462	-0.348
Dead+Wind 30 deg+Ice+Temp	30.996	5.983	-10.362	-904.573	-525.060	0.630
Dead+Wind 45 deg+Ice+Temp	30.996	8.487	-8.445	-735.453	-746.376	1.071
Dead+Wind 60 deg+Ice+Temp	30.996	10.413	-5.953	-515.844	-916.805	1.439
Dead+Wind 90 deg+Ice+Temp	30.996	12.054	0.051	12.556	-1062.805	1.863
Dead+Wind 120 deg+Ice+Temp	30.996	10.465	6.042	539.041	-923.941	1.787
Dead+Wind 135 deg+Ice+Temp	30.996	8.560	8.518	756.380	-756.469	1.563
Dead+Wind 150 deg+Ice+Temp	30.996	6.071	10.413	922.542	-537.423	1.233
Dead+Wind 180 deg+Ice+Temp	30.996	0.051	11.995	1060.302	-6.816	0.348
Dead+Wind 210 deg+Ice+Temp	30.996	-5.983	10.362	915.406	525.706	-0.630
Dead+Wind 225 deg+Ice+Temp	30.996	-8.487	8.445	746.286	747.022	-1.071
Dead+Wind 240 deg+Ice+Temp	30.996	-10.413	5.953	526.677	917.451	-1.439
Dead+Wind 270 deg+Ice+Temp	30.996	-12.054	-0.051	-1.722	1063.451	-1.863
Dead+Wind 300 deg+Ice+Temp	30.996	-10.465	-6.042	-528.208	924.588	-1.787
Dead+Wind 315 deg+Ice+Temp	30.996	-8.560	-8.518	-745.547	757.116	-1.563
Dead+Wind 330 deg+Ice+Temp	30.996	-6.071	-10.413	-911.710	538.070	-1.233
Dead+Wind 0 deg - Service	26.770	-0.023	-5.260	-448.907	3.370	-0.147
Dead+Wind 30 deg - Service	26.770	2.624	-4.544	-386.539	-225.703	0.223
Dead+Wind 45 deg - Service	26.770	3.722	-3.703	-313.792	-320.918	0.392
Dead+Wind 60 deg - Service	26.770	4.567	-2.610	-219.340	-394.251	0.534
Dead+Wind 90 deg - Service	26.770	5.287	0.023	7.888	-457.113	0.702
Dead+Wind 120 deg - Service	26.770	4.590	2.650	234.261	-397.445	0.682
Dead+Wind 135 deg - Service	26.770	3.755	3.736	327.698	-325.434	0.601
Dead+Wind 150 deg - Service	26.770	2.663	4.567	399.122	-231.234	0.479
Dead+Wind 180 deg - Service	26.770	0.023	5.260	458.297	-3.017	0.147
Dead+Wind 210 deg - Service	26.770	-2.624	4.544	395.929	226.056	-0.223
Dead+Wind 225 deg - Service	26.770	-3.722	3.703	323.182	321.271	-0.392
Dead+Wind 240 deg - Service	26.770	-4.567	2.610	228.730	394.604	-0.534
Dead+Wind 270 deg - Service	26.770	-5.287	-0.023	1.501	457.466	-0.702
Dead+Wind 300 deg - Service	26.770	-4.590	-2.650	-224.872	397.798	-0.682

Load Combination	*Vertical*	*Shear$_x$*	*Shear$_z$*	*Overturning Moment, M_x*	*Overturning Moment, M_z*	*Torque*
	K	*K*	*K*	*kip-ft*	*kip-ft*	*kip-ft*
Dead+Wind 315 deg - Service	26.770	-3.755	-3.736	-318.308	325.787	-0.601
Dead+Wind 330 deg - Service	26.770	-2.663	-4.567	-389.733	231.587	-0.479

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	-26.770	0.000	0.000	26.770	0.000	0.000%
2	-0.066	-26.770	-15.202	0.066	26.770	15.202	0.000%
3	7.582	-26.770	-13.133	-7.582	26.770	13.133	0.000%
4	10.757	-26.770	-10.703	-10.757	26.770	10.703	0.000%
5	13.199	-26.770	-7.544	-13.199	26.770	7.544	0.000%
6	15.279	-26.770	0.066	-15.279	26.770	-0.066	0.000%
7	13.265	-26.770	7.659	-13.265	26.770	-7.659	0.000%
8	10.851	-26.770	10.797	-10.851	26.770	-10.797	0.000%
9	7.697	-26.770	13.199	-7.697	26.770	-13.199	0.000%
10	0.066	-26.770	15.202	-0.066	26.770	-15.202	0.000%
11	-7.582	-26.770	13.133	7.582	26.770	-13.133	0.000%
12	-10.757	-26.770	10.703	10.757	26.770	-10.703	0.000%
13	-13.199	-26.770	7.544	13.199	26.770	-7.544	0.000%
14	-15.279	-26.770	-0.066	15.279	26.770	0.066	0.000%
15	-13.265	-26.770	-7.659	13.265	26.770	7.659	0.000%
16	-10.851	-26.770	-10.797	10.851	26.770	10.797	0.000%
17	-7.697	-26.770	-13.199	7.697	26.770	13.199	0.000%
18	0.000	-30.996	0.000	0.000	30.996	-0.000	0.000%
19	-0.051	-30.996	-11.995	0.051	30.996	11.995	0.000%
20	5.983	-30.996	-10.362	-5.983	30.996	10.362	0.000%
21	8.487	-30.996	-8.445	-8.487	30.996	8.445	0.000%
22	10.413	-30.996	-5.953	-10.413	30.996	5.953	0.000%
23	12.054	-30.996	0.051	-12.054	30.996	-0.051	0.000%
24	10.465	-30.996	6.042	-10.465	30.996	-6.042	0.000%
25	8.560	-30.996	8.518	-8.560	30.996	-8.518	0.000%
26	6.071	-30.996	10.413	-6.071	30.996	-10.413	0.000%
27	0.051	-30.996	11.995	-0.051	30.996	-11.995	0.000%
28	-5.983	-30.996	10.362	5.983	30.996	-10.362	0.000%
29	-8.487	-30.996	8.445	8.487	30.996	-8.445	0.000%
30	-10.413	-30.996	5.953	10.413	30.996	-5.953	0.000%
31	-12.054	-30.996	-0.051	12.054	30.996	0.051	0.000%
32	-10.465	-30.996	-6.042	10.465	30.996	6.042	0.000%
33	-8.560	-30.996	-8.518	8.560	30.996	8.518	0.000%
34	-6.071	-30.996	-10.413	6.071	30.996	10.413	0.000%
35	-0.023	-26.770	-5.260	0.023	26.770	5.260	0.000%
36	2.624	-26.770	-4.544	-2.624	26.770	4.544	0.000%
37	3.722	-26.770	-3.703	-3.722	26.770	3.703	0.000%
38	4.567	-26.770	-2.610	-4.567	26.770	2.610	0.000%
39	5.287	-26.770	0.023	-5.287	26.770	-0.023	0.000%
40	4.590	-26.770	2.650	-4.590	26.770	-2.650	0.000%
41	3.755	-26.770	3.736	-3.755	26.770	-3.736	0.000%
42	2.663	-26.770	4.567	-2.663	26.770	-4.567	0.000%
43	0.023	-26.770	5.260	-0.023	26.770	-5.260	0.000%
44	-2.624	-26.770	4.544	2.624	26.770	-4.544	0.000%
45	-3.722	-26.770	3.703	3.722	26.770	-3.703	0.000%
46	-4.567	-26.770	2.610	4.567	26.770	-2.610	0.000%
47	-5.287	-26.770	-0.023	5.287	26.770	0.023	0.000%
48	-4.590	-26.770	-2.650	4.590	26.770	2.650	0.000%
49	-3.755	-26.770	-3.736	3.755	26.770	3.736	0.000%
50	-2.663	-26.770	-4.567	2.663	26.770	4.567	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	0.00006556
3	Yes	4	0.00000001	0.00050065
4	Yes	4	0.00000001	0.00054372
5	Yes	4	0.00000001	0.00039780
6	Yes	4	0.00000001	0.00027264
7	Yes	4	0.00000001	0.00065792
8	Yes	4	0.00000001	0.00061423
9	Yes	4	0.00000001	0.00044291
10	Yes	4	0.00000001	0.00005023
11	Yes	4	0.00000001	0.00044075
12	Yes	4	0.00000001	0.00056595
13	Yes	4	0.00000001	0.00059739
14	Yes	4	0.00000001	0.00025490
15	Yes	4	0.00000001	0.00042130
16	Yes	4	0.00000001	0.00059172
17	Yes	4	0.00000001	0.00058242
18	Yes	4	0.00000001	0.00001342
19	Yes	5	0.00000001	0.00002370
20	Yes	5	0.00000001	0.00002892
21	Yes	5	0.00000001	0.00003036
22	Yes	5	0.00000001	0.00002860
23	Yes	5	0.00000001	0.00002477
24	Yes	5	0.00000001	0.00003099
25	Yes	5	0.00000001	0.00003190
26	Yes	5	0.00000001	0.00002976
27	Yes	5	0.00000001	0.00002424
28	Yes	5	0.00000001	0.00002925
29	Yes	5	0.00000001	0.00003114
30	Yes	5	0.00000001	0.00003018
31	Yes	5	0.00000001	0.00002473
32	Yes	5	0.00000001	0.00002926
33	Yes	5	0.00000001	0.00003120
34	Yes	5	0.00000001	0.00002986
35	Yes	4	0.00000001	0.00001254
36	Yes	4	0.00000001	0.00003584
37	Yes	4	0.00000001	0.00003935
38	Yes	4	0.00000001	0.00003161
39	Yes	4	0.00000001	0.00004147
40	Yes	4	0.00000001	0.00005982
41	Yes	4	0.00000001	0.00005109
42	Yes	4	0.00000001	0.00003428
43	Yes	4	0.00000001	0.00001260
44	Yes	4	0.00000001	0.00003007
45	Yes	4	0.00000001	0.00004299
46	Yes	4	0.00000001	0.00005173
47	Yes	4	0.00000001	0.00004061
48	Yes	4	0.00000001	0.00003762
49	Yes	4	0.00000001	0.00004749
50	Yes	4	0.00000001	0.00004701

Maximum Tower Deflections - Service Wind

Section No.	*Elevation ft*	*Horz. Deflection in*	*Gov. Load Comb.*	*Tilt °*	*Twist °*
L1	139 - 114	9.462	42	0.644	0.007
L2	114 - 89	6.272	41	0.548	0.003
L3	94 - 80	4.208	41	0.433	0.002
L4	80 - 69	3.021	41	0.367	0.001
L5	69 - 44	2.237	41	0.313	0.001
L6	50 - 0	1.184	41	0.216	0.001

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	*Appurtenance*	*Gov. Load Comb.*	*Deflection in*	*Tilt °*	*Twist °*	*Radius of Curvature ft*
137.000	BXA-70063/6CF	42	9.195	0.638	0.007	42335

Maximum Tower Deflections - Design Wind

Section No.	*Elevation ft*	*Horz. Deflection in*	*Gov. Load Comb.*	*Tilt °*	*Twist °*
L1	139 - 114	26.951	8	1.801	0.021
L2	114 - 89	17.957	8	1.558	0.010
L3	94 - 80	12.069	7	1.239	0.005
L4	80 - 69	8.672	7	1.052	0.004
L5	69 - 44	6.425	7	0.897	0.003
L6	50 - 0	3.402	7	0.621	0.002

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	*Appurtenance*	*Gov. Load Comb.*	*Deflection in*	*Tilt °*	*Twist °*	*Radius of Curvature ft*
137.000	BXA-70063/6CF	8	26.201	1.786	0.020	16058

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	139 - 114 (1)	TP29.875x24x0.188	25.000	0.000	0.0	38.075	17.668	-3.489	672.705	0.005
L2	114 - 89 (2)	TP35.813x29.875x0.25	25.000	0.000	0.0	39.000	27.277	-5.504	1063.800	0.005
L3	89 - 80 (3)	TP37.375x34.125x0.313	14.000	0.000	0.0	39.000	36.761	-7.855	1433.690	0.005
L4	80 - 69 (4)	TP40x37.375x0.375	11.000	0.000	0.0	39.000	47.164	-9.729	1839.380	0.005
L5	69 - 44 (5)	TP45.875x40x0.375	25.000	0.000	0.0	39.000	52.478	-13.252	2046.650	0.006
L6	44 - 0 (6)	TP55.625x43.715x0.438	50.000	0.000	0.0	39.000	76.635	-26.766	2988.760	0.009

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	139 - 114 (1)	TP29.875x24x0.188	122.274	11.319	38.075	0.297	0.000	0.000	38.075	0.000
L2	114 - 89 (2)	TP35.813x29.875x0.25	256.843	13.313	39.000	0.341	0.000	0.000	39.000	0.000
L3	89 - 80 (3)	TP37.375x34.125x0.313	370.238	13.222	39.000	0.339	0.000	0.000	39.000	0.000
L4	80 - 69 (4)	TP40x37.375x0.375	470.645	12.266	39.000	0.315	0.000	0.000	39.000	0.000
L5	69 - 44 (5)	TP45.875x40x0.375	667.596	14.040	39.000	0.360	0.000	0.000	39.000	0.000
L6	44 - 0 (6)	TP55.625x43.715x0.438	1328.967	15.282	39.000	0.392	0.000	0.000	39.000	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	139 - 114 (1)	TP29.875x24x0.188	5.960	0.337	26.000	0.026	1.382	0.063	26.000	0.002
L2	114 - 89 (2)	TP35.813x29.875x0.25	7.516	0.276	26.000	0.021	1.734	0.044	26.000	0.002
L3	89 - 80 (3)	TP37.375x34.125x0.313	8.675	0.236	26.000	0.018	1.734	0.030	26.000	0.001
L4	80 - 69 (4)	TP40x37.375x0.375	9.592	0.203	26.000	0.016	1.734	0.022	26.000	0.001
L5	69 - 44 (5)	TP45.875x40x0.375	11.165	0.213	26.000	0.016	1.734	0.018	26.000	0.001
L6	44 - 0 (6)	TP55.625x43.715x0.438	15.325	0.200	26.000	0.015	1.968	0.011	26.000	0.000

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	139 - 114 (1)	0.005	0.297	0.000	0.026	0.002	0.303 ✔	1.333	H1-3+VT ✔
L2	114 - 89 (2)	0.005	0.341	0.000	0.021	0.002	0.347 ✔	1.333	H1-3+VT ✔
L3	89 - 80 (3)	0.005	0.339	0.000	0.018	0.001	0.345 ✔	1.333	H1-3+VT ✔
L4	80 - 69 (4)	0.005	0.315	0.000	0.016	0.001	0.320 ✔	1.333	H1-3+VT ✔

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
L5	69 - 44 (5)	0.006	0.360	0.000	0.016	0.001	0.367 ✔	1.333	H1-3+VT ✔
L6	44 - 0 (6)	0.009	0.392	0.000	0.015	0.000	0.401 ✔	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	139 - 114	Pole	TP29.875x24x0.188	1	-3.489	896.716	22.7	Pass
L2	114 - 89	Pole	TP35.813x29.875x0.25	2	-5.504	1418.045	26.0	Pass
L3	89 - 80	Pole	TP37.375x34.125x0.313	3	-7.855	1911.109	25.9	Pass
L4	80 - 69	Pole	TP40x37.375x0.375	4	-9.729	2451.893	24.0	Pass
L5	69 - 44	Pole	TP45.875x40x0.375	5	-13.252	2728.184	27.5	Pass
L6	44 - 0	Pole	TP55.625x43.715x0.438	6	-26.766	3984.017	30.1	Pass
							Summary	
						Pole (L6)	30.1	Pass
						RATING =	**30.1**	**Pass**

Flange Bolt and Flange Plate Analysis:

Input Data:

Tower Reactions:

Overturning Moment =	$OM := 366 \cdot ft \cdot kips$	(Input From RisaTower)
Shear Force =	$Shear := 9 \cdot kips$	(Input From RisaTower)
Axial Force =	$Axial := 10 \cdot kips$	(Input From RisaTower)

Flange Bolt Data:

Use ASTM A325

Number of Flange Bolts =	$N := 18$	(User Input)
Diameter of Bolt Circle =	$D_{bc} := 42.0 \cdot in$	(User Input)
Bolt Ultimate Strength =	$F_u := 120 \cdot ksi$	(User Input)
Bolt Yield Strength =	$F_y := 92 \cdot ksi$	(User Input)
Bolt Modulus =	$E := 29000 \cdot ksi$	(User Input)
Diameter of Flange Bolts =	$D := 1.25 \cdot in$	(User Input)
Threads per Inch =	$n := 7$	(User Input)

Flange Plate Data:

Use ASTM A36

Plate Yield Strength =	$Fy_{bp} := 36 \cdot ksi$	(User Input)
Flange Plate Thickness =	$t_{bp} := 2.0 \cdot in$	(User Input)
Flange Plate Diameter =	$D_{bp} := 46.0 \cdot in$	(User Input)
Outer Pole Diameter =	$D_{pole} := 37.375 \cdot in$	(User Input)

Geometric Layout Data:

Distance from Bolts to Centroid of Pole:

Radius of Bolt Circle =: $R_{bc} := \frac{D_{bc}}{2} = 21 \cdot in$

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

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

$d_1 = 7.18 \cdot in$	$d_7 = 13.50 \cdot in$
$d_2 = 13.50 \cdot in$	$d_8 = 7.18 \cdot in$
$d_3 = 18.19 \cdot in$	$d_9 = 0.00 \cdot in$
$d_4 = 20.68 \cdot in$	$d_{10} = -7.18 \cdot in$
$d_5 = 20.68 \cdot in$	$d_{11} = -13.50 \cdot in$
$d_6 = 18.19 \cdot in$	$d_{12} = -18.19 \cdot in$

Critical Distances For Bending in Plate:

Outer Pole Radius = $R_{pole} := \frac{D_{pole}}{2} = 18.7 \cdot in$

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

$MA_1 = 0.00 \cdot in$	$MA_7 = 0.00 \cdot in$
$MA_2 = 0.00 \cdot in$	$MA_8 = 0.00 \cdot in$
$MA_3 = 0.00 \cdot in$	$MA_9 = 0.00 \cdot in$
$MA_4 = 1.99 \cdot in$	$MA_{10} = 0.00 \cdot in$
$MA_5 = 1.99 \cdot in$	$MA_{11} = 0.00 \cdot in$
$MA_6 = 0.00 \cdot in$	$MA_{12} = 0.00 \cdot in$

Effective Width of Flangeplate for Bending = $B_{eff} := .8 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2} = 21.5 \cdot in$

Flange Bolt Analysis:

Calculated Flange Bolt Properties:

Polar Moment of Inertia = $I_p := \sum_i (d_i)^2 = 3.969 \times 10^3 \cdot in^2$

Gross Area of Bolt = $A_g := \frac{\pi}{4} \cdot D^2 = 1.227 \cdot in^2$

Net Area of Bolt = $A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n}\right)^2 = 0.969 \cdot in^2$

Net Diameter = $D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} = 1.111 \cdot in$

Radius of Gyration of Bolt = $r := \frac{D_n}{4} = 0.278 \cdot in$

Section Modulus of Bolt = $S_x := \frac{\pi \cdot D_n^3}{32} = 0.135 \cdot in^3$

Check Flange Bolt Tension Force:

Maximum Tensile Force = $T_{Max} := OM \cdot \frac{R_{bc}}{I_p} - \frac{Axial}{N} = 22.7 \cdot kips$

Allowable Tensile Force = $T_{ALL.Gross} := 1.333 \cdot (0.33 \cdot A_g \cdot F_u) = 64.8 \cdot kips$ (1.333 increase allowed per TIA/EIA)

Bolt Tension % of Capacity = $\frac{T_{Max}}{T_{ALL.Gross}} = 35 \cdot \%$

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

Condition1 = "OK"

Flange Plate Analysis:

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

$C_1 = 8.5 \cdot kips$

$C_2 = 15.5 \cdot kips$

$C_3 = 20.7 \cdot kips$

$C_4 = 23.4 \cdot kips$

$C_5 = 23.4 \cdot kips$

$C_6 = 20.7 \cdot kips$

$C_7 = 15.5 \cdot kips$

$C_8 = 8.5 \cdot kips$

$C_9 = 0.6 \cdot kips$

$C_{10} = -7.4 \cdot kips$

$C_{11} = -14.4 \cdot kips$

$C_{12} = -19.6 \cdot kips$

Maximum Bending Stress in Plate =

$$f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{\left(B_{eff} \cdot t_{bp}^{\,2}\right)} = 6.5 \cdot ksi$$

Allowable Bending Stress in Plate = $F_{bp} := 1.33 \cdot 0.75 \cdot Fy_{bp} = 35.9 \cdot ksi$

Plate Bending Stress % of Capacity = $\frac{f_{bp}}{F_{bp}} = 18.2 \cdot \%$

Condition3 = $Condition2 := if\left(\frac{f_{bp}}{F_{bp}} < 1.00, \text{"Ok"}, \text{"Overstressed"}\right)$

Condition2 = "Ok"

Anchor Bolt and Base Plate Analysis:

Input Data:

Tower Reactions:

Overturning Moment =	$OM := 1329 \cdot ft \cdot kips$	(Input From tnxTower)
Shear Force =	$Shear := 15 \cdot kips$	(Input From tnxTower)
Axial Force =	$Axial := 27 \cdot kips$	(Input From tnxTower)

Anchor Bolt Data:

Use ASTM F1554 Grade 105

Number of Anchor Bolts =	$N := 18$	(User Input)
Diameter of Bolt Circle =	$D_{bc} := 62.00 \cdot in$	(User Input)
Bolt "Column" Distance =	$l := 3.0 \cdot in$	(User Input)
Bolt Ultimate Strength =	$F_u := 125 \cdot ksi$	(User Input)
Bolt Yield Strength =	$F_y := 105 \cdot ksi$	(User Input)
Bolt Modulus =	$E := 29000 \cdot ksi$	(User Input)
Diameter of Anchor Bolts =	$D := 2.00 \cdot in$	(User Input)
Threads per Inch =	$n := 4.5$	(User Input)

Base Plate Data:

Use ASTM A572 50

Plate Yield Strength =	$Fy_{bp} := 50 \cdot ksi$	(User Input)
Base Plate Thickness =	$t_{bp} := 2.5 \cdot in$	(User Input)
Base Plate Diameter =	$D_{bp} := 68.00 \cdot in$	(User Input)
Outer Pole Diameter =	$D_{pole} := 55.625 \cdot in$	(User Input)

Geometric Layout Data:

Distance from Bolts to Centroid of Pole:

Radius of Bolt Circle =: $R_{bc} := \frac{D_{bc}}{2} = 31 \cdot in$

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

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

$d_1 = 10.60 \cdot in$	$d_7 = 19.93 \cdot in$
$d_2 = 19.93 \cdot in$	$d_8 = 10.60 \cdot in$
$d_3 = 26.85 \cdot in$	$d_9 = 0.00 \cdot in$
$d_4 = 30.53 \cdot in$	$d_{10} = -10.60 \cdot in$
$d_5 = 30.53 \cdot in$	$d_{11} = -19.93 \cdot in$
$d_6 = 26.85 \cdot in$	etc.

Critical Distances For Bending in Plate:

Outer Pole Radius = $R_{pole} := \frac{D_{pole}}{2} = 27.8 \cdot in$

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

$MA_1 = 0.00 \cdot in$	$MA_7 = 0.00 \cdot in$
$MA_2 = 0.00 \cdot in$	$MA_8 = 0.00 \cdot in$
$MA_3 = 0.00 \cdot in$	$MA_9 = 0.00 \cdot in$
$MA_4 = 2.72 \cdot in$	$MA_{10} = 0.00 \cdot in$
$MA_5 = 2.72 \cdot in$	$MA_{11} = 0.00 \cdot in$
$MA_6 = 0.00 \cdot in$	etc

Effective Width of Baseplate for Bending = $B_{eff} := .8 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2} = 31.3 \cdot in$

Anchor Bolt Analysis:

Calculated Anchor Bolt Properties:

Polar Moment of Inertia = $I_p := \sum_i (d_i)^2 = 8.649 \times 10^3 \cdot in^2$

Gross Area of Bolt = $A_g := \frac{\pi}{4} \cdot D^2 = 3.142 \cdot in^2$

Net Area of Bolt = $A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n}\right)^2 = 2.498 \cdot in^2$

Net Diameter = $D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} = 1.783 \cdot in$

Radius of Gyration of Bolt = $r := \frac{D_n}{4} = 0.446 \cdot in$

Section Modulus of Bolt = $S_x := \frac{\pi \cdot D_n^{\ 3}}{32} = 0.557 \cdot in^3$

Check Anchor Bolt Tension Force:

Maximum Tensile Force = $T_{Max} := OM \cdot \frac{R_{bc}}{I_p} - \frac{Axial}{N} = 55.7 \cdot kips$

Allowable Tensile Force = $T_{ALL.Gross} := 1.333 \cdot (0.33 \cdot A_g \cdot F_u) = 172.7 \cdot kips$ (1.333 increase allowed per TIA/EIA)

$T_{ALL.Net} := 1.333 \cdot (0.60 \cdot A_n \cdot F_y) = 209.798 \cdot kips$ (1.333 increase allowed per TIA/EIA)

Bolt Tension % of Capacity = $\frac{T_{Max}}{T_{ALL.Net}} \cdot 100 = 27$ 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 = $M_x := \left(\frac{Shear}{N}\right) \cdot l = 0.208 \cdot ft \cdot kips$

Maximum Bending Stress = $f_{bx} := \frac{M_x}{S_x} = 4.5 \cdot ksi$

Allowable Bending Stress = $F_{bx} := 1.333 \cdot 0.6 \cdot F_y = 84 \cdot ksi$ (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 = $C_{Max} := OM \cdot \frac{R_{bc}}{I_p} + \frac{Axial}{N} = 58.7 \cdot kips$

Maximum Compressive Stress = $f_a := \frac{C_{Max}}{A_n} = 23.5 \cdot ksi$

$K := 0.65$

$$C_c := \sqrt{\frac{2 \cdot \pi^2 \cdot E}{F_y}} = 73.836$$

$$F_a := \begin{cases} \dfrac{\left[1 - \dfrac{\left(\frac{K \cdot l}{r}\right)^2}{2 \cdot C_c^2}\right] \cdot F_y}{\dfrac{5}{3} + \dfrac{3 \cdot \left(\frac{K \cdot l}{r}\right)}{8 \cdot C_c} - \dfrac{\left(\frac{K \cdot l}{r}\right)^3}{8 \cdot C_c^3}} & \text{if } \frac{K \cdot l}{r} \le C_c \\ \dfrac{12 \cdot \pi^2 \cdot E}{23 \cdot \left(\frac{K \cdot l}{r}\right)^2} & \text{if } \frac{K \cdot l}{r} > C_c \end{cases} = 63 \cdot ksi$$

Allowable Compressive Stress = $F_a := 1.333 \cdot F_a = 84 \cdot ksi$ (1.333 increase allowed per TIA/EIA)

Combined Stress % of Capacity = $\left(\frac{f_a}{F_a} + \frac{f_{bx}}{F_{bx}}\right) \cdot 100 = 28$

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

$Condition2 = \text{"OK"}$

Base Plate Analysis:

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

$C_1 = 21.1 \cdot kips$ $C_7 = 38.2 \cdot kips$

$C_2 = 38.2 \cdot kips$ $C_8 = 21.1 \cdot kips$

$C_3 = 51.0 \cdot kips$ $C_9 = 1.5 \cdot kips$

$C_4 = 57.8 \cdot kips$ $C_{10} = -18.1 \cdot kips$

$C_5 = 57.8 \cdot kips$ $C_{11} = -35.2 \cdot kips$

$C_6 = 51.0 \cdot kips$ etc.

Maximum Bending Stress in Plate = $f_{bp} := \sum_i \frac{6 \cdot C_i \cdot MA_i}{\left(B_{eff} \cdot t_{bp}^{\,2}\right)} = 9.6 \cdot ksi$

Allowable Bending Stress in Plate = $F_{bp} := 1.33 \cdot 0.75 \cdot Fy_{bp} = 49.9 \cdot ksi$

Plate Bending Stress % of Capacity = $\frac{f_{bp}}{F_{bp}} \cdot 100 = 19.3$

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

Condition3 = "Ok"

Standard Monopole Foundation:

Input Data:

Tower Data

Overturning Moment =	$OM := 1329 \cdot ft \cdot kips$	(User Input from tnxTower)
Shear Force =	$Shear := 15 \cdot kip$	(User Input from tnxTower)
Axial Force =	$Axial := 27 \cdot kip$	(User Input from tnxTower)
Tower Height =	$H_t := 139 \cdot ft$	(User Input)

Footing Data:

Overall Depth of Footing =	$D_f := 5.0 \cdot ft$	(User Input)
Length of Pier =	$L_p := 2.5 \cdot ft$	(User Input)
Extension of Pier Above Grade =	$L_{pag} := 0.5 \cdot ft$	(User Input)
Diameter of Pier =	$d_p := 7.0 \cdot ft$	(User Input)
Thickness of Footing =	$T_f := 3.0 \cdot ft$	(User Input)
Width of Footing =	$W_f := 28.0 \cdot ft$	(User Input)

Anchor Bolt Data:

Length of Anchor Bolts =	$L_{st} := 72 \cdot in$	(User Input)
Projection of Anchor Bolts Above Pier =	$A_{BP} := 12.0 \cdot in$	(User Input)
Anchor Bolt Diameter =	$d_{anchor} := 2.00 \cdot in$	(User Input)
Base Plate Bolt Circle =	$MP := 62.00 \cdot in$	(User Input)

Material Properties:

Concrete Compressive Strength =	$f_c := 4000 \cdot psi$	(User Input)	
Steel Reinforcment Yield Strength =	$f_y := 60000 \cdot psi$	(User Input)	
Anchor Bolt Yield Strength =	$f_{ya} := 105000 \cdot psi$	(User Input)	
Internal Friction Angle of Soil =	$\Phi_s := 30 \cdot deg$	(User Input)	
Allowable Soil Bearing Capacity =	$q_s := 3000 \cdot psf$	(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 =	$BS_{pier} := 11$	(User Input)	
Bar Diameter =	$d_{bpier} := 1.41 \cdot in$	(User Input)	
Number of Bars =	$NB_{pier} := 38$	(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 =	$d_{Tie} := 0.5 \cdot in$	(User Input)	

Pad Reinforcement:

Bar Size =	$BS_{top} := 11$	(User Input)	(Top of Pad)
Bar Diameter =	$d_{btop} := 1.41 \cdot in$	(User Input)	(Top of Pad)
Number of Bars =	$NB_{top} := 27$	(User Input)	(Top of Pad)
Bar Size =	$BS_{bot} := 11$	(User Input)	(Bottom of Pad)
Bar Diameter =	$d_{bbot} := 1.41 \cdot in$	(User Input)	(Bottom of Pad)
Number of Bars =	$NB_{bot} := 27$	(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 = $A_{bpier} := \frac{\pi \cdot d_{bpier}^2}{4} = 1.561 \cdot in^2$

Pad Top Reinforcement Bar Area = $A_{btop} := \frac{\pi \cdot d_{btop}^2}{4} = 1.561 \cdot in^2$

Pad Bottom Reinforcement Bar Area = $A_{bbot} := \frac{\pi \cdot d_{bbot}^2}{4} = 1.561 \cdot in^2$

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

Load Factor =

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

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

$$P_{pt} := K_p \cdot \gamma_s \cdot (D_f - T_f) + c \cdot 2 \cdot \sqrt{K_p} = 0.6 \cdot \text{ksf}$$

$$P_{top} := \text{if}\left[n < (D_f - T_f), P_{pt}, P_{pn}\right] = 0.6 \cdot \text{ksf}$$

$$P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p} = 1.5 \cdot \text{ksf}$$

$$P_{ave} := \frac{P_{top} + P_{bot}}{2} = 1.05 \cdot \text{ksf}$$

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

$$A_p := W_f \cdot T_p = 84$$

Ultimate Shear = $S_u := P_{ave} \cdot A_p = 88.2 \cdot \text{kip}$

Weight of Concrete Pad = $WT_c := \left[\left(W_f^{\,2} \cdot T_f\right) + d_p^{\,2} \cdot L_p\right] \cdot \gamma_c = 371.175 \cdot \text{kip}$

Weight of Soil Above Footing = $WT_{s1} := \left[\left(W_f^{\,2} - d_p^{\,2}\right) \cdot \begin{cases} (L_p - L_{pag} - n) & \text{if } (L_p - L_{pag} - n) \ge 0 \\ 0 & \text{if } (L_p - L_{pag} - n) \le 0 \end{cases}\right] \cdot \gamma_s = 147 \cdot \text{kip}$

Weight of Soil Wedge at Back Face = $WT_{s2} := \left(\frac{D_f^{\,2} \cdot \tan(\Phi_s)}{2} \cdot W_f\right) \cdot \gamma_s = 20.207 \cdot \text{kip}$

Weight of Soil Wedge at back face Corners = $WT_{s3} := 2 \cdot \left[(D_f)^3 \cdot \frac{\tan(\Phi_s)}{3}\right] \cdot \gamma_s = 4.811 \cdot \text{kips}$

Total Weight = $WT_{tot} := WT_c + WT_{s1} + \text{Axial} = 545.175 \cdot \text{kip}$

Resisting Moment = $M_r := (WT_{tot}) \cdot \frac{W_f}{2} + S_u \cdot \frac{T_f}{3} + \left[(WT_{s2} + WT_{s3}) \cdot \left(W_f + \frac{D_f \cdot \tan(\Phi_s)}{3}\right)\right] = 8445 \cdot \text{kip} \cdot \text{ft}$

Overturning Moment = $M_{ot} := OM + \text{Shear} \cdot (L_p + T_f) = 1412 \cdot \text{kip} \cdot \text{ft}$

Factor of Safety Actual = $FS := \frac{M_r}{M_{ot}} = 5.98$

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

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

OverTurning_Moment_Check = "Okay"

Shear Capacity in Pier:

Shear Resistance of Pier = $S_p := \frac{\mu \cdot WT_{tot}}{FS_{req}} = 122.664 \cdot kips$

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

Shear_Check = "Okay"

Bearing Pressure Caused by Footing:

Area of the Mat = $A_{mat} := W_f^2 = 784$

Section Modulus of Mat = $S := \frac{W_f^3}{6} = 3658.67 \cdot ft^3$

Maximum Pressure in Mat = $P_{max} := \frac{WT_{tot}}{A_{mat}} + \frac{M_{ot}}{S} = 1.081 \cdot ksf$

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

Max_Pressure_Check = "Okay"

Minimum Pressure in Mat = $P_{min} := \frac{WT_{tot}}{A_{mat}} - \frac{M_{ot}}{S} = 0.31 \cdot ksf$

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

Min_Pressure_Check = "Okay"

Distance to Resultant of Pressure Distribution = $X_p := \frac{P_{max}}{\frac{P_{max} - P_{min}}{W_f}} \cdot \frac{1}{3} = 13.078$

Distance to Kern = $X_k := \frac{W_f}{6} = 4.667$

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

Eccentricity = $e := \frac{M_{ot}}{WT_{tot}} = 2.589$

Adjusted Soil Pressure = $P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \left(\frac{W_f}{2} - e\right)} = 1.138 \cdot ksf$

$q_{adj} := if(P_{min} < 0, P_a, P_{max}) = 1.081 \cdot ksf$

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 = $P_b := \Phi_c \cdot 0.85 \cdot f_c \cdot \frac{\pi \cdot d_p^{\,2}}{4} = 1.225 \times 10^4 \cdot kips$ (ACI-2008 10.14)

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

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)

$d := T_f - Cvr_{pad} - d_{bbot} = 31.59 \cdot in$

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

$d_2 := d_1 - d$

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

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

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

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

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

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 = $b_o := (d_p + d) \cdot \pi = 30.3$

Area Included Inside Perimeter = $A_{bo} := \frac{\pi \cdot (d_p + d)^2}{4} = 72.9$

Area Outside of Perimeter = $A_{out} := A_{mat} - A_{bo} = 711.1$

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

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

$v_u := \mathrm{Find}(v_u) = 6.8 \cdot ksf$

$V_u := v_u \cdot d \cdot W_f = 504.4 \cdot kips$

Required Shear Strength = $V_{req} := LF \cdot V_u = 672.4 \cdot kips$

Available Shear Strength = $V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot psi} \cdot b_o \cdot d = 2466.8 \cdot kip$ (ACI-2008 11.11.2.1)

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

Punching_Shear_Check = "Okay"

Steel Reinforcement in Pad:

Required Reinforcement for Bending:

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

$q_b := q_{adj} - d_1 \cdot Slope = 0.792 \cdot ksf$

Maximum Bending at Face of Pier = $M_u := LF \cdot \left[(q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f = 2026.1 \cdot kip \cdot ft$

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

(ACI-200810.2.7.3)

$R_n := \frac{M_u}{\phi_m \cdot W_f \cdot d^2} = 80.6 \cdot psi$

$\rho := \frac{0.85 \cdot f_c}{f_y} \left(1 - \sqrt{1 - \frac{2 \cdot R_n}{0.85 \cdot f_c}} \right) = 0.0014$

$\rho_{min} := \rho = 0.00136$

Required Reinforcement for Temperature and Shrinkage:

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

Check Bottom Bars:

$As := \begin{vmatrix} \rho_{min} \cdot W_f \cdot d \text{ if } \rho_{min} > \frac{\rho_{sh}}{2} \\ \rho_{sh} \cdot W_f \cdot \frac{d}{2} \text{ otherwise} \end{vmatrix} = 14.425 \cdot in^2$

$As_{prov} := A_{bbot} \cdot NB_{bot} = 42.2 \cdot in^2$

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

Pad_Reinforcement_Bot = "Okay"

Check top Bars:

$As := \rho_{sh} \cdot \left(W_f \cdot \frac{d}{2} \right) = 9.6 \cdot in^2$

$As_{prov} := A_{btop} \cdot NB_{top} = 42.2 \cdot in^2$

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

Pad_Reinforcement_Top = "Okay"

Developement Length Pad Reinforcement:

Bar Spacing = $B_{sPad} := \frac{W_f - 2 \cdot Cvr_{pad} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1} = 11.23 \cdot in$

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)

$L_{dbt} := \frac{3 \cdot f_y \cdot \alpha_{pad} \cdot \beta_{pad} \cdot \gamma_{pad} \cdot \lambda_{pad}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \frac{c + k_{tr}}{d_{bbot}}} \cdot d_{bbot} = 47.2 \cdot in$

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 = $L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - Cvr_{pad} = 123 \cdot in$

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)

$A_{sprov} := NB_{pier} \cdot A_{bpier} = 59.34 \cdot in^2$

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

Steel_Area_Check = "Okay"

Bar Spacing In Pier = $B_{sPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier} = 5.535 \cdot in$

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

Maximum Moment in Pier = $M_p := \left[OM + Shear \cdot \left(L_p + \frac{A_{BP}}{2}\right)\right] \cdot LF = 21978.5 \cdot in \cdot kips$

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

$$\left(D\ \ N\ \ n\ \ P_u\ \ M_{xu}\right) := \left(d_p \cdot 12\ \ NB_{pier}\ \ BS_{pier}\ \ \frac{Axial \cdot 1.333}{kips}\ \ \frac{M_p}{in \cdot kips}\right)$$

$$\left(D\ \ N\ \ n\ \ P_u\ \ M_{xu}\right) = \left(84\ \ 38\ \ 11\ \ 35.991\ \ 2.198 \times 10^4\right)$$

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

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

$$\left(\phi P_n\ \ \phi M_{xn}\ \ f_{sp}\ \ \rho\right) = \left(177.618\ \ 1.085 \times 10^5\ \ -60\ \ 0.011\right)$$

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:

$L_{pier} := L_p - Cvr_{pier} = 27 \cdot in$

$L_{pad} := T_f - Cvr_{pad} = 33 \cdot in$

Tension: (ACI-2008 12.2.3)

Spacing or Cover Dimension = $c := if\left(Cvr_{pier} < \frac{B_{sPier}}{2}, Cvr_{pier}, \frac{B_{sPier}}{2}\right) = 2.767 \cdot in$

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

$$L_{dbt} := \frac{3 \cdot f_y \cdot \alpha_{pier} \cdot \beta_{pier} \cdot \gamma_{pier} \cdot \lambda_{pier}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \left(\frac{c + k_{tr}}{d_{bpier}}\right)} \cdot d_{bpier} = 51.12 \cdot in$$

Minimum Development Length = $L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{psi}}} \cdot .7 = 18.727 \cdot in$ (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)

$$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot psi}} = 26.753 \cdot in$$

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

$L_{dbc} := if(L_{dbc1} \ge L_{dbmin}, L_{dbc1}, L_{dbmin}) = 26.753 \cdot in$

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

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

Tie Size and Spacing in Column:

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

Used #4 Ties

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

$s_{lim1} := 16 \cdot d_{bpier} \cdot z = 22.56 \cdot in$

$s_{lim2} := 48 \cdot d_{Tie} \cdot z = 24 \cdot in$

$s_{lim3} := D_f \cdot z = 60 \cdot in$

$s_{lim4} := 18in$

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 = $n_{tie} := \frac{L_{pier} - 3 \cdot in}{s_{tie}} + 1 = 2.333$

Check Anchor Steel Embedment:

Depth Available = $D_{ab} := L_{st} - A_{BP} = 5 \cdot ft$

Length of Anchor Bolt = $L_{anchor} := \frac{(0.11 \cdot f_{ya}) \cdot in}{\sqrt{f_c \cdot psi}} = 15.218 \cdot ft$

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

Depth_Check = "No Good"

Note: Anchor plate is provided

SITE NAME	THOMPSON 2 CT	ECP - CELL #	AWS1	2	586
LATITUDE	41-58-44.20 N	LONGITUDE	71-51-09.26 W		
		SAVE BUTTON			
Additional Comments: AWS RRH, antenna and fiber line add		STRUCTURE TYPE	MONOPOLE		

AWS - LTE ANTENNA ADD	**ALPHA**		**BETA**		**GAMMA**	
EQUIPMENT TYPE	2100 MHz BBU		2100 MHz BBU		2100 MHz BBU	
ANTENNA TYPE	WBX065X19R050		WBX065X19R050		WBX065X19R050	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/ELEC)	0/2		0/2		0/2	
RAD CTR (FT AGL)	137		137		137	
VTM	Remote Variable Tilt		Remote Variable Tilt		Remote Variable Tilt	
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		BXA-70063-6CF		BXA-70063-6CF	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	2		2		2	
RAD CTR (FT AGL)	137		137		137	
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		BXA-70063-6CF		BXA-70063-6CF	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	2		2		2	
RAD CTR (FT AGL)	137		137		137	
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-80063-6CF		LPA-80063-6CF		LPA-80063-6CF	
QTY OF ANTENNAS PER FACE	2		2		2	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	2		2		2	
RAD CTR (FT AGL)	137		137		137	
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	**BXA-70063-6CF**		**BXA-70063-6CF**		**BXA-70063-6CF**	
QTY OF ANTENNAS PER FACE	**1**		**1**		**1**	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	2		2		2	
RAD CTR (FT AGL)	137		137		137	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL	2	FD9R 6004/2C-3L	2	FD9R 6004/2C-3L	2	FD9R 6004/2C-3L
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-185063/12CF		BXA-185063/12CF		BXA-185063/12CF	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	137		137		137	
TMA - QTY / MODEL						
DIPLEXER - QTY / MODEL		K 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-185063/12CF		BXA-185063/12CF		BXA-185063/12CF	
QTY OF ANTENNAS PER FACE	1		1		1	
ORIENTATION (DEG)	50		170		300	
DOWN TILT (MECH/DEG)	0		0		0	
RAD CTR (FT AGL)	137		137		137	
TMA - QTY / MODEL						
DIPLEX WITH CELLULAR CABLE	PLEX WITH CELLULAR CAB		DIPLEX WITH CELLULAR CABLE		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 - E	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

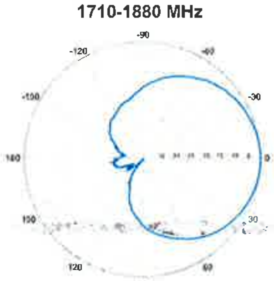
Amphenol ANTENNA SOLUTIONS

WBX065X19x050

X-Pol | VET Panel | 65° | 19.0 dBi

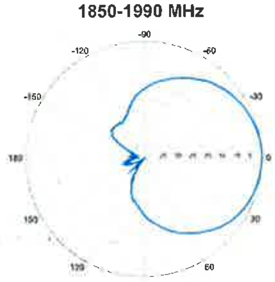
Ordering Options			
When ordering, replace "x" in the model number with the options below.			
WBX065X19M050	Antenna with Manual Electrical Tilt (MET)		
WBX065X19R050	Antenna with Remote Electrical Tilt (RET) for AISG v1.1		
WBX065X19R050G	Antenna with Remote Electrical Tilt (RET) for AISG v2.0/3GPP		
Electrical Characteristics	1710-2170 MHz		
Frequency bands	1710-1880 MHz	1850-1990 MHz	1900-2170 MHz
Polarization	±45°	±45°	±45°
Horizontal beamwidth	69°	66°	63°
Vertical beamwidth	4.9°	4.6°	4.3°
Gain	15.9 dBd / 18.0 dBi	16.4 dBd / 18.5 dBi	16.9 dBd / 19.0 dBi
Electrical downtilt	2-10° Variable Electrical Tilt		
Impedance	50Ω		
VSWR	< 1.35:1		
Upper sidelobe suppression	< -18 dB		
First null	> -20 dB typical		
Front-to-back ratio	> 25 dB		
Inter-port isolation	> 30 dB		
IM3 (2x20W carrier)	< -153 dBc		
Input power	2 x 160W		
Connector(s)	2 Ports / 7/16 DIN / Female / Bottom		
Operating temperature	-40° to +60° C / -40° to +140° F		
Mechanical Characteristics			
Dimensions Length x Width x Depth	1950 x 157 x 69 mm	76.8 x 6.2 x 2.7 in	
Weight without mounting brackets	9.5 kg	20.9 lbs	
Survival wind speed	241 km/hr	150 mph	
Wind load @ 161 km/hr (100 mph)	Front: 405 N Side: 176 N	Front: 91 lbf Side: 40 lbf	
RET type / Part number	Internal / RETU-CA01		
Mounting Options	Part Number	Fits Pipe Diameter	Weight
Pole mounting bracket kit	MKS05P01	40-115 mm 1.6-4.5 in	2.9 kg 6.5 lbs
Scissor tilt bracket kit	MKS05T03	40-115 mm 1.6-4.5 in	4.1 kg 9.1 lbs
Bar tilt bracket kit	MKS05T04	40-115 mm 1.6-4.5 in	4.0 kg 8.8 lbs
Concealment Options			
UNICELL module	UNX14-19	UNX20-19	
Azimuth swivel	±30°	±30°	
Elevation tilt	Fixed	Fixed	
Required mounting kit	UNX14-WBX-AZ	UNX20-WBX-AZ	

1710-1880 MHz



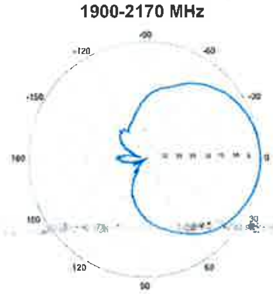
Horizontal

1850-1990 MHz



Horizontal

1900-2170 MHz



Horizontal

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

BXA-70063-6CF-EDIN-X

X-Pol | FET Panel | 63° | 14.5 dBd

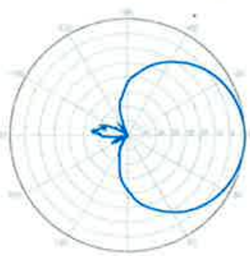
Replace "X" with desired electrical downtilt.

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

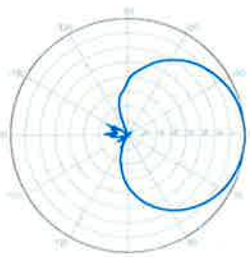
Electrical Characteristics	696-900 MHz	
Frequency bands	696-806 MHz	806-900 MHz
Polarization	±45°	
Horizontal beamwidth	65°	63°
Vertical beamwidth	13°	11°
Gain	14.0 dBd (16.1 dBi)	14.5 dBd (16.6 dBi)
Electrical downtilt (X)	0, 2, 3, 4, 5, 6, 8, 10	
Impedance	50Ω	
VSWR	≤1.35:1	
Upper sidelobe suppression (0°)	-18.3 dB	-18.2 dB
Front-to-back ratio (+/-30°)	-33.4 dB	-36.3 dB
Null fill	5% (-26.02 dB)	
Isolation between ports	< -25 dB	
Input power with EDIN connectors	500 W	
Input power with NE connectors	300 W	
IM3 (2x20W carriers)	< -153 dBc	
Lightning protection	Direct Ground	
Connector(s)	2 Ports / EDIN or NE / Female / Center (Back)	
Mechanical Characteristics		
Dimensions Length x Width x Depth	1804 x 285 x 132 mm	71.0 x 11.2 x 5.2 in
Depth with z-brackets	172 mm	6.8 in
Weight without mounting brackets	7.9 kg	17 lbs
Survival wind speed	> 201 km/hr	> 125 mph
Wind area	Front: 0.51 m² Side: 0.24 m²	Front: 5.5 ft² Side: 2.6 ft²
Wind load @ 161 km/hr (100 mph)	Front: 759 N Side: 391 N	Front: 169 lbf Side: 89 lbf

Mounting Options	Part Number	Fits Pipe Diameter	Weight
3-Point Mounting & Downtilt Bracket Kit	36210008	40-115 mm 1.57-4.5 in	6.9 kg 15.2 lbs
Concealment Configurations	For concealment configurations, order BXA-70063-6CF-EDIN-X-FP		

BXA-70063-6CF-EDIN-X

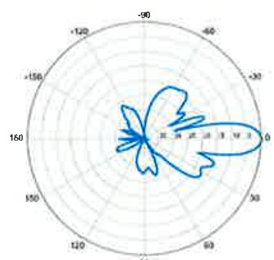


Horizontal | 750 MHz

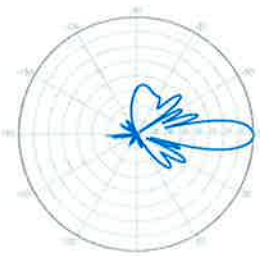


Horizontal | 850 MHz

BXA-70063-6CF-EDIN-0

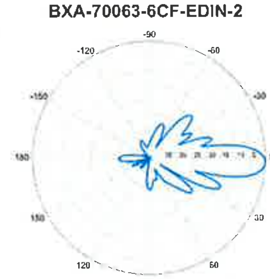


0° | Vertical | 750 MHz

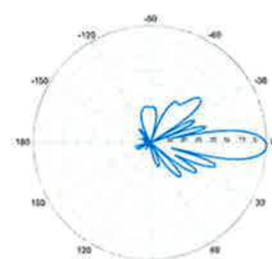


0° | Vertical | 850 MHz

BXA-70063-6CF-EDIN-2



2° | Vertical | 750 MHz



2° | Vertical | 850 MHz

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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

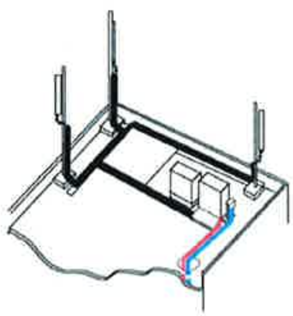
Because of its small size and weight, the Alcatel-Lucent RRH2x40-AWS can be installed close to the antenna. Operators can therefore locate the Alcatel-Lucent RRH2x40-AWS where RF engineering is deemed ideal, minimizing trade-offs between available sites and RF optimum sites. The RF feeder cost and installation 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

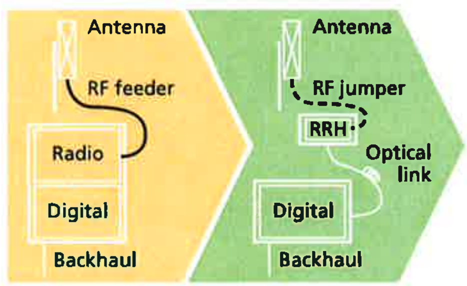
- Zero-footprint deployment
- Easy installation, with a lightweight unit can be carried and set up by one person
- Optimized RF power, with flexible site selection and elimination of a TMA
- Convection-cooled (fanless)
- Noise-free
- Best-in-class power efficiency, with significantly reduced energy consumption

Benefits

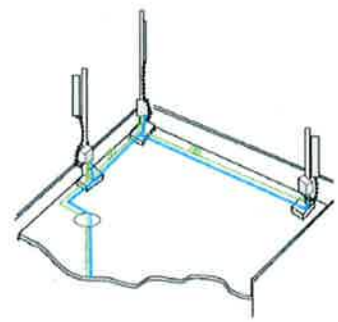
- Leverages existing real estate with lower site costs
- Reduces installation costs, with fewer installation materials and simplified logistics
- Decreases power costs and minimizes environmental impacts, with the potential for eco-sustainable power options
- Improves RF performance and adds flexibility 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 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 IEEE C62.41 NEMA LS-1 IEC 61643-1 IEC 61643-12 EN 61643-11	N/A N/A N/A N/A N/A N/A

* This data is provisional and subject to change.