·T· · ·Mobile·

Please Reply To:
Sam Simons
35 Griffin Road South
Bloomfield, CT 06002
203-482-5156
Sam.Simons@T-Mobile.com

March 6, 2017

Attorney Melanie Bachman
Acting Executive Director
Connecticut Siting Council Ten
Franklin Square
New Britain, CT 06501

**EM-T-MOBILE-105-161003**
T-Mobile Site ID CTNL801A
61-1 Buttonball Road, Old Lyme CT
Notice of Construction Completion

Dear Attorney Bachman:

In correspondence to the rejection letter please see attached revised Structural Analysis Report referenced on the above T- Mobile Northeast LLC ("T-Mobile") notice of exempt modification on October 31, 2016. T-Mobile hereby notifies the Council that construction of the acknowledged modifications were complete as of December 31, 2016.

Please don't hesitate to contact me with any questions.

Sincerely,

Samuel Simons, Engineering Development - Connecticut

cc: Mark Richard, Engineering and Operations

CENTEK engineering

Centered on Solutions℠

# Structural Analysis Report

100-ft Sabre Monopole

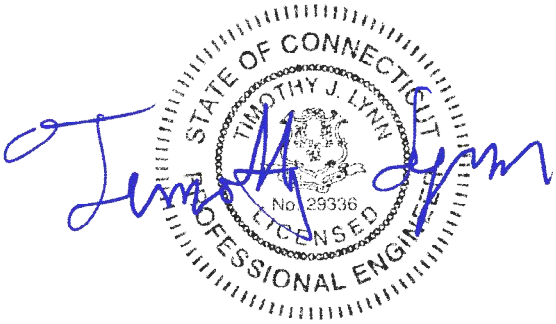
Proposed T-Mobile
Antenna Upgrade

T-Mobile Site Ref: CTNL801A

61-1 Buttonball Road
Old Lyme, CT

Centek Project No. 16159.10

Date: December 6, 2016




**Prepared for:**
T-Mobile USA
35 Griffin Road
Bloomfield, CT 06002

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

# *Table of Contents*

## *Introduction*

The purpose of this report is to summarize the results of the non-linear, P-Δ structural analysis of the antenna upgrade proposed by T-Mobile on the monopole (tower) located in Old Lyme, CT.

The host tower is a 100-ft tall, three-section, eighteen sided, tapered monopole originally designed and manufactured by Sabre Industries dated October 18, 2013. The tower geometry, structure member sizes and foundation system information were obtained from a previous structural analysis report prepared by Destek job no. 1664081 dated September 8, 2016.

Antenna and appurtenance information were obtained from the aforementioned structural report, visual verification from grade conducted by Centek personnel on December 6, 2016 and a RF data sheet.

The tower consists of three (3) tapered vertical sections consisting of A572-65 pole sections. The top tower section is flange connected to the mid tower section and the mid tower section is slip joint connected to the bottom section. The diameter of the pole (flat-flat) is 21.00-in at the top and 37.46-in at the base.

T-Mobile proposes the removal of three (3) panel antennas and the installation of three (3) panel antennas and three (3) RRHs mounted on three (3) proposed T-Arms. 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:

- T-MOBILE (Existing to Relocate):
  Antennas: Three (3) Ericsson AIR21 B2A/B4P panel antennas flush mounted to be relocated to three (3) Site Pro 5-ft T-arms (p/n RMV5-296) with a RAD center elevation of 97-ft above existing grade.
  Coax Cables: Twelve (12) 1-5/8" ∅ coax cables and one (1) 1-1/4" ∅ fiber cable running on the inside of the monopole.
- T-MOBILE (Existing to Remove):
  Antennas: Three (3) Ericsson AIR21 B4A/B2P panel antennas flush mounted with a RAD center elevation of 87-ft above existing grade.
- **T-MOBILE (Proposed):**
  **Antennas: Three (3) Ericsson KRC 118 048/1 panel antennas and three (3) Ericsson RRUS-11 remote radio heads mounted on three (3) Site Pro 5-ft T-arms (p/n RMV5-296) with a RAD center elevation of 95-ft[(1)] above existing grade.**
  ***Note 1: Top of antennas not to exceed top of 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, and the model assumes that the tower members are subjected to bending, axial, and shear forces.

The existing tower was analyzed for the controlling basic wind speed (3-second gust) with no ice and the applicable wind and ice combination to determine stresses in members as per guidelines of TIA-222-G-2005 entitled "Structural Standard for Antenna Support Structures and Antennas", the American Institute of Steel Construction (AISC) and the Manual of Steel Construction; Load and Resistance Factor Design (LRFD).

The controlling wind speed is determined by evaluating the local available wind speed data as provided in Appendix N of the CSBC[1] and the wind speed data available in the TIA-222-G-2005 Standard.

## *Tower Loading*

Tower loading was determined by the basic wind speed as applied to projected surface areas with modification factors per TIA-222-G-2005, gravity loads of the tower structure and its components, and the application of 0.75" radial ice on the tower structure and its components.

| | | |
|---|---|---|
| Basic Wind Speed: | New London; v = 105-120 mph | *[Annex B of TIA-222-G-2005]* |
| | Old Lyme; v = 105 mph | *[Appendix N of the 2016 CT Building Code]* |
| Load Cases: | Load Case 1; 105 mph wind speed w/ no ice plus gravity load – used in calculation of tower stresses and rotation. | *[Appendix N of the 2016 CT Building Code]* |
| | Load Case 2; 50 mph wind speed w/ 0.75" radial ice plus gravity load – used in calculation of tower stresses. | *[Annex B of TIA-222-G-2005]* |

[1] The 2012 International Building Code as amended by the 2016 Connecticut State Building Code (CSBC).

## Tower Capacity

Tower stresses were calculated utilizing the structural analysis software tnxTower. Allowable stresses were determined based on Table 4-8 of the TIA 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 **57.0%** of its total capacity.

| Tower Section | Elevation | Stress Ratio (percentage of capacity) | Result |
|---|---|---|---|
| Pole Shaft (L3) | 1.00'-50.00' | 57.0% | **PASS** |

## Foundation and Anchors

The foundation consists of a 5.5-ft square x 5-ft long reinforced concrete pier on a 17.0-ft square x 1.5-ft thick reinforced concrete pad. The sub-grade conditions used in the analysis of the foundation were obtained from the aforementioned structural report. The base of the tower is connected to the foundation by means of (8) 2.25"∅, ASTM A615 Grade 75 anchor bolts embedded 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 | 12 kips |
| | Compression | 15 kips |
| | Moment | 829 kip-ft |

- The foundation was found to be within allowable limits.

| Foundation | Design Limit | TIA-222-G Section 9.4 FS[(1)] | Proposed Loading (FS)[(1)] | Result |
|---|---|---|---|---|
| Reinforced Concrete Pad and Pier | OTM[(2)] | 1.0 | 1.46 | **PASS** |

*Note 1: FS denotes Factor of Safety.*
*Note 2: OTM denotes Overturning Moment*

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

| Tower Component | Design Limit | Stress Ratio (percentage of capacity) | Result |
|---|---|---|---|
| Anchor Bolts | Combined Compression and Shear | 45.8% | **PASS** |
| Base Plate | Bending | 63.2% | **PASS** |

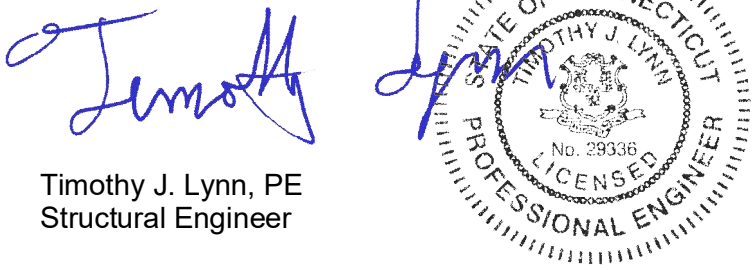
## *Conclusion*

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

The analysis is based, in part, on the information provided to this office by T-Mobile. 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:




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.

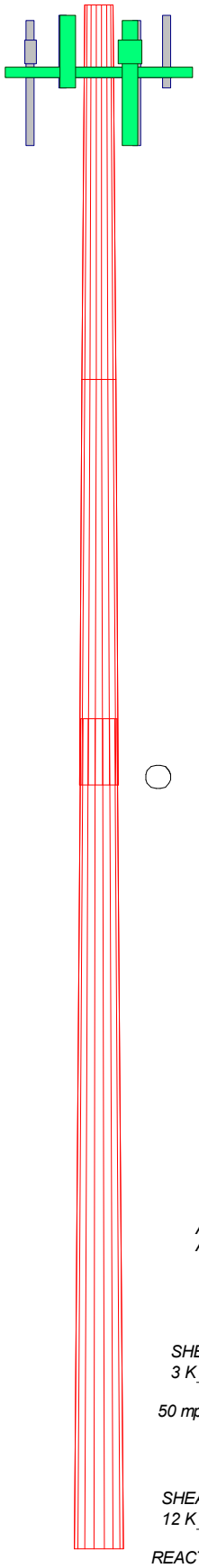
## General Description of Structural Analysis Program

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 | Length (ft) | Number of Sides | Thickness (in) | Socket Length (ft) | Top Dia (in) | Bot Dia (in) | Grade | Weight (K) |
|---|---|---|---|---|---|---|---|---|
| 1 | 24.000 | 18 | 0.188 | | 21.000 | 25.080 | | 1.1 |
| 2 | 26.000 | 18 | 0.188 | 4.250 | 25.080 | 29.500 | | 1.4 |
| 3 | 53.250 | 18 | 0.250 | | 28.403 | 37.460 | | 4.7 |
| | | | | | | | A572-65 | 7.2 |




*ALL REACTIONS ARE FACTORED*

*AXIAL 25 K*
*SHEAR 3 K*
*MOMENT 225 kip-ft*

*50 mph WIND - 0.750 in ICE*

*AXIAL 15 K*
*SHEAR 12 K*
*MOMENT 829 kip-ft*

*REACTIONS - 105 mph WIND*

## DESIGNED APPURTENANCE LOADING

| TYPE | ELEVATION | TYPE | ELEVATION |
|---|---|---|---|
| AIR21 B2A/B4P (T-Mobile - Existing) | 97 | Site Pro RMV5-296 T-ARM (T-Mobile - Proposed) | 96 |
| AIR21 B2A/B4P (T-Mobile - Existing) | 97 | Site Pro RMV5-296 T-ARM (T-Mobile - Proposed) | 96 |
| AIR21 B2A/B4P (T-Mobile - Existing) | 97 | KRC 118 048/1 (T-Mobile - Proposed) | 95 |
| RRUS-11 (T-Mobile - Proposed) | 97 | KRC 118 048/1 (T-Mobile - Proposed) | 95 |
| RRUS-11 (T-Mobile - Proposed) | 97 | KRC 118 048/1 (T-Mobile - Proposed) | 95 |
| RRUS-11 (T-Mobile - Proposed) | 97 | | |
| Site Pro RMV5-296 T-ARM (T-Mobile - Proposed) | 96 | | |

## MATERIAL STRENGTH

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

## TOWER DESIGN NOTES

1. Tower designed for Exposure C to the TIA-222-G Standard.
2. Tower designed for a 105 mph basic wind in accordance with the TIA-222-G Standard.
3. Tower is also designed for a 50 mph basic wind with 0.75 in ice. Ice is considered to increase in thickness with height.
4. Deflections are based upon a 60 mph wind.
5. Tower Structure Class II.
6. Topographic Category 1 with Crest Height of 0.000 ft
7. TOWER RATING: 57%


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


| | | |
|---|---|---|
| Job: **16159.10 - CTNL801A** | | |
| Project: **100-ft Sabre Monopole - 61-1 Buttonball Road Old Lyme, CT** | | |
| Client: T-Mobile | Drawn by: TJL | App'd: |
| Code: TIA-222-G | Date: 12/06/16 | Scale: NTS |
| Path: J:\Jobs\16159\00.WI\10_CTNL801A\Backup Documentation\Calcs\ER Files\107 Sabre Monopole_Old Lyme, CT.eri | | Dwg No. E-1 |

## Tower Input Data

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

Basic wind speed of 105 mph.
Structure Class II.
Exposure Category C.
Topographic Category 1.
Crest Height 0.000 ft.
Nominal ice thickness of 0.750 in.
Ice thickness is considered to increase with height.
Ice density of 56 pcf.
A wind speed of 50 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 60 mph.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.
Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

## Options

| | | | | | |
|---|---|---|---|---|---|
| | Consider Moments - Legs | | Distribute Leg Loads As Uniform | | Use ASCE 10 X-Brace Ly Rules |
| | Consider Moments - Horizontals | | Assume Legs Pinned | | Calculate Redundant Bracing Forces |
| | Consider Moments - Diagonals | √ | Assume Rigid Index Plate | | Ignore Redundant Members in FEA |
| | Use Moment Magnification | | Use Clear Spans For Wind Area | | SR Leg Bolts Resist Compression |
| √ | Use Code Stress Ratios | | Use Clear Spans For KL/r | | All Leg Panels Have Same Allowable |
| √ | Use Code Safety Factors - Guys | | Retension Guys To Initial Tension | | Offset Girt At Foundation |
| | Escalate Ice | √ | Bypass Mast Stability Checks | √ | Consider Feed Line Torque |
| | Always Use Max Kz | | Use Azimuth Dish Coefficients | | Include Angle Block Shear Check |
| | Use Special Wind Profile | √ | Project Wind Area of Appurt. | | Use TIA-222-G Bracing Resist. Exemption |
| | Include Bolts In Member Capacity | | Autocalc Torque Arm Areas | | Use TIA-222-G Tension Splice Exemption |
| | Leg Bolts Are At Top Of Section | | Add IBC .6D+W Combination | | Poles |
| | Secondary Horizontal Braces Leg | √ | Sort Capacity Reports By Component | √ | Include Shear-Torsion Interaction |
| | Use Diamond Inner Bracing (4 Sided) | | Triangulate Diamond Inner Bracing | | Always Use Sub-Critical Flow |
| | SR Members Have Cut Ends | | Treat Feed Line Bundles As Cylinder | | Use Top Mounted Sockets |
| | SR Members Are Concentric | | | | |

## Tapered Pole Section Geometry

| *Section* | *Elevation*<br>*ft* | *Section Length*<br>*ft* | *Splice Length*<br>*ft* | *Number of Sides* | *Top Diameter*<br>*in* | *Bottom Diameter*<br>*in* | *Wall Thickness*<br>*in* | *Bend Radius*<br>*in* | *Pole Grade* |
|---|---|---|---|---|---|---|---|---|---|
| L1 | 100.000-76.000 | 24.000 | 0.000 | 18 | 21.000 | 25.080 | 0.188 | 0.750 | A572-65 (65 ksi) |
| L2 | 76.000-50.000 | 26.000 | 4.250 | 18 | 25.080 | 29.500 | 0.188 | 0.750 | A572-65 (65 ksi) |
| L3 | 50.000-1.000 | 53.250 | | 18 | 28.403 | 37.460 | 0.250 | 1.000 | A572-65 |

| Section | Elevation<br>ft | Section Length<br>ft | Splice Length<br>ft | Number of Sides | Top Diameter<br>in | Bottom Diameter<br>in | Wall Thickness<br>in | Bend Radius<br>in | Pole Grade |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | (65 ksi) |

## Tapered Pole Properties

| Section | Tip Dia.<br>in | Area<br>$in^2$ | I<br>$in^4$ | r<br>in | C<br>in | I/C<br>$in^3$ | J<br>$in^4$ | It/Q<br>$in^2$ | w<br>in | w/t |
|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 21.324 | 12.386 | 677.826 | 7.388 | 10.668 | 63.538 | 1356.544 | 6.194 | 3.366 | 17.952 |
| | 25.467 | 14.814 | 1159.715 | 8.837 | 12.741 | 91.025 | 2320.956 | 7.408 | 4.084 | 21.782 |
| L2 | 25.467 | 14.814 | 1159.715 | 8.837 | 12.741 | 91.025 | 2320.956 | 7.408 | 4.084 | 21.782 |
| | 29.955 | 17.445 | 1893.670 | 10.406 | 14.986 | 126.363 | 3789.831 | 8.724 | 4.862 | 25.931 |
| L3 | 29.575 | 22.339 | 2236.842 | 9.994 | 14.428 | 155.030 | 4476.627 | 11.172 | 4.559 | 18.235 |
| | 38.038 | 29.526 | 5164.918 | 13.210 | 19.030 | 271.414 | 10336.631 | 14.766 | 6.153 | 24.612 |

| Tower Elevation<br>ft | Gusset Area (per face)<br>$ft^2$ | Gusset Thickness<br>in | Gusset Grade | Adjust. Factor $A_f$ | Adjust. Factor $A_r$ | Weight Mult. | Double Angle Stitch Bolt Spacing Diagonals<br>in | Double Angle Stitch Bolt Spacing Horizontals<br>in | Double Angle Stitch Bolt Spacing Redundants<br>in |
|---|---|---|---|---|---|---|---|---|---|
| L1<br>100.000-76.000 | | | | 1 | 1 | 1 | | | |
| L2<br>76.000-50.000 | | | | 1 | 1 | 1 | | | |
| L3<br>50.000-1.000 | | | | 1 | 1 | 1 | | | |

## Feed Line/Linear Appurtenances - Entered As Area

| Description | Face or Leg | Allow Shield | Component Type | Placement<br>ft | Total Number | | $C_AA_A$<br>$ft^2/ft$ | Weight<br>klf |
|---|---|---|---|---|---|---|---|---|
| 1 5/8<br>(T-Mobile - Existing) | C | No | Inside Pole | 100.000 - 1.000 | 12 | No Ice | 0.000 | 0.001 |
| | | | | | | 1/2" Ice | 0.000 | 0.001 |
| | | | | | | 1" Ice | 0.000 | 0.001 |
| HYBRIFLEX 1-1/4"<br>(T-Mobile - Existing) | C | No | Inside Pole | 100.000 - 1.000 | 1 | No Ice | 0.000 | 0.001 |
| | | | | | | 1/2" Ice | 0.000 | 0.001 |
| | | | | | | 1" Ice | 0.000 | 0.001 |

## Feed Line/Linear Appurtenances Section Areas

| Tower Section | Tower Elevation<br>ft | Face | $A_R$<br>$ft^2$ | $A_F$<br>$ft^2$ | $C_AA_A$ In Face<br>$ft^2$ | $C_AA_A$ Out Face<br>$ft^2$ | Weight<br>K |
|---|---|---|---|---|---|---|---|
| L1 | 100.000-76.000 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.000 | 0.000 | 0.000 | 0.000 | 0.331 |
| L2 | 76.000-50.000 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.000 | 0.000 | 0.000 | 0.000 | 0.358 |

| Tower Section | Tower Elevation ft | Face | $A_R$ $ft^2$ | $A_F$ $ft^2$ | $C_AA_A$ In Face $ft^2$ | $C_AA_A$ Out Face $ft^2$ | Weight K |
|---|---|---|---|---|---|---|---|
| L3 | 50.000-1.000 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.000 | 0.000 | 0.000 | 0.000 | 0.675 |

## Feed Line/Linear Appurtenances Section Areas - With Ice

| Tower Section | Tower Elevation ft | Face or Leg | Ice Thickness in | $A_R$ $ft^2$ | $A_F$ $ft^2$ | $C_AA_A$ In Face $ft^2$ | $C_AA_A$ Out Face $ft^2$ | Weight K |
|---|---|---|---|---|---|---|---|---|
| L1 | 100.000-76.000 | A | 1.654 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | | 0.000 | 0.000 | 0.000 | 0.000 | 0.331 |
| L2 | 76.000-50.000 | A | 1.599 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | | 0.000 | 0.000 | 0.000 | 0.000 | 0.358 |
| L3 | 50.000-1.000 | A | 1.463 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | | 0.000 | 0.000 | 0.000 | 0.000 | 0.675 |

## Feed Line Center of Pressure

| Section | Elevation ft | $CP_X$ in | $CP_Z$ in | $CP_X$ Ice in | $CP_Z$ Ice in |
|---|---|---|---|---|---|
| L1 | 100.000-76.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| L2 | 76.000-50.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| L3 | 50.000-1.000 | 0.000 | 0.000 | 0.000 | 0.000 |

## Shielding Factor Ka

| Tower Section | Feed Line Record No. | Description | Feed Line Segment Elev. | $K_a$ No Ice | $K_a$ Ice |
|---|---|---|---|---|---|

## Discrete Tower Loads

| Description | Face or Leg | Offset Type | Offsets: Horz Lateral ft<br>Vert ft<br>ft | Azimuth Adjustment ° | Placement ft | | $C_AA_A$ Front $ft^2$ | $C_AA_A$ Side $ft^2$ | Weight K |
|---|---|---|---|---|---|---|---|---|---|
| AIR21 B2A/B4P | A | From Face | 3.000 | 0.000 | 97.000 | No Ice | 6.049 | 4.356 | 0.083 |
| (T-Mobile - Existing) | | | 2.000 | | | 1/2" Ice | 6.419 | 4.705 | 0.125 |
| | | | 0.000 | | | 1" Ice | 6.795 | 5.061 | 0.172 |
| AIR21 B2A/B4P | B | From Face | 3.000 | 0.000 | 97.000 | No Ice | 6.049 | 4.356 | 0.083 |
| (T-Mobile - Existing) | | | 2.000 | | | 1/2" Ice | 6.419 | 4.705 | 0.125 |

| Description | Face or Leg | Offset Type | Offsets: Horz Lateral ft / Vert ft / ft | Azimuth Adjustment ° | Placement ft | | $C_AA_A$ Front $ft^2$ | $C_AA_A$ Side $ft^2$ | Weight K |
|---|---|---|---|---|---|---|---|---|---|
| | | | 0.000 | | | 1" Ice | 6.795 | 5.061 | 0.172 |
| AIR21 B2A/B4P | C | From Face | 3.000 | 0.000 | 97.000 | No Ice | 6.049 | 4.356 | 0.083 |
| (T-Mobile - Existing) | | | 2.000 | | | 1/2" Ice | 6.419 | 4.705 | 0.125 |
| | | | 0.000 | | | 1" Ice | 6.795 | 5.061 | 0.172 |
| KRC 118 048/1 | A | From Face | 3.000 | 0.000 | 95.000 | No Ice | 11.544 | 8.822 | 0.126 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 12.162 | 9.421 | 0.198 |
| | | | 0.000 | | | 1" Ice | 12.786 | 10.026 | 0.277 |
| KRC 118 048/1 | B | From Face | 3.000 | 0.000 | 95.000 | No Ice | 11.544 | 8.822 | 0.126 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 12.162 | 9.421 | 0.198 |
| | | | 0.000 | | | 1" Ice | 12.786 | 10.026 | 0.277 |
| KRC 118 048/1 | C | From Face | 3.000 | 0.000 | 95.000 | No Ice | 11.544 | 8.822 | 0.126 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 12.162 | 9.421 | 0.198 |
| | | | 0.000 | | | 1" Ice | 12.786 | 10.026 | 0.277 |
| RRUS-11 | A | From Face | 3.000 | 0.000 | 97.000 | No Ice | 2.566 | 1.068 | 0.050 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 2.765 | 1.211 | 0.070 |
| | | | 0.000 | | | 1" Ice | 2.971 | 1.361 | 0.092 |
| RRUS-11 | B | From Face | 3.000 | 0.000 | 97.000 | No Ice | 2.566 | 1.068 | 0.050 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 2.765 | 1.211 | 0.070 |
| | | | 0.000 | | | 1" Ice | 2.971 | 1.361 | 0.092 |
| RRUS-11 | C | From Face | 3.000 | 0.000 | 97.000 | No Ice | 2.566 | 1.068 | 0.050 |
| (T-Mobile - Proposed) | | | -2.000 | | | 1/2" Ice | 2.765 | 1.211 | 0.070 |
| | | | 0.000 | | | 1" Ice | 2.971 | 1.361 | 0.092 |
| Site Pro RMV5-296 T-ARM | A | From Face | 1.000 | 0.000 | 96.000 | No Ice | 8.000 | 8.000 | 0.930 |
| (T-Mobile - Proposed) | | | 0.000 | | | 1/2" Ice | 12.000 | 12.000 | 1.200 |
| | | | 0.000 | | | 1" Ice | 16.000 | 16.000 | 1.470 |
| Site Pro RMV5-296 T-ARM | B | From Face | 1.000 | 0.000 | 96.000 | No Ice | 8.000 | 8.000 | 0.930 |
| (T-Mobile - Proposed) | | | 0.000 | | | 1/2" Ice | 12.000 | 12.000 | 1.200 |
| | | | 0.000 | | | 1" Ice | 16.000 | 16.000 | 1.470 |
| Site Pro RMV5-296 T-ARM | C | From Face | 1.000 | 0.000 | 96.000 | No Ice | 8.000 | 8.000 | 0.930 |
| (T-Mobile - Proposed) | | | 0.000 | | | 1/2" Ice | 12.000 | 12.000 | 1.200 |
| | | | 0.000 | | | 1" Ice | 16.000 | 16.000 | 1.470 |

## Tower Pressures - No Ice

$G_H = 1.100$

| 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 | 87.646 | 1.231 | 0.033 | 46.791 | A | 0.000 | 46.791 | 46.791 | 100.00 | 0.000 | 0.000 |
| 100.000-76.00 | | | | | B | 0.000 | 46.791 | | 100.00 | 0.000 | 0.000 |
| 0 | | | | | C | 0.000 | 46.791 | | 100.00 | 0.000 | 0.000 |
| L2 | 62.649 | 1.147 | 0.031 | 60.040 | A | 0.000 | 60.040 | 60.040 | 100.00 | 0.000 | 0.000 |
| 76.000-50.000 | | | | | B | 0.000 | 60.040 | | 100.00 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 60.040 | | 100.00 | 0.000 | 0.000 |
| L3 | 25.648 | 0.95 | 0.025 | 138.042 | A | 0.000 | 138.042 | 138.042 | 100.00 | 0.000 | 0.000 |
| 50.000-1.000 | | | | | B | 0.000 | 138.042 | | 100.00 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 138.042 | | 100.00 | 0.000 | 0.000 |

## Tower Pressure - With Ice

$G_H = 1.100$

| Section Elevation ft | z ft | $K_Z$ | $q_z$ ksf | $t_Z$ in | $A_G$ ft² | Face | $A_F$ ft² | $A_R$ ft² | $A_{leg}$ ft² | Leg % | $C_AA_A$ In Face ft² | $C_AA_A$ Out Face ft² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 87.646 | 1.231 | 0.007 | 1.654 | 53.407 | A | 0.000 | 53.407 | 53.407 | 100.00 | 0.000 | 0.000 |
| 100.000-76.000 | | | | | | B | 0.000 | 53.407 | | 100.00 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 53.407 | | 100.00 | 0.000 | 0.000 |
| L2 | 62.649 | 1.147 | 0.007 | 1.599 | 66.971 | A | 0.000 | 66.971 | 66.971 | 100.00 | 0.000 | 0.000 |
| 76.000-50.000 | | | | | | B | 0.000 | 66.971 | | 100.00 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 66.971 | | 100.00 | 0.000 | 0.000 |
| L3 50.000-1.000 | 25.648 | 0.95 | 0.006 | 1.463 | 151.103 | A | 0.000 | 151.103 | 151.103 | 100.00 | 0.000 | 0.000 |
| | | | | | | B | 0.000 | 151.103 | | 100.00 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 151.103 | | 100.00 | 0.000 | 0.000 |

## Tower Pressure - Service

$G_H = 1.100$

| Section Elevation ft | z ft | $K_Z$ | $q_z$ ksf | $A_G$ ft² | Face | $A_F$ ft² | $A_R$ ft² | $A_{leg}$ ft² | Leg % | $C_AA_A$ In Face ft² | $C_AA_A$ Out Face ft² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 87.646 | 1.231 | 0.010 | 46.791 | A | 0.000 | 46.791 | 46.791 | 100.00 | 0.000 | 0.000 |
| 100.000-76.00 | | | | | B | 0.000 | 46.791 | | 100.00 | 0.000 | 0.000 |
| 0 | | | | | C | 0.000 | 46.791 | | 100.00 | 0.000 | 0.000 |
| L2 | 62.649 | 1.147 | 0.009 | 60.040 | A | 0.000 | 60.040 | 60.040 | 100.00 | 0.000 | 0.000 |
| 76.000-50.000 | | | | | B | 0.000 | 60.040 | | 100.00 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 60.040 | | 100.00 | 0.000 | 0.000 |
| L3 | 25.648 | 0.95 | 0.007 | 138.042 | A | 0.000 | 138.042 | 138.042 | 100.00 | 0.000 | 0.000 |
| 50.000-1.000 | | | | | B | 0.000 | 138.042 | | 100.00 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 138.042 | | 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 | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.033 | 1 | 1 | 46.791 | 1.104 | 0.046 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.031 | 1 | 1 | 60.040 | 1.320 | 0.051 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.025 | 1 | 1 | 138.042 | 2.472 | 0.050 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 237.993 kip-ft | 4.896 | | |

## Tower Forces - No Ice - Wind 45 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.033 | 1 | 1 | 46.791 | 1.104 | 0.046 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.031 | 1 | 1 | 60.040 | 1.320 | 0.051 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.025 | 1 | 1 | 138.042 | 2.472 | 0.050 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 237.993 kip-ft | 4.896 | | |

## Tower Forces - No Ice - Wind 60 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.033 | 1 | 1 | 46.791 | 1.104 | 0.046 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.031 | 1 | 1 | 60.040 | 1.320 | 0.051 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.025 | 1 | 1 | 138.042 | 2.472 | 0.050 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 237.993 kip-ft | 4.896 | | |

## Tower Forces - No Ice - Wind 90 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.033 | 1 | 1 | 46.791 | 1.104 | 0.046 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.031 | 1 | 1 | 60.040 | 1.320 | 0.051 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.025 | 1 | 1 | 138.042 | 2.472 | 0.050 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 237.993 kip-ft | 4.896 | | |

## Tower Forces - With Ice - Wind Normal To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 2.321 | A | 1 | 1.2 | 0.007 | 1 | 1 | 53.407 | 0.528 | 0.022 | C |
| 100.000-76.00 | | | B | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| 0 | | | C | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| L2 | 0.358 | 2.910 | A | 1 | 1.2 | 0.007 | 1 | 1 | 66.971 | 0.616 | 0.024 | C |
| 76.000-50.000 | | | B | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| L3 | 0.675 | 7.774 | A | 1 | 1.2 | 0.006 | 1 | 1 | 151.103 | 1.133 | 0.023 | C |
| 50.000-1.000 | | | B | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| Sum Weight: | 1.364 | 13.004 | | | | | | OTM | 111.640 kip-ft | 2.277 | | |

## Tower Forces - With Ice - Wind 45 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 2.321 | A | 1 | 1.2 | 0.007 | 1 | 1 | 53.407 | 0.528 | 0.022 | C |
| 100.000-76.00 | | | B | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| 0 | | | C | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| L2 | 0.358 | 2.910 | A | 1 | 1.2 | 0.007 | 1 | 1 | 66.971 | 0.616 | 0.024 | C |
| 76.000-50.000 | | | B | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| L3 | 0.675 | 7.774 | A | 1 | 1.2 | 0.006 | 1 | 1 | 151.103 | 1.133 | 0.023 | C |
| 50.000-1.000 | | | B | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| Sum Weight: | 1.364 | 13.004 | | | | | | OTM | 111.640 kip-ft | 2.277 | | |

## Tower Forces - With Ice - Wind 60 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 2.321 | A | 1 | 1.2 | 0.007 | 1 | 1 | 53.407 | 0.528 | 0.022 | C |
| 100.000-76.00 | | | B | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| 0 | | | C | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| L2 | 0.358 | 2.910 | A | 1 | 1.2 | 0.007 | 1 | 1 | 66.971 | 0.616 | 0.024 | C |
| 76.000-50.000 | | | B | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| L3 | 0.675 | 7.774 | A | 1 | 1.2 | 0.006 | 1 | 1 | 151.103 | 1.133 | 0.023 | C |
| 50.000-1.000 | | | B | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| Sum Weight: | 1.364 | 13.004 | | | | | | OTM | 111.640 kip-ft | 2.277 | | |

## Tower Forces - With Ice - Wind 90 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 2.321 | A | 1 | 1.2 | 0.007 | 1 | 1 | 53.407 | 0.528 | 0.022 | C |
| 100.000-76.00 | | | B | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| 0 | | | C | 1 | 1.2 | | 1 | 1 | 53.407 | | | |
| L2 | 0.358 | 2.910 | A | 1 | 1.2 | 0.007 | 1 | 1 | 66.971 | 0.616 | 0.024 | C |
| 76.000-50.000 | | | B | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 66.971 | | | |
| L3 | 0.675 | 7.774 | A | 1 | 1.2 | 0.006 | 1 | 1 | 151.103 | 1.133 | 0.023 | C |
| 50.000-1.000 | | | B | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| | | | C | 1 | 1.2 | | 1 | 1 | 151.103 | | | |
| Sum Weight: | 1.364 | 13.004 | | | | | | OTM | 111.640 kip-ft | 2.277 | | |

## Tower Forces - Service - Wind Normal To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.010 | 1 | 1 | 46.791 | 0.323 | 0.013 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.009 | 1 | 1 | 60.040 | 0.386 | 0.015 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.007 | 1 | 1 | 138.042 | 0.722 | 0.015 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 69.532 kip-ft | 1.431 | | |

## Tower Forces - Service - Wind 45 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.010 | 1 | 1 | 46.791 | 0.323 | 0.013 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.009 | 1 | 1 | 60.040 | 0.386 | 0.015 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.007 | 1 | 1 | 138.042 | 0.722 | 0.015 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 69.532 kip-ft | 1.431 | | |

## Tower Forces - Service - Wind 60 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.010 | 1 | 1 | 46.791 | 0.323 | 0.013 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.009 | 1 | 1 | 60.040 | 0.386 | 0.015 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.007 | 1 | 1 | 138.042 | 0.722 | 0.015 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 69.532 kip-ft | 1.431 | | |

## Tower Forces - Service - Wind 90 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $q_z$ ksf | $D_F$ | $D_R$ | $A_E$ ft² | F K | w klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L1 | 0.331 | 1.111 | A | 1 | 0.65 | 0.010 | 1 | 1 | 46.791 | 0.323 | 0.013 | C |
| 100.000-76.00 | | | B | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| 0 | | | C | 1 | 0.65 | | 1 | 1 | 46.791 | | | |
| L2 | 0.358 | 1.427 | A | 1 | 0.65 | 0.009 | 1 | 1 | 60.040 | 0.386 | 0.015 | C |
| 76.000-50.000 | | | B | 1 | 0.65 | | 1 | 1 | 60.040 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 60.040 | | | |

| Section Elevation<br>ft | Add Weight<br>K | Self Weight<br>K | Face | e | $C_F$ | $q_z$<br>ksf | $D_F$ | $D_R$ | $A_E$<br>ft² | F<br>K | w<br>klf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| L3 | 0.675 | 4.699 | A | 1 | 0.65 | 0.007 | 1 | 1 | 138.042 | 0.722 | 0.015 | C |
| 50.000-1.000 | | | B | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| | | | C | 1 | 0.65 | | 1 | 1 | 138.042 | | | |
| Sum Weight: | 1.364 | 7.237 | | | | | | OTM | 69.532 kip-ft | 1.431 | | |

## Force Totals

| Load Case | Vertical Forces<br>K | Sum of Forces X<br>K | Sum of Forces Z<br>K | Sum of Overturning Moments, $M_x$<br>kip-ft | Sum of Overturning Moments, $M_z$<br>kip-ft | Sum of Torques<br>kip-ft |
|---|---|---|---|---|---|---|
| Leg Weight | 7.237 | | | | | |
| Bracing Weight | 0.000 | | | | | |
| Total Member Self-Weight | 7.237 | | | 0.000 | 0.000 | |
| Total Weight | 12.168 | | | 0.000 | 0.000 | |
| Wind 0 deg - No Ice | | 0.000 | -7.694 | -503.399 | 0.000 | 0.000 |
| Wind 30 deg - No Ice | | 3.847 | -6.663 | -435.957 | -251.700 | 0.000 |
| Wind 45 deg - No Ice | | 5.440 | -5.440 | -355.957 | -355.957 | 0.000 |
| Wind 60 deg - No Ice | | 6.663 | -3.847 | -251.700 | -435.957 | 0.000 |
| Wind 90 deg - No Ice | | 7.694 | 0.000 | 0.000 | -503.399 | 0.000 |
| Wind 120 deg - No Ice | | 6.663 | 3.847 | 251.700 | -435.957 | 0.000 |
| Wind 135 deg - No Ice | | 5.440 | 5.440 | 355.957 | -355.957 | 0.000 |
| Wind 150 deg - No Ice | | 3.847 | 6.663 | 435.957 | -251.700 | 0.000 |
| Wind 180 deg - No Ice | | 0.000 | 7.694 | 503.399 | 0.000 | 0.000 |
| Wind 210 deg - No Ice | | -3.847 | 6.663 | 435.957 | 251.700 | 0.000 |
| Wind 225 deg - No Ice | | -5.440 | 5.440 | 355.957 | 355.957 | 0.000 |
| Wind 240 deg - No Ice | | -6.663 | 3.847 | 251.700 | 435.957 | 0.000 |
| Wind 270 deg - No Ice | | -7.694 | 0.000 | 0.000 | 503.399 | 0.000 |
| Wind 300 deg - No Ice | | -6.663 | -3.847 | -251.700 | 435.957 | 0.000 |
| Wind 315 deg - No Ice | | -5.440 | -5.440 | -355.957 | 355.957 | 0.000 |
| Wind 330 deg - No Ice | | -3.847 | -6.663 | -435.957 | 251.700 | 0.000 |
| Member Ice | 5.767 | | | | | |
| Total Weight Ice | 22.182 | | | 0.000 | 0.000 | |
| Wind 0 deg - Ice | | 0.000 | -3.345 | -213.032 | 0.000 | 0.000 |
| Wind 30 deg - Ice | | 1.672 | -2.897 | -184.491 | -106.516 | 0.000 |
| Wind 45 deg - Ice | | 2.365 | -2.365 | -150.636 | -150.636 | 0.000 |
| Wind 60 deg - Ice | | 2.897 | -1.672 | -106.516 | -184.491 | 0.000 |
| Wind 90 deg - Ice | | 3.345 | 0.000 | 0.000 | -213.032 | 0.000 |
| Wind 120 deg - Ice | | 2.897 | 1.672 | 106.516 | -184.491 | 0.000 |
| Wind 135 deg - Ice | | 2.365 | 2.365 | 150.636 | -150.636 | 0.000 |
| Wind 150 deg - Ice | | 1.672 | 2.897 | 184.491 | -106.516 | 0.000 |
| Wind 180 deg - Ice | | 0.000 | 3.345 | 213.032 | 0.000 | 0.000 |
| Wind 210 deg - Ice | | -1.672 | 2.897 | 184.491 | 106.516 | 0.000 |
| Wind 225 deg - Ice | | -2.365 | 2.365 | 150.636 | 150.636 | 0.000 |
| Wind 240 deg - Ice | | -2.897 | 1.672 | 106.516 | 184.491 | 0.000 |
| Wind 270 deg - Ice | | -3.345 | 0.000 | 0.000 | 213.032 | 0.000 |
| Wind 300 deg - Ice | | -2.897 | -1.672 | -106.516 | 184.491 | 0.000 |
| Wind 315 deg - Ice | | -2.365 | -2.365 | -150.636 | 150.636 | 0.000 |
| Wind 330 deg - Ice | | -1.672 | -2.897 | -184.491 | 106.516 | 0.000 |
| Total Weight | 12.168 | | | 0.000 | 0.000 | |
| Wind 0 deg - Service | | 0.000 | -2.248 | -147.073 | 0.000 | 0.000 |
| Wind 30 deg - Service | | 1.124 | -1.947 | -127.369 | -73.536 | 0.000 |
| Wind 45 deg - Service | | 1.589 | -1.589 | -103.996 | -103.996 | 0.000 |

| Load Case | Vertical Forces K | Sum of Forces X K | Sum of Forces Z K | Sum of Overturning Moments, $M_x$ kip-ft | Sum of Overturning Moments, $M_z$ kip-ft | Sum of Torques kip-ft |
|---|---|---|---|---|---|---|
| Wind 60 deg - Service | | 1.947 | -1.124 | -73.536 | -127.369 | 0.000 |
| Wind 90 deg - Service | | 2.248 | 0.000 | 0.000 | -147.073 | 0.000 |
| Wind 120 deg - Service | | 1.947 | 1.124 | 73.536 | -127.369 | 0.000 |
| Wind 135 deg - Service | | 1.589 | 1.589 | 103.996 | -103.996 | 0.000 |
| Wind 150 deg - Service | | 1.124 | 1.947 | 127.369 | -73.536 | 0.000 |
| Wind 180 deg - Service | | 0.000 | 2.248 | 147.073 | 0.000 | 0.000 |
| Wind 210 deg - Service | | -1.124 | 1.947 | 127.369 | 73.536 | 0.000 |
| Wind 225 deg - Service | | -1.589 | 1.589 | 103.996 | 103.996 | 0.000 |
| Wind 240 deg - Service | | -1.947 | 1.124 | 73.536 | 127.369 | 0.000 |
| Wind 270 deg - Service | | -2.248 | 0.000 | 0.000 | 147.073 | 0.000 |
| Wind 300 deg - Service | | -1.947 | -1.124 | -73.536 | 127.369 | 0.000 |
| Wind 315 deg - Service | | -1.589 | -1.589 | -103.996 | 103.996 | 0.000 |
| Wind 330 deg - Service | | -1.124 | -1.947 | -127.369 | 73.536 | 0.000 |

## Load Combinations

| Comb. No. | Description |
|---|---|
| 1 | Dead Only |
| 2 | 1.2 Dead+1.6 Wind 0 deg - No Ice |
| 3 | 0.9 Dead+1.6 Wind 0 deg - No Ice |
| 4 | 1.2 Dead+1.6 Wind 30 deg - No Ice |
| 5 | 0.9 Dead+1.6 Wind 30 deg - No Ice |
| 6 | 1.2 Dead+1.6 Wind 45 deg - No Ice |
| 7 | 0.9 Dead+1.6 Wind 45 deg - No Ice |
| 8 | 1.2 Dead+1.6 Wind 60 deg - No Ice |
| 9 | 0.9 Dead+1.6 Wind 60 deg - No Ice |
| 10 | 1.2 Dead+1.6 Wind 90 deg - No Ice |
| 11 | 0.9 Dead+1.6 Wind 90 deg - No Ice |
| 12 | 1.2 Dead+1.6 Wind 120 deg - No Ice |
| 13 | 0.9 Dead+1.6 Wind 120 deg - No Ice |
| 14 | 1.2 Dead+1.6 Wind 135 deg - No Ice |
| 15 | 0.9 Dead+1.6 Wind 135 deg - No Ice |
| 16 | 1.2 Dead+1.6 Wind 150 deg - No Ice |
| 17 | 0.9 Dead+1.6 Wind 150 deg - No Ice |
| 18 | 1.2 Dead+1.6 Wind 180 deg - No Ice |
| 19 | 0.9 Dead+1.6 Wind 180 deg - No Ice |
| 20 | 1.2 Dead+1.6 Wind 210 deg - No Ice |
| 21 | 0.9 Dead+1.6 Wind 210 deg - No Ice |
| 22 | 1.2 Dead+1.6 Wind 225 deg - No Ice |
| 23 | 0.9 Dead+1.6 Wind 225 deg - No Ice |
| 24 | 1.2 Dead+1.6 Wind 240 deg - No Ice |
| 25 | 0.9 Dead+1.6 Wind 240 deg - No Ice |
| 26 | 1.2 Dead+1.6 Wind 270 deg - No Ice |
| 27 | 0.9 Dead+1.6 Wind 270 deg - No Ice |
| 28 | 1.2 Dead+1.6 Wind 300 deg - No Ice |
| 29 | 0.9 Dead+1.6 Wind 300 deg - No Ice |
| 30 | 1.2 Dead+1.6 Wind 315 deg - No Ice |
| 31 | 0.9 Dead+1.6 Wind 315 deg - No Ice |
| 32 | 1.2 Dead+1.6 Wind 330 deg - No Ice |
| 33 | 0.9 Dead+1.6 Wind 330 deg - No Ice |
| 34 | 1.2 Dead+1.0 Ice+1.0 Temp |
| 35 | 1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp |
| 36 | 1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp |
| 37 | 1.2 Dead+1.0 Wind 45 deg+1.0 Ice+1.0 Temp |
| 38 | 1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp |

| Comb. No. | Description |
|---|---|
| 39 | 1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp |
| 40 | 1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp |
| 41 | 1.2 Dead+1.0 Wind 135 deg+1.0 Ice+1.0 Temp |
| 42 | 1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp |
| 43 | 1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp |
| 44 | 1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp |
| 45 | 1.2 Dead+1.0 Wind 225 deg+1.0 Ice+1.0 Temp |
| 46 | 1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp |
| 47 | 1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp |
| 48 | 1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp |
| 49 | 1.2 Dead+1.0 Wind 315 deg+1.0 Ice+1.0 Temp |
| 50 | 1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp |
| 51 | Dead+Wind 0 deg - Service |
| 52 | Dead+Wind 30 deg - Service |
| 53 | Dead+Wind 45 deg - Service |
| 54 | Dead+Wind 60 deg - Service |
| 55 | Dead+Wind 90 deg - Service |
| 56 | Dead+Wind 120 deg - Service |
| 57 | Dead+Wind 135 deg - Service |
| 58 | Dead+Wind 150 deg - Service |
| 59 | Dead+Wind 180 deg - Service |
| 60 | Dead+Wind 210 deg - Service |
| 61 | Dead+Wind 225 deg - Service |
| 62 | Dead+Wind 240 deg - Service |
| 63 | Dead+Wind 270 deg - Service |
| 64 | Dead+Wind 300 deg - Service |
| 65 | Dead+Wind 315 deg - Service |
| 66 | Dead+Wind 330 deg - Service |

## Maximum Member Forces

| Section No. | Elevation ft | Component Type | Condition | Gov. Load Comb. | Axial K | Major Axis Moment kip-ft | Minor Axis Moment kip-ft |
|---|---|---|---|---|---|---|---|
| L1 | 100 - 76 | Pole | Max Tension | 18 | 0.000 | 0.000 | 0.000 |
| | | | Max. Compression | 34 | -11.467 | 0.000 | 0.000 |
| | | | Max. Mx | 10 | -5.676 | -115.235 | 0.000 |
| | | | Max. My | 2 | -5.676 | 0.000 | 115.235 |
| | | | Max. Vy | 10 | 6.548 | -115.235 | 0.000 |
| | | | Max. Vx | 2 | -6.548 | 0.000 | 115.235 |
| | | | Max. Torque | 16 | | | 0.000 |
| L2 | 76 - 50 | Pole | Max Tension | 1 | 0.000 | 0.000 | 0.000 |
| | | | Max. Compression | 34 | -14.481 | 0.000 | 0.000 |
| | | | Max. Mx | 10 | -7.472 | -276.132 | 0.000 |
| | | | Max. My | 18 | -7.472 | 0.000 | -276.132 |
| | | | Max. Vy | 10 | 8.278 | -276.132 | 0.000 |
| | | | Max. Vx | 18 | 8.278 | 0.000 | -276.132 |
| | | | Max. Torque | 20 | | | -0.000 |
| L3 | 50 - 1 | Pole | Max Tension | 1 | 0.000 | 0.000 | 0.000 |
| | | | Max. Compression | 34 | -24.883 | 0.000 | 0.000 |
| | | | Max. Mx | 10 | -14.589 | -828.531 | 0.000 |
| | | | Max. My | 2 | -14.589 | 0.000 | 828.531 |
| | | | Max. Vy | 10 | 12.325 | -828.531 | 0.000 |
| | | | Max. Vx | 2 | -12.325 | 0.000 | 828.531 |
| | | | Max. Torque | 20 | | | -0.000 |

## Maximum Reactions

| Location | Condition | Gov. Load Comb. | Vertical K | Horizontal, X K | Horizontal, Z K |
|---|---|---|---|---|---|
| Pole | Max. Vert | 35 | 24.883 | 0.000 | 3.345 |
| | Max. $H_x$ | 26 | 14.601 | 12.310 | 0.000 |
| | Max. $H_z$ | 2 | 14.601 | 0.000 | 12.310 |
| | Max. $M_x$ | 2 | 828.531 | 0.000 | 12.310 |
| | Max. $M_z$ | 10 | 828.531 | -12.310 | 0.000 |
| | Max. Torsion | 16 | 0.000 | -6.155 | -10.661 |
| | Min. Vert | 23 | 10.951 | 8.705 | -8.705 |
| | Min. $H_x$ | 10 | 14.601 | -12.310 | 0.000 |
| | Min. $H_z$ | 18 | 14.601 | 0.000 | -12.310 |
| | Min. $M_x$ | 18 | -828.531 | 0.000 | -12.310 |
| | Min. $M_z$ | 26 | -828.531 | 12.310 | 0.000 |
| | Min. Torsion | 20 | -0.000 | 6.155 | -10.661 |

## 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 | 12.168 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1.2 Dead+1.6 Wind 0 deg - No Ice | 14.601 | 0.000 | -12.310 | -828.531 | 0.000 | 0.000 |
| 0.9 Dead+1.6 Wind 0 deg - No Ice | 10.951 | 0.000 | -12.310 | -822.483 | 0.000 | 0.000 |
| 1.2 Dead+1.6 Wind 30 deg - No Ice | 14.601 | 6.155 | -10.661 | -717.529 | -414.266 | 0.000 |
| 0.9 Dead+1.6 Wind 30 deg - No Ice | 10.951 | 6.155 | -10.661 | -712.292 | -411.242 | 0.000 |
| 1.2 Dead+1.6 Wind 45 deg - No Ice | 14.601 | 8.705 | -8.705 | -585.860 | -585.860 | 0.000 |
| 0.9 Dead+1.6 Wind 45 deg - No Ice | 10.951 | 8.705 | -8.705 | -581.584 | -581.584 | 0.000 |
| 1.2 Dead+1.6 Wind 60 deg - No Ice | 14.601 | 10.661 | -6.155 | -414.266 | -717.529 | -0.000 |
| 0.9 Dead+1.6 Wind 60 deg - No Ice | 10.951 | 10.661 | -6.155 | -411.242 | -712.292 | -0.000 |
| 1.2 Dead+1.6 Wind 90 deg - No Ice | 14.601 | 12.310 | 0.000 | 0.000 | -828.531 | 0.000 |
| 0.9 Dead+1.6 Wind 90 deg - No Ice | 10.951 | 12.310 | 0.000 | 0.000 | -822.483 | 0.000 |
| 1.2 Dead+1.6 Wind 120 deg - No Ice | 14.601 | 10.661 | 6.155 | 414.266 | -717.529 | 0.000 |
| 0.9 Dead+1.6 Wind 120 deg - No Ice | 10.951 | 10.661 | 6.155 | 411.242 | -712.292 | 0.000 |
| 1.2 Dead+1.6 Wind 135 deg - No Ice | 14.601 | 8.705 | 8.705 | 585.860 | -585.860 | 0.000 |
| 0.9 Dead+1.6 Wind 135 deg - No Ice | 10.951 | 8.705 | 8.705 | 581.584 | -581.584 | 0.000 |
| 1.2 Dead+1.6 Wind 150 deg - No Ice | 14.601 | 6.155 | 10.661 | 717.529 | -414.266 | -0.000 |
| 0.9 Dead+1.6 Wind 150 deg - No Ice | 10.951 | 6.155 | 10.661 | 712.292 | -411.242 | -0.000 |
| 1.2 Dead+1.6 Wind 180 deg - No Ice | 14.601 | 0.000 | 12.310 | 828.531 | 0.000 | 0.000 |
| 0.9 Dead+1.6 Wind 180 deg - | 10.951 | 0.000 | 12.310 | 822.483 | 0.000 | 0.000 |

| 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 |
| No Ice<br>1.2 Dead+1.6 Wind 210 deg - No Ice | 14.601 | -6.155 | 10.661 | 717.529 | 414.266 | 0.000 |
| 0.9 Dead+1.6 Wind 210 deg - No Ice | 10.951 | -6.155 | 10.661 | 712.292 | 411.242 | 0.000 |
| 1.2 Dead+1.6 Wind 225 deg - No Ice | 14.601 | -8.705 | 8.705 | 585.860 | 585.860 | 0.000 |
| 0.9 Dead+1.6 Wind 225 deg - No Ice | 10.951 | -8.705 | 8.705 | 581.584 | 581.584 | 0.000 |
| 1.2 Dead+1.6 Wind 240 deg - No Ice | 14.601 | -10.661 | 6.155 | 414.266 | 717.529 | -0.000 |
| 0.9 Dead+1.6 Wind 240 deg - No Ice | 10.951 | -10.661 | 6.155 | 411.242 | 712.292 | -0.000 |
| 1.2 Dead+1.6 Wind 270 deg - No Ice | 14.601 | -12.310 | 0.000 | 0.000 | 828.531 | 0.000 |
| 0.9 Dead+1.6 Wind 270 deg - No Ice | 10.951 | -12.310 | 0.000 | 0.000 | 822.483 | 0.000 |
| 1.2 Dead+1.6 Wind 300 deg - No Ice | 14.601 | -10.661 | -6.155 | -414.266 | 717.529 | 0.000 |
| 0.9 Dead+1.6 Wind 300 deg - No Ice | 10.951 | -10.661 | -6.155 | -411.242 | 712.292 | 0.000 |
| 1.2 Dead+1.6 Wind 315 deg - No Ice | 14.601 | -8.705 | -8.705 | -585.860 | 585.860 | 0.000 |
| 0.9 Dead+1.6 Wind 315 deg - No Ice | 10.951 | -8.705 | -8.705 | -581.584 | 581.584 | 0.000 |
| 1.2 Dead+1.6 Wind 330 deg - No Ice | 14.601 | -6.155 | -10.661 | -717.529 | 414.266 | -0.000 |
| 0.9 Dead+1.6 Wind 330 deg - No Ice | 10.951 | -6.155 | -10.661 | -712.292 | 411.242 | -0.000 |
| 1.2 Dead+1.0 Ice+1.0 Temp | 24.883 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| 1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp | 24.883 | 0.000 | -3.345 | -224.835 | 0.000 | 0.000 |
| 1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp | 24.883 | 1.672 | -2.897 | -194.713 | -112.417 | 0.000 |
| 1.2 Dead+1.0 Wind 45 deg+1.0 Ice+1.0 Temp | 24.883 | 2.365 | -2.365 | -158.982 | -158.982 | 0.000 |
| 1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp | 24.883 | 2.897 | -1.672 | -112.417 | -194.713 | -0.000 |
| 1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp | 24.883 | 3.345 | 0.000 | 0.000 | -224.835 | 0.000 |
| 1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp | 24.883 | 2.897 | 1.672 | 112.417 | -194.713 | 0.000 |
| 1.2 Dead+1.0 Wind 135 deg+1.0 Ice+1.0 Temp | 24.883 | 2.365 | 2.365 | 158.982 | -158.982 | 0.000 |
| 1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp | 24.883 | 1.672 | 2.897 | 194.713 | -112.417 | -0.000 |
| 1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp | 24.883 | 0.000 | 3.345 | 224.835 | 0.000 | 0.000 |
| 1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp | 24.883 | -1.672 | 2.897 | 194.713 | 112.417 | 0.000 |
| 1.2 Dead+1.0 Wind 225 deg+1.0 Ice+1.0 Temp | 24.883 | -2.365 | 2.365 | 158.982 | 158.982 | 0.000 |
| 1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp | 24.883 | -2.897 | 1.672 | 112.417 | 194.713 | -0.000 |
| 1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp | 24.883 | -3.345 | 0.000 | 0.000 | 224.835 | 0.000 |
| 1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp | 24.883 | -2.897 | -1.672 | -112.417 | 194.713 | 0.000 |
| 1.2 Dead+1.0 Wind 315 deg+1.0 Ice+1.0 Temp | 24.883 | -2.365 | -2.365 | -158.982 | 158.982 | 0.000 |
| 1.2 Dead+1.0 Wind 330 | 24.883 | -1.672 | -2.897 | -194.713 | 112.417 | -0.000 |

| 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 |
| deg+1.0 Ice+1.0 Temp | | | | | | |
| Dead+Wind 0 deg - Service | 12.168 | 0.000 | -2.248 | -150.634 | 0.000 | 0.000 |
| Dead+Wind 30 deg - Service | 12.168 | 1.124 | -1.947 | -130.453 | -75.317 | 0.000 |
| Dead+Wind 45 deg - Service | 12.168 | 1.589 | -1.589 | -106.515 | -106.515 | 0.000 |
| Dead+Wind 60 deg - Service | 12.168 | 1.947 | -1.124 | -75.317 | -130.453 | -0.000 |
| Dead+Wind 90 deg - Service | 12.168 | 2.248 | 0.000 | 0.000 | -150.634 | 0.000 |
| Dead+Wind 120 deg - Service | 12.168 | 1.947 | 1.124 | 75.317 | -130.453 | 0.000 |
| Dead+Wind 135 deg - Service | 12.168 | 1.589 | 1.589 | 106.515 | -106.515 | 0.000 |
| Dead+Wind 150 deg - Service | 12.168 | 1.124 | 1.947 | 130.453 | -75.317 | -0.000 |
| Dead+Wind 180 deg - Service | 12.168 | 0.000 | 2.248 | 150.634 | 0.000 | 0.000 |
| Dead+Wind 210 deg - Service | 12.168 | -1.124 | 1.947 | 130.453 | 75.317 | 0.000 |
| Dead+Wind 225 deg - Service | 12.168 | -1.589 | 1.589 | 106.515 | 106.515 | 0.000 |
| Dead+Wind 240 deg - Service | 12.168 | -1.947 | 1.124 | 75.317 | 130.453 | -0.000 |
| Dead+Wind 270 deg - Service | 12.168 | -2.248 | 0.000 | 0.000 | 150.634 | 0.000 |
| Dead+Wind 300 deg - Service | 12.168 | -1.947 | -1.124 | -75.317 | 130.453 | 0.000 |
| Dead+Wind 315 deg - Service | 12.168 | -1.589 | -1.589 | -106.515 | 106.515 | 0.000 |
| Dead+Wind 330 deg - Service | 12.168 | -1.124 | -1.947 | -130.453 | 75.317 | -0.000 |

# Solution Summary

| | Sum of Applied Forces | | | Sum of Reactions | | | |
|---|---|---|---|---|---|---|---|
| Load Comb. | PX<br>K | PY<br>K | PZ<br>K | PX<br>K | PY<br>K | PZ<br>K | % Error |
| 1 | 0.000 | -12.168 | 0.000 | 0.000 | 12.168 | 0.000 | 0.000% |
| 2 | 0.000 | -14.601 | -12.310 | 0.000 | 14.601 | 12.310 | 0.000% |
| 3 | 0.000 | -10.951 | -12.310 | 0.000 | 10.951 | 12.310 | 0.000% |
| 4 | 6.155 | -14.601 | -10.661 | -6.155 | 14.601 | 10.661 | 0.000% |
| 5 | 6.155 | -10.951 | -10.661 | -6.155 | 10.951 | 10.661 | 0.000% |
| 6 | 8.705 | -14.601 | -8.705 | -8.705 | 14.601 | 8.705 | 0.000% |
| 7 | 8.705 | -10.951 | -8.705 | -8.705 | 10.951 | 8.705 | 0.000% |
| 8 | 10.661 | -14.601 | -6.155 | -10.661 | 14.601 | 6.155 | 0.000% |
| 9 | 10.661 | -10.951 | -6.155 | -10.661 | 10.951 | 6.155 | 0.000% |
| 10 | 12.310 | -14.601 | 0.000 | -12.310 | 14.601 | 0.000 | 0.000% |
| 11 | 12.310 | -10.951 | 0.000 | -12.310 | 10.951 | 0.000 | 0.000% |
| 12 | 10.661 | -14.601 | 6.155 | -10.661 | 14.601 | -6.155 | 0.000% |
| 13 | 10.661 | -10.951 | 6.155 | -10.661 | 10.951 | -6.155 | 0.000% |
| 14 | 8.705 | -14.601 | 8.705 | -8.705 | 14.601 | -8.705 | 0.000% |
| 15 | 8.705 | -10.951 | 8.705 | -8.705 | 10.951 | -8.705 | 0.000% |
| 16 | 6.155 | -14.601 | 10.661 | -6.155 | 14.601 | -10.661 | 0.000% |
| 17 | 6.155 | -10.951 | 10.661 | -6.155 | 10.951 | -10.661 | 0.000% |
| 18 | 0.000 | -14.601 | 12.310 | 0.000 | 14.601 | -12.310 | 0.000% |
| 19 | 0.000 | -10.951 | 12.310 | 0.000 | 10.951 | -12.310 | 0.000% |
| 20 | -6.155 | -14.601 | 10.661 | 6.155 | 14.601 | -10.661 | 0.000% |
| 21 | -6.155 | -10.951 | 10.661 | 6.155 | 10.951 | -10.661 | 0.000% |
| 22 | -8.705 | -14.601 | 8.705 | 8.705 | 14.601 | -8.705 | 0.000% |
| 23 | -8.705 | -10.951 | 8.705 | 8.705 | 10.951 | -8.705 | 0.000% |
| 24 | -10.661 | -14.601 | 6.155 | 10.661 | 14.601 | -6.155 | 0.000% |
| 25 | -10.661 | -10.951 | 6.155 | 10.661 | 10.951 | -6.155 | 0.000% |
| 26 | -12.310 | -14.601 | 0.000 | 12.310 | 14.601 | 0.000 | 0.000% |
| 27 | -12.310 | -10.951 | 0.000 | 12.310 | 10.951 | 0.000 | 0.000% |
| 28 | -10.661 | -14.601 | -6.155 | 10.661 | 14.601 | 6.155 | 0.000% |
| 29 | -10.661 | -10.951 | -6.155 | 10.661 | 10.951 | 6.155 | 0.000% |
| 30 | -8.705 | -14.601 | -8.705 | 8.705 | 14.601 | 8.705 | 0.000% |
| 31 | -8.705 | -10.951 | -8.705 | 8.705 | 10.951 | 8.705 | 0.000% |
| 32 | -6.155 | -14.601 | -10.661 | 6.155 | 14.601 | 10.661 | 0.000% |
| 33 | -6.155 | -10.951 | -10.661 | 6.155 | 10.951 | 10.661 | 0.000% |
| 34 | 0.000 | -24.883 | 0.000 | 0.000 | 24.883 | 0.000 | 0.000% |
| 35 | 0.000 | -24.883 | -3.345 | 0.000 | 24.883 | 3.345 | 0.000% |

| | Sum of Applied Forces | | | Sum of Reactions | | | |
|---|---|---|---|---|---|---|---|
| Load Comb. | PX K | PY K | PZ K | PX K | PY K | PZ K | % Error |
| 36 | 1.672 | -24.883 | -2.897 | -1.672 | 24.883 | 2.897 | 0.000% |
| 37 | 2.365 | -24.883 | -2.365 | -2.365 | 24.883 | 2.365 | 0.000% |
| 38 | 2.897 | -24.883 | -1.672 | -2.897 | 24.883 | 1.672 | 0.000% |
| 39 | 3.345 | -24.883 | 0.000 | -3.345 | 24.883 | 0.000 | 0.000% |
| 40 | 2.897 | -24.883 | 1.672 | -2.897 | 24.883 | -1.672 | 0.000% |
| 41 | 2.365 | -24.883 | 2.365 | -2.365 | 24.883 | -2.365 | 0.000% |
| 42 | 1.672 | -24.883 | 2.897 | -1.672 | 24.883 | -2.897 | 0.000% |
| 43 | 0.000 | -24.883 | 3.345 | 0.000 | 24.883 | -3.345 | 0.000% |
| 44 | -1.672 | -24.883 | 2.897 | 1.672 | 24.883 | -2.897 | 0.000% |
| 45 | -2.365 | -24.883 | 2.365 | 2.365 | 24.883 | -2.365 | 0.000% |
| 46 | -2.897 | -24.883 | 1.672 | 2.897 | 24.883 | -1.672 | 0.000% |
| 47 | -3.345 | -24.883 | 0.000 | 3.345 | 24.883 | 0.000 | 0.000% |
| 48 | -2.897 | -24.883 | -1.672 | 2.897 | 24.883 | 1.672 | 0.000% |
| 49 | -2.365 | -24.883 | -2.365 | 2.365 | 24.883 | 2.365 | 0.000% |
| 50 | -1.672 | -24.883 | -2.897 | 1.672 | 24.883 | 2.897 | 0.000% |
| 51 | 0.000 | -12.168 | -2.248 | 0.000 | 12.168 | 2.248 | 0.000% |
| 52 | 1.124 | -12.168 | -1.947 | -1.124 | 12.168 | 1.947 | 0.000% |
| 53 | 1.589 | -12.168 | -1.589 | -1.589 | 12.168 | 1.589 | 0.000% |
| 54 | 1.947 | -12.168 | -1.124 | -1.947 | 12.168 | 1.124 | 0.000% |
| 55 | 2.248 | -12.168 | 0.000 | -2.248 | 12.168 | 0.000 | 0.000% |
| 56 | 1.947 | -12.168 | 1.124 | -1.947 | 12.168 | -1.124 | 0.000% |
| 57 | 1.589 | -12.168 | 1.589 | -1.589 | 12.168 | -1.589 | 0.000% |
| 58 | 1.124 | -12.168 | 1.947 | -1.124 | 12.168 | -1.947 | 0.000% |
| 59 | 0.000 | -12.168 | 2.248 | 0.000 | 12.168 | -2.248 | 0.000% |
| 60 | -1.124 | -12.168 | 1.947 | 1.124 | 12.168 | -1.947 | 0.000% |
| 61 | -1.589 | -12.168 | 1.589 | 1.589 | 12.168 | -1.589 | 0.000% |
| 62 | -1.947 | -12.168 | 1.124 | 1.947 | 12.168 | -1.124 | 0.000% |
| 63 | -2.248 | -12.168 | 0.000 | 2.248 | 12.168 | 0.000 | 0.000% |
| 64 | -1.947 | -12.168 | -1.124 | 1.947 | 12.168 | 1.124 | 0.000% |
| 65 | -1.589 | -12.168 | -1.589 | 1.589 | 12.168 | 1.589 | 0.000% |
| 66 | -1.124 | -12.168 | -1.947 | 1.124 | 12.168 | 1.947 | 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 | 0.00012091 |
| 3 | Yes | 4 | 0.00000001 | 0.00005230 |
| 4 | Yes | 5 | 0.00000001 | 0.00039077 |
| 5 | Yes | 5 | 0.00000001 | 0.00017615 |
| 6 | Yes | 5 | 0.00000001 | 0.00044284 |
| 7 | Yes | 5 | 0.00000001 | 0.00019819 |
| 8 | Yes | 5 | 0.00000001 | 0.00039077 |
| 9 | Yes | 5 | 0.00000001 | 0.00017615 |
| 10 | Yes | 4 | 0.00000001 | 0.00012091 |
| 11 | Yes | 4 | 0.00000001 | 0.00005230 |
| 12 | Yes | 5 | 0.00000001 | 0.00039077 |
| 13 | Yes | 5 | 0.00000001 | 0.00017615 |
| 14 | Yes | 5 | 0.00000001 | 0.00044284 |
| 15 | Yes | 5 | 0.00000001 | 0.00019819 |
| 16 | Yes | 5 | 0.00000001 | 0.00039077 |
| 17 | Yes | 5 | 0.00000001 | 0.00017615 |
| 18 | Yes | 4 | 0.00000001 | 0.00012091 |
| 19 | Yes | 4 | 0.00000001 | 0.00005230 |
| 20 | Yes | 5 | 0.00000001 | 0.00039077 |

| | | | | |
|---|---|---|---|---|
| 21 | Yes | 5 | 0.00000001 | 0.00017615 |
| 22 | Yes | 5 | 0.00000001 | 0.00044284 |
| 23 | Yes | 5 | 0.00000001 | 0.00019819 |
| 24 | Yes | 5 | 0.00000001 | 0.00039077 |
| 25 | Yes | 5 | 0.00000001 | 0.00017615 |
| 26 | Yes | 4 | 0.00000001 | 0.00012091 |
| 27 | Yes | 4 | 0.00000001 | 0.00005230 |
| 28 | Yes | 5 | 0.00000001 | 0.00039077 |
| 29 | Yes | 5 | 0.00000001 | 0.00017615 |
| 30 | Yes | 5 | 0.00000001 | 0.00044284 |
| 31 | Yes | 5 | 0.00000001 | 0.00019819 |
| 32 | Yes | 5 | 0.00000001 | 0.00039077 |
| 33 | Yes | 5 | 0.00000001 | 0.00017615 |
| 34 | Yes | 4 | 0.00000001 | 0.00000001 |
| 35 | Yes | 5 | 0.00000001 | 0.00018118 |
| 36 | Yes | 5 | 0.00000001 | 0.00021665 |
| 37 | Yes | 5 | 0.00000001 | 0.00022725 |
| 38 | Yes | 5 | 0.00000001 | 0.00021665 |
| 39 | Yes | 5 | 0.00000001 | 0.00018118 |
| 40 | Yes | 5 | 0.00000001 | 0.00021665 |
| 41 | Yes | 5 | 0.00000001 | 0.00022725 |
| 42 | Yes | 5 | 0.00000001 | 0.00021665 |
| 43 | Yes | 5 | 0.00000001 | 0.00018118 |
| 44 | Yes | 5 | 0.00000001 | 0.00021665 |
| 45 | Yes | 5 | 0.00000001 | 0.00022725 |
| 46 | Yes | 5 | 0.00000001 | 0.00021665 |
| 47 | Yes | 5 | 0.00000001 | 0.00018118 |
| 48 | Yes | 5 | 0.00000001 | 0.00021665 |
| 49 | Yes | 5 | 0.00000001 | 0.00022725 |
| 50 | Yes | 5 | 0.00000001 | 0.00021665 |
| 51 | Yes | 4 | 0.00000001 | 0.00002051 |
| 52 | Yes | 4 | 0.00000001 | 0.00009599 |
| 53 | Yes | 4 | 0.00000001 | 0.00011017 |
| 54 | Yes | 4 | 0.00000001 | 0.00009599 |
| 55 | Yes | 4 | 0.00000001 | 0.00002051 |
| 56 | Yes | 4 | 0.00000001 | 0.00009599 |
| 57 | Yes | 4 | 0.00000001 | 0.00011017 |
| 58 | Yes | 4 | 0.00000001 | 0.00009599 |
| 59 | Yes | 4 | 0.00000001 | 0.00002051 |
| 60 | Yes | 4 | 0.00000001 | 0.00009599 |
| 61 | Yes | 4 | 0.00000001 | 0.00011017 |
| 62 | Yes | 4 | 0.00000001 | 0.00009599 |
| 63 | Yes | 4 | 0.00000001 | 0.00002051 |
| 64 | Yes | 4 | 0.00000001 | 0.00009599 |
| 65 | Yes | 4 | 0.00000001 | 0.00011017 |
| 66 | Yes | 4 | 0.00000001 | 0.00009599 |

## Maximum Tower Deflections - Service Wind

| *Section No.* | *Elevation* | *Horz. Deflection* | *Gov. Load Comb.* | *Tilt* | *Twist* |
|---|---|---|---|---|---|
| | *ft* | *in* | | ° | ° |
| L1 | 100 - 76 | 7.422 | 55 | 0.598 | 0.000 |
| L2 | 76 - 50 | 4.502 | 55 | 0.541 | 0.000 |
| L3 | 54.25 - 1 | 2.349 | 55 | 0.394 | 0.000 |

## Critical Deflections and Radius of Curvature - Service Wind

| Elevation<br>ft | Appurtenance | Gov. Load Comb. | Deflection<br>in | Tilt<br>° | Twist<br>° | Radius of Curvature<br>ft |
|---|---|---|---|---|---|---|
| 97.000 | AIR21 B2A/B4P | 55 | 7.045 | 0.594 | 0.000 | 57556 |
| 96.000 | Site Pro RMV5-296 T-ARM | 55 | 6.920 | 0.593 | 0.000 | 57556 |
| 95.000 | KRC 118 048/1 | 55 | 6.794 | 0.591 | 0.000 | 57556 |

## Maximum Tower Deflections - Design Wind

| Section No. | Elevation<br>ft | Horz. Deflection<br>in | Gov. Load Comb. | Tilt<br>° | Twist<br>° |
|---|---|---|---|---|---|
| L1 | 100 - 76 | 40.866 | 10 | 3.292 | 0.000 |
| L2 | 76 - 50 | 24.786 | 10 | 2.980 | 0.000 |
| L3 | 54.25 - 1 | 12.932 | 10 | 2.167 | 0.000 |

## Critical Deflections and Radius of Curvature - Design Wind

| Elevation<br>ft | Appurtenance | Gov. Load Comb. | Deflection<br>in | Tilt<br>° | Twist<br>° | Radius of Curvature<br>ft |
|---|---|---|---|---|---|---|
| 97.000 | AIR21 B2A/B4P | 10 | 38.791 | 3.273 | 0.000 | 10495 |
| 96.000 | Site Pro RMV5-296 T-ARM | 10 | 38.100 | 3.266 | 0.000 | 10495 |
| 95.000 | KRC 118 048/1 | 10 | 37.411 | 3.258 | 0.000 | 10495 |

## *Compression Checks*

## Pole Design Data

| Section No. | Elevation<br>ft | Size | L<br>ft | $L_u$<br>ft | Kl/r | A<br>$in^2$ | $P_u$<br>K | $\phi P_n$<br>K | Ratio $\frac{P_u}{\phi P_n}$ |
|---|---|---|---|---|---|---|---|---|---|
| L1 | 100 - 98.8 | TP25.08x21x0.188 | 24.000 | 0.000 | 0.0 | 12.507 | -0.076 | 901.218 | 0.000 |
| | 98.8 - 97.6 | | | | | 12.629 | -0.153 | 907.406 | 0.000 |
| | 97.6 - 96.4 | | | | | 12.750 | -0.636 | 913.545 | 0.001 |
| | 96.4 - 95.2 | | | | | 12.872 | -3.975 | 919.634 | 0.004 |
| | 95.2 - 94 | | | | | 12.993 | -4.402 | 925.675 | 0.005 |
| | 94 - 92.8 | | | | | 13.115 | -4.481 | 931.666 | 0.005 |
| | 92.8 - 91.6 | | | | | 13.236 | -4.561 | 937.608 | 0.005 |
| | 91.6 - 90.4 | | | | | 13.357 | -4.642 | 943.500 | 0.005 |
| | 90.4 - 89.2 | | | | | 13.479 | -4.724 | 949.344 | 0.005 |
| | 89.2 - 88 | | | | | 13.600 | -4.806 | 955.138 | 0.005 |
| | 88 - 86.8 | | | | | 13.722 | -4.890 | 960.883 | 0.005 |
| | 86.8 - 85.6 | | | | | 13.843 | -4.974 | 966.579 | 0.005 |
| | 85.6 - 84.4 | | | | | 13.964 | -5.058 | 972.226 | 0.005 |
| | 84.4 - 83.2 | | | | | 14.086 | -5.144 | 977.823 | 0.005 |

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | A $in^2$ | $P_u$ K | $\phi P_n$ K | Ratio $\frac{P_u}{\phi P_n}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 83.2 - 82 | | | | | 14.207 | -5.231 | 983.371 | 0.005 |
| | 82 - 80.8 | | | | | 14.328 | -5.318 | 988.870 | 0.005 |
| | 80.8 - 79.6 | | | | | 14.450 | -5.406 | 994.320 | 0.005 |
| | 79.6 - 78.4 | | | | | 14.571 | -5.495 | 999.720 | 0.005 |
| | 78.4 - 77.2 | | | | | 14.693 | -5.585 | 1005.070 | 0.006 |
| | 77.2 - 76 | | | | | 14.814 | -5.676 | 1010.370 | 0.006 |
| L2 | 76 - 74.8553 | TP29.5x25.08x0.188 | 26.000 | 0.000 | 0.0 | 14.930 | -5.763 | 1015.390 | 0.006 |
| | 74.8553 - 73.7105 | | | | | 15.046 | -5.852 | 1020.350 | 0.006 |
| | 73.7105 - 72.5658 | | | | | 15.162 | -5.941 | 1025.280 | 0.006 |
| | 72.5658 - 71.4211 | | | | | 15.277 | -6.031 | 1030.150 | 0.006 |
| | 71.4211 - 70.2763 | | | | | 15.393 | -6.121 | 1034.990 | 0.006 |
| | 70.2763 - 69.1316 | | | | | 15.509 | -6.213 | 1039.770 | 0.006 |
| | 69.1316 - 67.9868 | | | | | 15.625 | -6.305 | 1044.520 | 0.006 |
| | 67.9868 - 66.8421 | | | | | 15.741 | -6.398 | 1049.220 | 0.006 |
| | 66.8421 - 65.6974 | | | | | 15.856 | -6.492 | 1053.870 | 0.006 |
| | 65.6974 - 64.5526 | | | | | 15.972 | -6.586 | 1058.480 | 0.006 |
| | 64.5526 - 63.4079 | | | | | 16.088 | -6.681 | 1063.040 | 0.006 |
| | 63.4079 - 62.2632 | | | | | 16.204 | -6.777 | 1067.560 | 0.006 |
| | 62.2632 - 61.1184 | | | | | 16.320 | -6.874 | 1072.040 | 0.006 |
| | 61.1184 - 59.9737 | | | | | 16.436 | -6.972 | 1076.470 | 0.006 |
| | 59.9737 - 58.8289 | | | | | 16.551 | -7.070 | 1080.850 | 0.007 |
| | 58.8289 - 57.6842 | | | | | 16.667 | -7.170 | 1085.190 | 0.007 |
| | 57.6842 - 56.5395 | | | | | 16.783 | -7.270 | 1089.490 | 0.007 |
| | 56.5395 - 55.3947 | | | | | 16.899 | -7.370 | 1093.740 | 0.007 |
| | 55.3947 - 54.25 | | | | | 17.015 | -7.472 | 1097.940 | 0.007 |
| | 54.25 - 50 | | | | | 17.445 | -3.574 | 1113.170 | 0.003 |
| L3 | 54.25 - 50 | TP37.46x28.403x0.25 | 53.250 | 0.000 | 0.0 | 22.913 | -4.656 | 1636.390 | 0.003 |
| | 50 - 47.4211 | | | | | 23.261 | -8.521 | 1653.640 | 0.005 |
| | 47.4211 - 44.8421 | | | | | 23.609 | -8.818 | 1670.670 | 0.005 |
| | 44.8421 - 42.2632 | | | | | 23.957 | -9.120 | 1687.470 | 0.005 |
| | 42.2632 - 39.6842 | | | | | 24.305 | -9.427 | 1704.040 | 0.006 |
| | 39.6842 - 37.1053 | | | | | 24.653 | -9.738 | 1720.390 | 0.006 |
| | 37.1053 - 34.5263 | | | | | 25.001 | -10.055 | 1736.510 | 0.006 |
| | 34.5263 - 31.9474 | | | | | 25.349 | -10.375 | 1752.400 | 0.006 |
| | 31.9474 - 29.3684 | | | | | 25.697 | -10.701 | 1768.060 | 0.006 |

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | A $in^2$ | $P_u$ K | $\phi P_n$ K | Ratio $\frac{P_u}{\phi P_n}$ |
|---|---|---|---|---|---|---|---|---|---|
| | 29.3684 - 26.7895 | | | | | 26.045 | -11.031 | 1783.490 | 0.006 |
| | 26.7895 - 24.2105 | | | | | 26.393 | -11.366 | 1798.700 | 0.006 |
| | 24.2105 - 21.6316 | | | | | 26.742 | -11.706 | 1813.680 | 0.006 |
| | 21.6316 - 19.0526 | | | | | 27.090 | -12.050 | 1828.430 | 0.007 |
| | 19.0526 - 16.4737 | | | | | 27.438 | -12.399 | 1842.960 | 0.007 |
| | 16.4737 - 13.8947 | | | | | 27.786 | -12.752 | 1857.260 | 0.007 |
| | 13.8947 - 11.3158 | | | | | 28.134 | -13.111 | 1871.330 | 0.007 |
| | 11.3158 - 8.73684 | | | | | 28.482 | -13.473 | 1885.170 | 0.007 |
| | 8.73684 - 6.15789 | | | | | 28.830 | -13.841 | 1898.780 | 0.007 |
| | 6.15789 - 3.57895 | | | | | 29.178 | -14.212 | 1912.170 | 0.007 |
| | 3.57895 - 1 | | | | | 29.526 | -14.589 | 1925.330 | 0.008 |

## Pole Bending Design Data

| Section No. | Elevation ft | Size | $M_{ux}$ kip-ft | $\phi M_{nx}$ kip-ft | Ratio $\frac{M_{ux}}{\phi M_{nx}}$ | $M_{uy}$ kip-ft | $\phi M_{ny}$ kip-ft | Ratio $\frac{M_{uy}}{\phi M_{ny}}$ |
|---|---|---|---|---|---|---|---|---|
| L1 | 100 - 98.8 | TP25.08x21x0.188 | 0.051 | 389.068 | 0.000 | 0.000 | 389.068 | 0.000 |
| | 98.8 - 97.6 | | 0.205 | 395.575 | 0.001 | 0.000 | 395.575 | 0.000 |
| | 97.6 - 96.4 | | 1.229 | 402.113 | 0.003 | 0.000 | 402.113 | 0.000 |
| | 96.4 - 95.2 | | 4.410 | 408.682 | 0.011 | 0.000 | 408.682 | 0.000 |
| | 95.2 - 94 | | 10.170 | 415.279 | 0.024 | 0.000 | 415.279 | 0.000 |
| | 94 - 92.8 | | 16.403 | 421.906 | 0.039 | 0.000 | 421.906 | 0.000 |
| | 92.8 - 91.6 | | 22.742 | 428.561 | 0.053 | 0.000 | 428.561 | 0.000 |
| | 91.6 - 90.4 | | 29.190 | 435.243 | 0.067 | 0.000 | 435.243 | 0.000 |
| | 90.4 - 89.2 | | 35.746 | 441.952 | 0.081 | 0.000 | 441.952 | 0.000 |
| | 89.2 - 88 | | 42.411 | 448.688 | 0.095 | 0.000 | 448.688 | 0.000 |
| | 88 - 86.8 | | 49.187 | 455.448 | 0.108 | 0.000 | 455.448 | 0.000 |
| | 86.8 - 85.6 | | 56.073 | 462.234 | 0.121 | 0.000 | 462.234 | 0.000 |
| | 85.6 - 84.4 | | 63.071 | 469.045 | 0.134 | 0.000 | 469.045 | 0.000 |
| | 84.4 - 83.2 | | 70.181 | 475.879 | 0.147 | 0.000 | 475.879 | 0.000 |
| | 83.2 - 82 | | 77.404 | 482.737 | 0.160 | 0.000 | 482.737 | 0.000 |
| | 82 - 80.8 | | 84.741 | 489.617 | 0.173 | 0.000 | 489.617 | 0.000 |
| | 80.8 - 79.6 | | 92.191 | 496.518 | 0.186 | 0.000 | 496.518 | 0.000 |
| | 79.6 - 78.4 | | 99.757 | 503.442 | 0.198 | 0.000 | 503.442 | 0.000 |
| | 78.4 - 77.2 | | 107.438 | 510.386 | 0.211 | 0.000 | 510.386 | 0.000 |
| | 77.2 - 76 | | 115.236 | 517.349 | 0.223 | 0.000 | 517.349 | 0.000 |
| L2 | 76 - 74.8553 | TP29.5x25.08x0.188 | 122.779 | 524.011 | 0.234 | 0.000 | 524.011 | 0.000 |
| | 74.8553 - 73.7105 | | 130.423 | 530.689 | 0.246 | 0.000 | 530.689 | 0.000 |
| | 73.7105 - 72.5658 | | 138.167 | 537.384 | 0.257 | 0.000 | 537.384 | 0.000 |
| | 72.5658 - 71.4211 | | 146.012 | 544.096 | 0.268 | 0.000 | 544.096 | 0.000 |
| | 71.4211 - 70.2763 | | 153.958 | 550.822 | 0.280 | 0.000 | 550.822 | 0.000 |

| Section No. | Elevation ft | Size | $M_{ux}$ kip-ft | $\phi M_{nx}$ kip-ft | Ratio $\frac{M_{ux}}{\phi M_{nx}}$ | $M_{uy}$ kip-ft | $\phi M_{ny}$ kip-ft | Ratio $\frac{M_{uy}}{\phi M_{ny}}$ |
|---|---|---|---|---|---|---|---|---|
| | 70.2763 - 69.1316 | | 162.006 | 557.564 | 0.291 | 0.000 | 557.564 | 0.000 |
| | 69.1316 - 67.9868 | | 170.157 | 564.320 | 0.302 | 0.000 | 564.320 | 0.000 |
| | 67.9868 - 66.8421 | | 178.410 | 571.090 | 0.312 | 0.000 | 571.090 | 0.000 |
| | 66.8421 - 65.6974 | | 186.767 | 577.873 | 0.323 | 0.000 | 577.873 | 0.000 |
| | 65.6974 - 64.5526 | | 195.227 | 584.669 | 0.334 | 0.000 | 584.669 | 0.000 |
| | 64.5526 - 63.4079 | | 203.792 | 591.477 | 0.345 | 0.000 | 591.477 | 0.000 |
| | 63.4079 - 62.2632 | | 212.463 | 598.298 | 0.355 | 0.000 | 598.298 | 0.000 |
| | 62.2632 - 61.1184 | | 221.238 | 605.129 | 0.366 | 0.000 | 605.129 | 0.000 |
| | 61.1184 - 59.9737 | | 230.120 | 611.971 | 0.376 | 0.000 | 611.971 | 0.000 |
| | 59.9737 - 58.8289 | | 239.107 | 618.822 | 0.386 | 0.000 | 618.822 | 0.000 |
| | 58.8289 - 57.6842 | | 248.202 | 625.684 | 0.397 | 0.000 | 625.684 | 0.000 |
| | 57.6842 - 56.5395 | | 257.404 | 632.555 | 0.407 | 0.000 | 632.555 | 0.000 |
| | 56.5395 - 55.3947 | | 266.714 | 639.433 | 0.417 | 0.000 | 639.433 | 0.000 |
| | 55.3947 - 54.25 | | 276.132 | 646.321 | 0.427 | 0.000 | 646.321 | 0.000 |
| | 54.25 - 50 | | 137.338 | 671.949 | 0.204 | 0.000 | 671.949 | 0.000 |
| L3 | 54.25 - 50 | TP37.46x28.403x0.25 | 174.779 | 970.875 | 0.180 | 0.000 | 970.875 | 0.000 |
| | 50 - 47.4211 | | 334.718 | 996.142 | 0.336 | 0.000 | 996.142 | 0.000 |
| | 47.4211 - 44.8421 | | 357.853 | 1021.592 | 0.350 | 0.000 | 1021.592 | 0.000 |
| | 44.8421 - 42.2632 | | 381.517 | 1047.200 | 0.364 | 0.000 | 1047.200 | 0.000 |
| | 42.2632 - 39.6842 | | 405.707 | 1072.975 | 0.378 | 0.000 | 1072.975 | 0.000 |
| | 39.6842 - 37.1053 | | 430.418 | 1098.908 | 0.392 | 0.000 | 1098.908 | 0.000 |
| | 37.1053 - 34.5263 | | 455.646 | 1124.992 | 0.405 | 0.000 | 1124.992 | 0.000 |
| | 34.5263 - 31.9474 | | 481.385 | 1151.217 | 0.418 | 0.000 | 1151.217 | 0.000 |
| | 31.9474 - 29.3684 | | 507.632 | 1177.575 | 0.431 | 0.000 | 1177.575 | 0.000 |
| | 29.3684 - 26.7895 | | 534.383 | 1204.075 | 0.444 | 0.000 | 1204.075 | 0.000 |
| | 26.7895 - 24.2105 | | 561.633 | 1230.692 | 0.456 | 0.000 | 1230.692 | 0.000 |
| | 24.2105 - 21.6316 | | 589.376 | 1257.425 | 0.469 | 0.000 | 1257.425 | 0.000 |
| | 21.6316 - 19.0526 | | 617.609 | 1284.275 | 0.481 | 0.000 | 1284.275 | 0.000 |
| | 19.0526 - 16.4737 | | 646.326 | 1311.233 | 0.493 | 0.000 | 1311.233 | 0.000 |
| | 16.4737 - 13.8947 | | 675.523 | 1338.292 | 0.505 | 0.000 | 1338.292 | 0.000 |
| | 13.8947 - 11.3158 | | 705.195 | 1365.442 | 0.516 | 0.000 | 1365.442 | 0.000 |
| | 11.3158 - | | 735.337 | 1392.675 | 0.528 | 0.000 | 1392.675 | 0.000 |

| Section No. | Elevation<br>ft | Size | $M_{ux}$<br>kip-ft | $\phi M_{nx}$<br>kip-ft | Ratio $\frac{M_{ux}}{\phi M_{nx}}$ | $M_{uy}$<br>kip-ft | $\phi M_{ny}$<br>kip-ft | Ratio $\frac{M_{uy}}{\phi M_{ny}}$ |
|---|---|---|---|---|---|---|---|---|
| | 8.73684 | | | | | | | |
| | 8.73684 - 6.15789 | | 765.943 | 1419.992 | 0.539 | 0.000 | 1419.992 | 0.000 |
| | 6.15789 - 3.57895 | | 797.010 | 1447.392 | 0.551 | 0.000 | 1447.392 | 0.000 |
| | 3.57895 - 1 | | 828.532 | 1474.850 | 0.562 | 0.000 | 1474.850 | 0.000 |

## Pole Shear Design Data

| Section No. | Elevation<br>ft | Size | Actual $V_u$<br>K | $\phi V_n$<br>K | Ratio $\frac{V_u}{\phi V_n}$ | Actual $T_u$<br>kip-ft | $\phi T_n$<br>kip-ft | Ratio $\frac{T_u}{\phi T_n}$ |
|---|---|---|---|---|---|---|---|---|
| L1 | 100 - 98.8 | TP25.08x21x0.188 | 0.086 | 450.609 | 0.000 | 0.000 | 779.087 | 0.000 |
| | 98.8 - 97.6 | | 0.172 | 453.703 | 0.000 | 0.000 | 792.118 | 0.000 |
| | 97.6 - 96.4 | | 1.534 | 456.772 | 0.003 | 0.000 | 805.211 | 0.000 |
| | 96.4 - 95.2 | | 3.233 | 459.817 | 0.007 | 0.000 | 818.363 | 0.000 |
| | 95.2 - 94 | | 5.150 | 462.837 | 0.011 | 0.000 | 831.575 | 0.000 |
| | 94 - 92.8 | | 5.239 | 465.833 | 0.011 | 0.000 | 844.842 | 0.000 |
| | 92.8 - 91.6 | | 5.328 | 468.804 | 0.011 | 0.000 | 858.167 | 0.000 |
| | 91.6 - 90.4 | | 5.419 | 471.750 | 0.011 | 0.000 | 871.550 | 0.000 |
| | 90.4 - 89.2 | | 5.510 | 474.672 | 0.012 | 0.000 | 884.983 | 0.000 |
| | 89.2 - 88 | | 5.601 | 477.569 | 0.012 | 0.000 | 898.475 | 0.000 |
| | 88 - 86.8 | | 5.693 | 480.442 | 0.012 | 0.000 | 912.008 | 0.000 |
| | 86.8 - 85.6 | | 5.786 | 483.290 | 0.012 | 0.000 | 925.600 | 0.000 |
| | 85.6 - 84.4 | | 5.879 | 486.113 | 0.012 | 0.000 | 939.233 | 0.000 |
| | 84.4 - 83.2 | | 5.973 | 488.912 | 0.012 | 0.000 | 952.925 | 0.000 |
| | 83.2 - 82 | | 6.068 | 491.686 | 0.012 | 0.000 | 966.650 | 0.000 |
| | 82 - 80.8 | | 6.163 | 494.435 | 0.012 | 0.000 | 980.433 | 0.000 |
| | 80.8 - 79.6 | | 6.258 | 497.160 | 0.013 | 0.000 | 994.250 | 0.000 |
| | 79.6 - 78.4 | | 6.354 | 499.860 | 0.013 | 0.000 | 1008.117 | 0.000 |
| | 78.4 - 77.2 | | 6.451 | 502.536 | 0.013 | 0.000 | 1022.017 | 0.000 |
| | 77.2 - 76 | | 6.548 | 505.187 | 0.013 | 0.000 | 1035.967 | 0.000 |
| L2 | 76 - 74.8553 | TP29.5x25.08x0.188 | 6.635 | 507.693 | 0.013 | 0.000 | 1049.300 | 0.000 |
| | 74.8553 - 73.7105 | | 6.723 | 510.177 | 0.013 | 0.000 | 1062.675 | 0.000 |
| | 73.7105 - 72.5658 | | 6.811 | 512.638 | 0.013 | 0.000 | 1076.083 | 0.000 |
| | 72.5658 - 71.4211 | | 6.899 | 515.077 | 0.013 | 0.000 | 1089.525 | 0.000 |
| | 71.4211 - 70.2763 | | 6.988 | 517.493 | 0.014 | 0.000 | 1102.992 | 0.000 |
| | 70.2763 - 69.1316 | | 7.078 | 519.887 | 0.014 | 0.000 | 1116.492 | 0.000 |
| | 69.1316 - 67.9868 | | 7.167 | 522.259 | 0.014 | 0.000 | 1130.017 | 0.000 |
| | 67.9868 - 66.8421 | | 7.258 | 524.608 | 0.014 | 0.000 | 1143.575 | 0.000 |
| | 66.8421 - 65.6974 | | 7.348 | 526.935 | 0.014 | 0.000 | 1157.158 | 0.000 |
| | 65.6974 - 64.5526 | | 7.439 | 529.239 | 0.014 | 0.000 | 1170.767 | 0.000 |
| | 64.5526 - 63.4079 | | 7.531 | 531.522 | 0.014 | 0.000 | 1184.400 | 0.000 |
| | 63.4079 - 62.2632 | | 7.623 | 533.781 | 0.014 | 0.000 | 1198.058 | 0.000 |
| | 62.2632 - | | 7.715 | 536.019 | 0.014 | 0.000 | 1211.742 | 0.000 |

| Section No. | Elevation ft | Size | Actual $V_u$ K | $\phi V_n$ K | Ratio $\frac{V_u}{\phi V_n}$ | Actual $T_u$ kip-ft | $\phi T_n$ kip-ft | Ratio $\frac{T_u}{\phi T_n}$ |
|---|---|---|---|---|---|---|---|---|
| | 61.1184 | | | | | | | |
| | 61.1184 - 59.9737 | | 7.808 | 538.233 | 0.015 | 0.000 | 1225.442 | 0.000 |
| | 59.9737 - 58.8289 | | 7.901 | 540.426 | 0.015 | 0.000 | 1239.158 | 0.000 |
| | 58.8289 - 57.6842 | | 7.995 | 542.596 | 0.015 | 0.000 | 1252.900 | 0.000 |
| | 57.6842 - 56.5395 | | 8.089 | 544.744 | 0.015 | 0.000 | 1266.658 | 0.000 |
| | 56.5395 - 55.3947 | | 8.183 | 546.869 | 0.015 | 0.000 | 1280.433 | 0.000 |
| | 55.3947 - 54.25 | | 8.278 | 548.972 | 0.015 | 0.000 | 1294.225 | 0.000 |
| | 54.25 - 50 | | 3.916 | 556.584 | 0.007 | 0.000 | 1345.542 | 0.000 |
| L3 | 54.25 - 50 | TP37.46x28.403x0.25 | 4.751 | 818.194 | 0.006 | 0.000 | 1944.125 | 0.000 |
| | 50 - 47.4211 | | 8.875 | 826.821 | 0.011 | 0.000 | 1994.725 | 0.000 |
| | 47.4211 - 44.8421 | | 9.081 | 835.335 | 0.011 | 0.000 | 2045.675 | 0.000 |
| | 44.8421 - 42.2632 | | 9.286 | 843.736 | 0.011 | 0.000 | 2096.967 | 0.000 |
| | 42.2632 - 39.6842 | | 9.489 | 852.022 | 0.011 | 0.000 | 2148.583 | 0.000 |
| | 39.6842 - 37.1053 | | 9.691 | 860.195 | 0.011 | 0.000 | 2200.508 | 0.000 |
| | 37.1053 - 34.5263 | | 9.891 | 868.253 | 0.011 | 0.000 | 2252.733 | 0.000 |
| | 34.5263 - 31.9474 | | 10.089 | 876.198 | 0.012 | 0.000 | 2305.250 | 0.000 |
| | 31.9474 - 29.3684 | | 10.286 | 884.030 | 0.012 | 0.000 | 2358.033 | 0.000 |
| | 29.3684 - 26.7895 | | 10.480 | 891.747 | 0.012 | 0.000 | 2411.083 | 0.000 |
| | 26.7895 - 24.2105 | | 10.673 | 899.351 | 0.012 | 0.000 | 2464.392 | 0.000 |
| | 24.2105 - 21.6316 | | 10.864 | 906.841 | 0.012 | 0.000 | 2517.925 | 0.000 |
| | 21.6316 - 19.0526 | | 11.054 | 914.217 | 0.012 | 0.000 | 2571.692 | 0.000 |
| | 19.0526 - 16.4737 | | 11.241 | 921.479 | 0.012 | 0.000 | 2625.675 | 0.000 |
| | 16.4737 - 13.8947 | | 11.426 | 928.628 | 0.012 | 0.000 | 2679.850 | 0.000 |
| | 13.8947 - 11.3158 | | 11.610 | 935.663 | 0.012 | 0.000 | 2734.217 | 0.000 |
| | 11.3158 - 8.73684 | | 11.792 | 942.584 | 0.013 | 0.000 | 2788.758 | 0.000 |
| | 8.73684 - 6.15789 | | 11.972 | 949.391 | 0.013 | 0.000 | 2843.467 | 0.000 |
| | 6.15789 - 3.57895 | | 12.149 | 956.084 | 0.013 | 0.000 | 2898.317 | 0.000 |
| | 3.57895 - 1 | | 12.325 | 962.664 | 0.013 | 0.000 | 2953.317 | 0.000 |

## Pole Interaction Design Data

| Section No. | Elevation ft | Ratio $P_u/\phi P_n$ | Ratio $M_{ux}/\phi M_{nx}$ | Ratio $M_{uy}/\phi M_{ny}$ | Ratio $V_u/\phi V_n$ | Ratio $T_u/\phi T_n$ | Comb. Stress Ratio | Allow. Stress Ratio | Criteria |
|---|---|---|---|---|---|---|---|---|---|
| L1 | 100 - 98.8 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 ✔ | 1.000 | 4.8.2 ✔ |
| | 98.8 - 97.6 | 0.000 | 0.001 | 0.000 | 0.000 | 0.000 | 0.001 ✔ | 1.000 | 4.8.2 ✔ |
| | 97.6 - 96.4 | 0.001 | 0.003 | 0.000 | 0.003 | 0.000 | 0.004 ✔ | 1.000 | 4.8.2 ✔ |
| | 96.4 - 95.2 | 0.004 | 0.011 | 0.000 | 0.007 | 0.000 | 0.015 ✔ | 1.000 | 4.8.2 ✔ |
| | 95.2 - 94 | 0.005 | 0.024 | 0.000 | 0.011 | 0.000 | 0.029 ✔ | 1.000 | 4.8.2 ✔ |
| | 94 - 92.8 | 0.005 | 0.039 | 0.000 | 0.011 | 0.000 | 0.044 ✔ | 1.000 | 4.8.2 ✔ |
| | 92.8 - 91.6 | 0.005 | 0.053 | 0.000 | 0.011 | 0.000 | 0.058 ✔ | 1.000 | 4.8.2 ✔ |
| | 91.6 - 90.4 | 0.005 | 0.067 | 0.000 | 0.011 | 0.000 | 0.072 ✔ | 1.000 | 4.8.2 ✔ |
| | 90.4 - 89.2 | 0.005 | 0.081 | 0.000 | 0.012 | 0.000 | 0.086 ✔ | 1.000 | 4.8.2 ✔ |
| | 89.2 - 88 | 0.005 | 0.095 | 0.000 | 0.012 | 0.000 | 0.100 ✔ | 1.000 | 4.8.2 ✔ |
| | 88 - 86.8 | 0.005 | 0.108 | 0.000 | 0.012 | 0.000 | 0.113 ✔ | 1.000 | 4.8.2 ✔ |
| | 86.8 - 85.6 | 0.005 | 0.121 | 0.000 | 0.012 | 0.000 | 0.127 ✔ | 1.000 | 4.8.2 ✔ |
| | 85.6 - 84.4 | 0.005 | 0.134 | 0.000 | 0.012 | 0.000 | 0.140 ✔ | 1.000 | 4.8.2 ✔ |
| | 84.4 - 83.2 | 0.005 | 0.147 | 0.000 | 0.012 | 0.000 | 0.153 ✔ | 1.000 | 4.8.2 ✔ |
| | 83.2 - 82 | 0.005 | 0.160 | 0.000 | 0.012 | 0.000 | 0.166 ✔ | 1.000 | 4.8.2 ✔ |
| | 82 - 80.8 | 0.005 | 0.173 | 0.000 | 0.012 | 0.000 | 0.179 ✔ | 1.000 | 4.8.2 ✔ |
| | 80.8 - 79.6 | 0.005 | 0.186 | 0.000 | 0.013 | 0.000 | 0.191 ✔ | 1.000 | 4.8.2 ✔ |
| | 79.6 - 78.4 | 0.005 | 0.198 | 0.000 | 0.013 | 0.000 | 0.204 ✔ | 1.000 | 4.8.2 ✔ |
| | 78.4 - 77.2 | 0.006 | 0.211 | 0.000 | 0.013 | 0.000 | 0.216 ✔ | 1.000 | 4.8.2 ✔ |
| | 77.2 - 76 | 0.006 | 0.223 | 0.000 | 0.013 | 0.000 | 0.229 ✔ | 1.000 | 4.8.2 ✔ |
| L2 | 76 - 74.8553 | 0.006 | 0.234 | 0.000 | 0.013 | 0.000 | 0.240 ✔ | 1.000 | 4.8.2 ✔ |
| | 74.8553 - 73.7105 | 0.006 | 0.246 | 0.000 | 0.013 | 0.000 | 0.252 ✔ | 1.000 | 4.8.2 ✔ |
| | 73.7105 - 72.5658 | 0.006 | 0.257 | 0.000 | 0.013 | 0.000 | 0.263 ✔ | 1.000 | 4.8.2 ✔ |
| | 72.5658 - 71.4211 | 0.006 | 0.268 | 0.000 | 0.013 | 0.000 | 0.274 ✔ | 1.000 | 4.8.2 ✔ |
| | 71.4211 - 70.2763 | 0.006 | 0.280 | 0.000 | 0.014 | 0.000 | 0.286 ✔ | 1.000 | 4.8.2 ✔ |
| | 70.2763 - 69.1316 | 0.006 | 0.291 | 0.000 | 0.014 | 0.000 | 0.297 ✔ | 1.000 | 4.8.2 ✔ |

| Section No. | Elevation ft | Ratio $P_u/\phi P_n$ | Ratio $M_{ux}/\phi M_{nx}$ | Ratio $M_{uy}/\phi M_{ny}$ | Ratio $V_u/\phi V_n$ | Ratio $T_u/\phi T_n$ | Comb. Stress Ratio | Allow. Stress Ratio | Criteria |
|---|---|---|---|---|---|---|---|---|---|
| | 69.1316 - 67.9868 | 0.006 | 0.302 | 0.000 | 0.014 | 0.000 | 0.308 ✔ | 1.000 | 4.8.2 ✔ |
| | 67.9868 - 66.8421 | 0.006 | 0.312 | 0.000 | 0.014 | 0.000 | 0.319 ✔ | 1.000 | 4.8.2 ✔ |
| | 66.8421 - 65.6974 | 0.006 | 0.323 | 0.000 | 0.014 | 0.000 | 0.330 ✔ | 1.000 | 4.8.2 ✔ |
| | 65.6974 - 64.5526 | 0.006 | 0.334 | 0.000 | 0.014 | 0.000 | 0.340 ✔ | 1.000 | 4.8.2 ✔ |
| | 64.5526 - 63.4079 | 0.006 | 0.345 | 0.000 | 0.014 | 0.000 | 0.351 ✔ | 1.000 | 4.8.2 ✔ |
| | 63.4079 - 62.2632 | 0.006 | 0.355 | 0.000 | 0.014 | 0.000 | 0.362 ✔ | 1.000 | 4.8.2 ✔ |
| | 62.2632 - 61.1184 | 0.006 | 0.366 | 0.000 | 0.014 | 0.000 | 0.372 ✔ | 1.000 | 4.8.2 ✔ |
| | 61.1184 - 59.9737 | 0.006 | 0.376 | 0.000 | 0.015 | 0.000 | 0.383 ✔ | 1.000 | 4.8.2 ✔ |
| | 59.9737 - 58.8289 | 0.007 | 0.386 | 0.000 | 0.015 | 0.000 | 0.393 ✔ | 1.000 | 4.8.2 ✔ |
| | 58.8289 - 57.6842 | 0.007 | 0.397 | 0.000 | 0.015 | 0.000 | 0.404 ✔ | 1.000 | 4.8.2 ✔ |
| | 57.6842 - 56.5395 | 0.007 | 0.407 | 0.000 | 0.015 | 0.000 | 0.414 ✔ | 1.000 | 4.8.2 ✔ |
| | 56.5395 - 55.3947 | 0.007 | 0.417 | 0.000 | 0.015 | 0.000 | 0.424 ✔ | 1.000 | 4.8.2 ✔ |
| | 55.3947 - 54.25 | 0.007 | 0.427 | 0.000 | 0.015 | 0.000 | 0.434 ✔ | 1.000 | 4.8.2 ✔ |
| | 54.25 - 50 | 0.003 | 0.204 | 0.000 | 0.007 | 0.000 | 0.208 ✔ | 1.000 | 4.8.2 ✔ |
| L3 | 54.25 - 50 | 0.003 | 0.180 | 0.000 | 0.006 | 0.000 | 0.183 ✔ | 1.000 | 4.8.2 ✔ |
| | 50 - 47.4211 | 0.005 | 0.336 | 0.000 | 0.011 | 0.000 | 0.341 ✔ | 1.000 | 4.8.2 ✔ |
| | 47.4211 - 44.8421 | 0.005 | 0.350 | 0.000 | 0.011 | 0.000 | 0.356 ✔ | 1.000 | 4.8.2 ✔ |
| | 44.8421 - 42.2632 | 0.005 | 0.364 | 0.000 | 0.011 | 0.000 | 0.370 ✔ | 1.000 | 4.8.2 ✔ |
| | 42.2632 - 39.6842 | 0.006 | 0.378 | 0.000 | 0.011 | 0.000 | 0.384 ✔ | 1.000 | 4.8.2 ✔ |
| | 39.6842 - 37.1053 | 0.006 | 0.392 | 0.000 | 0.011 | 0.000 | 0.397 ✔ | 1.000 | 4.8.2 ✔ |
| | 37.1053 - 34.5263 | 0.006 | 0.405 | 0.000 | 0.011 | 0.000 | 0.411 ✔ | 1.000 | 4.8.2 ✔ |
| | 34.5263 - 31.9474 | 0.006 | 0.418 | 0.000 | 0.012 | 0.000 | 0.424 ✔ | 1.000 | 4.8.2 ✔ |
| | 31.9474 - 29.3684 | 0.006 | 0.431 | 0.000 | 0.012 | 0.000 | 0.437 ✔ | 1.000 | 4.8.2 ✔ |
| | 29.3684 - 26.7895 | 0.006 | 0.444 | 0.000 | 0.012 | 0.000 | 0.450 ✔ | 1.000 | 4.8.2 ✔ |
| | 26.7895 - 24.2105 | 0.006 | 0.456 | 0.000 | 0.012 | 0.000 | 0.463 ✔ | 1.000 | 4.8.2 ✔ |
| | 24.2105 - 21.6316 | 0.006 | 0.469 | 0.000 | 0.012 | 0.000 | 0.475 ✔ | 1.000 | 4.8.2 ✔ |

| Section No. | Elevation ft | Ratio $P_u$ / $\phi P_n$ | Ratio $M_{ux}$ / $\phi M_{nx}$ | Ratio $M_{uy}$ / $\phi M_{ny}$ | Ratio $V_u$ / $\phi V_n$ | Ratio $T_u$ / $\phi T_n$ | Comb. Stress Ratio | Allow. Stress Ratio | Criteria |
|---|---|---|---|---|---|---|---|---|---|
| | 21.6316 - 19.0526 | 0.007 | 0.481 | 0.000 | 0.012 | 0.000 | 0.488 ✔ | 1.000 | 4.8.2 ✔ |
| | 19.0526 - 16.4737 | 0.007 | 0.493 | 0.000 | 0.012 | 0.000 | 0.500 ✔ | 1.000 | 4.8.2 ✔ |
| | 16.4737 - 13.8947 | 0.007 | 0.505 | 0.000 | 0.012 | 0.000 | 0.512 ✔ | 1.000 | 4.8.2 ✔ |
| | 13.8947 - 11.3158 | 0.007 | 0.516 | 0.000 | 0.012 | 0.000 | 0.524 ✔ | 1.000 | 4.8.2 ✔ |
| | 11.3158 - 8.73684 | 0.007 | 0.528 | 0.000 | 0.013 | 0.000 | 0.535 ✔ | 1.000 | 4.8.2 ✔ |
| | 8.73684 - 6.15789 | 0.007 | 0.539 | 0.000 | 0.013 | 0.000 | 0.547 ✔ | 1.000 | 4.8.2 ✔ |
| | 6.15789 - 3.57895 | 0.007 | 0.551 | 0.000 | 0.013 | 0.000 | 0.558 ✔ | 1.000 | 4.8.2 ✔ |
| | 3.57895 - 1 | 0.008 | 0.562 | 0.000 | 0.013 | 0.000 | 0.570 ✔ | 1.000 | 4.8.2 ✔ |

## Section Capacity Table

| Section No. | Elevation ft | Component Type | Size | Critical Element | P K | $\phi P_{allow}$ K | % Capacity | Pass Fail |
|---|---|---|---|---|---|---|---|---|
| L1 | 100 - 76 | Pole | TP25.08x21x0.188 | 1 | -5.676 | 1010.370 | 22.9 | Pass |
| L2 | 76 - 50 | Pole | TP29.5x25.08x0.188 | 2 | -7.472 | 1097.940 | 43.4 | Pass |
| L3 | 50 - 1 | Pole | TP37.46x28.403x0.25 | 3 | -14.589 | 1925.330 | 57.0 | Pass |
| | | | | | | | Summary | |
| | | | | | | Pole (L3) | 57.0 | Pass |
| | | | | | | **RATING =** | **57.0** | **Pass** |

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| | |
|---|---|
| Subject: | Flange Bolts and Flangeplate Analysis |
| Location: | 100-ft Sabre Monopole<br>Old Lyme, CT |
| Rev. 0: 12/6/16 | Prepared by: T.J.L. Checked by: C.F.C.<br>Job No. 16159.10 |

## Flange Bolt and Flange Plate Analysis:

### Input Data:

Tower Reactions:

| | | |
|---|---|---|
| Overturning Moment = | OM := 115.2·ft·kips | (Input From tnxTower) |
| Shear Force = | Shear := 6.5·kips | (Input From tnxTower) |
| Axial Force = | Axial := 11.5·kips | (Input From tnxTower) |

Flange Bolt Data:

Use ASTM A325

| | | |
|---|---|---|
| Number of Flange Bolts = | N := 10 | (User Input) |
| Diameter of Bolt Circle = | $D_{bc}$ := 27.625·in | (User Input) |
| Bolt Minimum Tensile Strength = | $F_{ub}$ := 120·ksi | (User Input) |
| Bolt Modulus = | E := 29000·ksi | (User Input) |
| Diameter of Flange Bolts = | D := 0.75·in | (User Input) |
| Threads per Inch = | n := 10 | (User Input) |

Flange Plate Data:

Use ASTM A572 Grade 50

| | | |
|---|---|---|
| Plate Yield Strength = | $Fy_{bp}$ := 50·ksi | (User Input) |
| Flange Plate Thickness = | $t_{bp}$ := 0.75·in | (User Input) |
| Flange Plate Diameter = | $D_{bp}$ := 29.875·in | (User Input) |
| Outer Pole Diameter = | $D_{pole}$ := 25.08·in | (User Input) |

## Geometric Layout Data:

Distance from Bolts to Centroid of Pole:

Radius of Bolt Circle =: $R_{bc} := \frac{D_{bc}}{2} = 13.813 \cdot in$

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

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

$d_1 = 8.12 \cdot in$ $d_7 = -13.14 \cdot in$

$d_2 = 13.14 \cdot in$ $d_8 = -13.14 \cdot in$

$d_3 = 13.14 \cdot in$ $d_9 = -8.12 \cdot in$

$d_4 = 8.12 \cdot in$ $d_{10} = -0.00 \cdot in$

$d_5 = 0.00 \cdot in$ $d_{11} = \blacksquare \cdot in$

$d_6 = -8.12 \cdot in$ $d_{12} = \blacksquare \cdot in$

Critical Distances For Bending in Plate:

Outer Pole Radius = $R_{pole} := \frac{D_{pole}}{2} = 12.54 \cdot in$

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

$MA_1 = 0.00 \cdot in$ $MA_7 = 0.00 \cdot in$

$MA_2 = 0.60 \cdot in$ $MA_8 = 0.00 \cdot in$

$MA_3 = 0.60 \cdot in$ $MA_9 = 0.00 \cdot in$

$MA_4 = 0.00 \cdot in$ $MA_{10} = 0.00 \cdot in$

$MA_5 = 0.00 \cdot in$ $MA_{11} = \blacksquare \cdot in$

$MA_6 = 0.00 \cdot in$ $MA_{12} = \blacksquare \cdot in$

Effective Width of Flangeplate for Bending = $B_{eff} := .8 \cdot 2 \cdot \sqrt{\left(\frac{D_{bp}}{2}\right)^2 - \left(\frac{D_{pole}}{2}\right)^2} = 13 \cdot in$

## Flange Bolt Analysis:

Calculated Flange Bolt Properties:

Polar Moment of Inertia = $I_p := \sum_i \left(d_i\right)^2 = 953.926 \cdot in^2$

Gross Area of Bolt = $A_g := \frac{\pi}{4} \cdot D^2 = 0.442 \cdot in^2$

Net Area of Bolt = $A_n := \frac{\pi}{4} \cdot \left(D - \frac{0.9743 \cdot in}{n}\right)^2 = 0.334 \cdot in^2$

Net Diameter = $D_n := \frac{2 \cdot \sqrt{A_n}}{\sqrt{\pi}} = 0.653 \cdot in$

Radius of Gyration of Bolt = $r := \frac{D_n}{4} = 0.163 \cdot in$

Section Modulus of Bolt = $S_x := \frac{\pi \cdot D_n^3}{32} = 0.027 \cdot in^3$

Check Flange Bolt Tension Force:

Maximum Tensile Force = $T_{Max} := OM \cdot \frac{R_{bc}}{I_p} - \frac{Axial}{N} = 18.9 \cdot kips$

Maximum Shear Force = $V_{Max} := \frac{Shear}{N} = 0.7 \cdot kips$

Design Tensile Strength = $\Phi R_{nt} := \left(0.75 \cdot F_{ub} \cdot 0.75 \cdot A_g\right) = 29.8 \cdot kips$

Bolt Tension % of Capacity = $\frac{T_{Max}}{\Phi R_{nt}} = 63.27 \cdot \%$

Condition1 = $Condition1 := if\left(\frac{T_{Max}}{\Phi R_{nt}} \le 1.00, "OK", "Overstressed"\right)$

Condition1 = "OK"

Design Shear Strength = $\Phi R_{nv} := \left(0.75 \cdot 0.45 \cdot F_{ub} \cdot A_g\right) = 17.9 \cdot kips$

Condition2 = $Condition2 := if\left[\left(\frac{V_{Max}}{\Phi R_{nv}}\right)^2 + \left(\frac{T_{Max}}{\Phi R_{nt}}\right)^2 \le 1.00, "OK", "Overstressed"\right]$

Condition2 = "OK"

## Flange Plate Analysis:

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

$C_1 = 12.9 \cdot kips$ $C_7 = -17.9 \cdot kips$

$C_2 = 20.2 \cdot kips$ $C_8 = -17.9 \cdot kips$

$C_3 = 20.2 \cdot kips$ $C_9 = -10.6 \cdot kips$

$C_4 = 12.9 \cdot kips$ $C_{10} = 1.1 \cdot kips$

$C_5 = 1.2 \cdot kips$ $C_{11} = \blacksquare \cdot kips$

$C_6 = -10.6 \cdot kips$ $C_{12} = \blacksquare \cdot kips$

Maximum Bending Stress in Plate =

$$f_{bp} := \sum_i \frac{4 \cdot C_i \cdot MA_i}{\left(B_{eff} \, t_{bp}^{\,2}\right)} = 13.2 \cdot ksi$$

Allowable Bending Stress in Plate = $F_{bp} := 0.9 \cdot Fy_{bp} = 45 \cdot ksi$

Plate Bending Stress % of Capacity = $\frac{f_{bp}}{F_{bp}} = 29.3 \cdot \%$

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

Condition3 = "Ok"

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| | | |
|---|---|---|
| Subject: | | Anchor Bolt and Baseplate Analysis |
| Location: | | 100-FT Sabre Monopole<br>Old Lyme, CT |
| Rev. 0: 12/6/16 | | Prepared by: T.J.L. Checked by: C.F.C.<br>Job No. 16159.10 |

## Anchor Bolt and Base Plate Analysis:

### Input Data:

Tower Reactions:

| | | |
|---|---|---|
| Overturning Moment = | OM := 829·ft·kips | (Input From RisaTower) |
| Shear Force = | Shear := 12·kips | (Input From RisaTower) |
| Axial Force = | Axial := 15·kips | (Input From RisaTower) |

Anchor Bolt Data:

ASTM A615 Grade 75

| | | |
|---|---|---|
| Number of Anchor Bolts = | N := 8 | (User Input) |
| Diameter of Bolt Circle = | $D_{bc}$ := 43.25·in | (User Input) |
| Bolt Ultimate Strength = | $F_u$ := 100·ksi | (User Input) |
| Bolt Yield Strength = | $F_y$ := 75·ksi | (User Input) |
| Bolt Modulus = | E := 29000·ksi | (User Input) |
| Diameter of Anchor Bolts = | D := 2.25·in | (User Input) |
| Threads per Inch = | n := 4.5 | (User Input) |
| Top of Concrete to Bot Leveling Nut = | $l_{ar}$ := 4·in | (User Input) |

Base Plate Data:

Use ASTM A572 Grade 50

| | | |
|---|---|---|
| Plate Yield Strength = | $Fy_{bp}$ := 50·ksi | (User Input) |
| Base Plate Thickness = | $t_{bp}$ := 2.25·in | (User Input) |
| Base Plate Diameter = | $D_{bp}$ := 41·in | (User Input) |
| Outer Pole Diameter = | $D_{pole}$ := 37.46·in | (User Input) |
| | η := 0.5 | For Ungrouted Base Plate<br>per TIA-222-G Section 4.9.9 |

## Geometric Layout Data:

Distance from Bolts to Centroid of Pole:

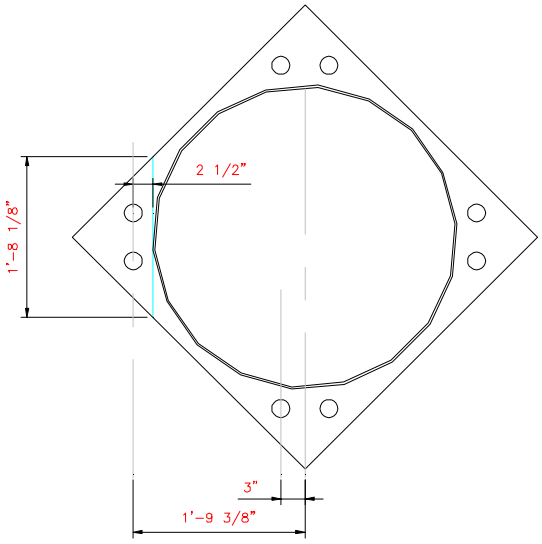
$d_1 := 21.375in$ $d_2 := 3in$ (User Input)

Critical Distances For Bending in Plate:

(User Input)

$ma_1 := 2.5in$

Effective Width of Baseplate for Bending = $B_{eff} := 0.8 \cdot 20.125in$ (User Input)




## Anchor Bolt Analysis:

Calculated Anchor Bolt Properties:

Polar Moment of Inertia = $I_p := \left[ \left( d_1 \right)^2 \cdot 4 + \left( d_2 \right)^2 \cdot 4 \right] = 1864 \cdot in^2$

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

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

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

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

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

Tensile Root Diameter = $d_{rt} := D - \frac{0.9743 \cdot in}{n} = 2.033 \cdot in$

Plastic Section Modulus = $Z := \frac{d_{rt}^3}{6} = 1.401 \cdot in^3$

Check Anchor Bolt Tension Force:

Maximum Tensile Force = $T_{Max} := OM \cdot \frac{d_1}{I_p} - \frac{Axial}{N} = 112.2 \cdot kips$

Maximum Compressive Force = $P_u := OM \cdot \frac{d_1}{I_p} + \frac{Axial}{N} = 116 \cdot kips$

Maximum Shear Force = $V_u := \frac{Shear}{N} = 1.5 \cdot kips$

Design Tensile Strength = $\Phi R_{nt} := 0.8 \cdot F_u \cdot A_n = 259.815 \cdot k$

Bolt % of Capacity = $\frac{\left(P_u + \frac{V_u}{\eta}\right)}{\Phi R_{nt}} \cdot 100 = 45.8$

Condition1 = $Condition1 := if\left[\frac{\left(P_u + \frac{V_u}{\eta}\right)}{\Phi R_{nt}} \le 1.00, "OK", "Overstressed"\right]$

Condition1 = "OK"

Design Shear Strength = $\Phi R_{nv} := 0.75 \cdot 0.45 \cdot F_u \cdot A_g = 134.193 \cdot k$

Design Flexural Strength = $\Phi R_{nm} := 0.9 \cdot F_y \cdot Z = 94.597 \cdot in \cdot k$

$$M_u := \begin{cases} 0 & \text{if } l_{ar} < D \\ 0.65 \cdot l_{ar} \cdot V_u & \text{otherwise} \end{cases} = 3.9 \cdot in \cdot k$$

Bolt % of Capacity = $\left[\left(\frac{V_u}{\Phi R_{nv}}\right)^2 + \left(\frac{P_u}{\Phi R_{nt}} + \frac{M_u}{\Phi R_{nm}}\right)^2\right] \cdot 100 = 23.8$

Condition2 = $Condition2 := if\left[\left(\frac{V_u}{\Phi R_{nv}}\right)^2 + \left(\frac{P_u}{\Phi R_{nt}} + \frac{M_u}{\Phi R_{nm}}\right)^2 \le 1.00, "OK", "Overstressed"\right]$

Condition2 = "OK"

## Base Plate Analysis:

Force from Bolts =

$$C_1 := \frac{OM \cdot d_1}{I_p} + \frac{Axial}{N} = 115.978 \cdot kips$$

$$C_2 := \frac{OM \cdot d_2}{I_p} + \frac{Axial}{N} = 17.889 \cdot kips$$

Applied Bending Stress in Plate =

$$f_{bp} := \frac{4 \cdot \left(2 \cdot C_1 \cdot ma_1\right)}{B_{eff} \, t_{bp}^{\,2}} = 28.46 \cdot ksi$$

Allowable Bending Stress in Plate =

$$F_{bp} := 0.9 \cdot Fy_{bp} = 45 \cdot ksi$$

Plate Bending Stress % of Capacity =

$$\frac{f_{bp}}{F_{bp}} = 63.2 \cdot \%$$

Condition2= =

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

Condition2 = "Ok"

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| | |
|---|---|
| Subject: | FOUNDATION ANALYSIS |
| Location: | 100-ft Sabre Monopole<br>Old Lyme, CT |
| Rev. 0: 12/6/16 | Prepared by: T.J.L Checked by: C.F.C.<br>Job no. 16159.10 |

## Standard Monopole Foundation:

### Input Data:

| | | | |
|---|---|---|---|
| **Tower Data** | | | |
| Overturning Moment = | $OM := 829 \cdot ft \cdot kips$ | (User Input) | |
| Shear Force = | $Shear := 12 \cdot kip$ | (User Input) | |
| Axial Force = | $Axial := 15 \cdot kip$ | (User Input) | |
| Tower Height = | $H_t := 100 \cdot ft$ | (User Input) | |
| **Footing Data:** | | | |
| Overall Depth of Footing = | $D_f := 6 \cdot ft$ | (User Input) | |
| Length of Pier = | $L_p := 5 \cdot ft$ | (User Input) | |
| Extension of Pier Above Grade = | $L_{pag} := 0.5 \cdot ft$ | (User Input) | |
| Diameter of Pier = | $d_p := 5.5 \cdot ft$ | (User Input) | |
| Thickness of Footing = | $T_f := 1.5 \cdot ft$ | (User Input) | |
| Width of Footing = | $W_f := 17 \cdot ft$ | (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 = | $d_{anchor} := 2.25 \cdot in$ | (User Input) | |
| Base Plate Bolt Circle = | $MP := 43.25 \cdot in$ | (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 = | $f_{ya} := 75000 \cdot psi$ | (User Input) | |
| Internal Friction Angle of Soil = | $\Phi_s := 30 \cdot deg$ | (User Input) | |
| Ultimate Soil Bearing Capacity = | $q_u := 8000 \cdot psf$ | (User Input) | |
| Allowable Soil Bearing Capacity = | $q_a := \frac{q_u}{2} = 4000 \cdot psf$ | (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 = | $n := 3.33 \cdot ft$ | (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 = | $\mu := 0.3$ | (User Input) | |

Pier Reinforcement:

| | | | |
|---|---|---|---|
| Bar Size = | $BS_{pier} := 7$ | (User Input) | |
| Bar Diameter = | $d_{bpier} := 0.875 \cdot in$ | (User Input) | |
| Number of Bars = | $NB_{pier} := 30$ | (User Input) | |
| Clear Cover of Reinforcement = | $Cvr_{pier} := 3 \cdot in$ | (User Input) | |
| Reinforcement Location Factor = | $\alpha_{pier} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Coating Factor = | $\beta_{pier} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Concrete Strength Factor = | $\lambda_{pier} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Reinforcement Size Factor = | $\gamma_{pier} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Diameter of Tie = | $d_{Tie} := 3 \cdot in$ | (User Input) | |

Pad Reinforcement:

| | | | |
|---|---|---|---|
| Bar Size = | $BS_{top} := 8$ | (User Input) | (Top of Pad) |
| Bar Diameter = | $d_{btop} := 1.0 \cdot in$ | (User Input) | (Top of Pad) |
| Number of Bars = | $NB_{top} := 18$ | (User Input) | (Top of Pad) |
| Bar Size = | $BS_{bot} := 8$ | (User Input) | (Bottom of Pad) |
| Bar Diameter = | $d_{bbot} := 1.0 \cdot in$ | (User Input) | (Bottom of Pad) |
| Number of Bars = | $NB_{bot} := 18$ | (User Input) | (Bottom of Pad) |
| Clear Cover of Reinforcement = | $Cvr_{pad} := 3.0 \cdot in$ | (User Input) | |
| Reinforcement Location Factor = | $\alpha_{pad} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Coating Factor = | $\beta_{pad} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Concrete Strength Factor = | $\lambda_{pad} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |
| Reinforcement Size Factor = | $\gamma_{pad} := 1.0$ | (User Input) | (ACI-2008 12.2.4) |

## Calculated Factors:

Pier Reinforcement Bar Area = $A_{bpier} := \frac{\pi \cdot d_{bpier}^2}{4} = 0.601 \cdot in^2$

Pad Top Reinforcement Bar Area = $A_{btop} := \frac{\pi \cdot d_{btop}^2}{4} = 0.785 \cdot in^2$

Pad Bottom Reinforcement Bar Area = $A_{bbot} := \frac{\pi \cdot d_{bbot}^2}{4} = 0.785 \cdot in^2$

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

## Stability of Footing:

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

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

Passive Pressure = $P_{pn} := K_p \cdot \gamma_s \cdot n + c \cdot 2 \cdot \sqrt{K_p} = 0.999 \cdot ksf$

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

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

$P_{bot} := K_p \cdot \gamma_s \cdot D_f + c \cdot 2 \cdot \sqrt{K_p} = 1.8 \cdot ksf$

$P_{ave} := \frac{P_{top} + P_{bot}}{2} = 1.575 \cdot ksf$

$T_p := if[n < (D_f - T_f), T_f, (D_f - n)] = 1.5$

$A_p := W_f \cdot T_p = 25.5$

Ultimate Shear = $S_u := P_{ave} \cdot A_p = 40.163 \cdot kip$

Weight of Concrete Pad = $WT_c := \left[\left(W_f^2 \cdot T_f\right) + d_p^2 L_p\right] \cdot \gamma_c = 87.713 \cdot kip$

Weight of Soil Above Footing = $WT_{s1} := \left[\left(W_f^2 - d_p^2\right) \cdot \left(\left|L_p - L_{pag} - n\right|\right)\right] \cdot \gamma_s = 30.27 \cdot kip$

Weight of Soil Wedge at Back Face = $WT_{s2} := \left(\frac{D_f^2 \cdot \tan(\Phi_s)}{2} \cdot W_f\right) \cdot \gamma_s = 17.667 \cdot kip$

Weight of Soil Wedge at back face Corners = $WT_{s3} := 2 \cdot \left[(D_f)^3 \cdot \frac{\tan(\Phi_s)}{3}\right] \cdot \gamma_s = 8.314 \cdot kips$

Total Weight = $WT_{tot} := WT_c + WT_{s1} + Axial = 132.986 \cdot kip$

Resisting Weight = $WT_R := 0.9 \cdot WT_c + 0.75 \cdot WT_{s1} + 0.75 \cdot Axial = 112.897 \cdot kip$

Resisting Moment = $M_r := (WT_R) \cdot \frac{W_f}{2} + 0.75 \cdot S_u \cdot \frac{T_f}{3} + 0.75 \cdot \left[\left(WT_{s2} + WT_{s3}\right) \cdot \left(W_f + \frac{D_f \cdot \tan(\Phi_s)}{3}\right)\right] = 1328 \cdot kip \cdot ft$

Overturning Moment = $M_{ot} := OM + Shear \cdot (L_p + T_f) = 907 \cdot kip \cdot ft$

Factor of Safety Actual = $FS := \frac{M_r}{M_{ot}} = 1.46$

Factor of Safety Required = $FS_{req} := 1$

$OverTurning\_Moment\_Check := if(FS \geq FS_{req}, "Okay", "No Good")$

$OverTurning\_Moment\_Check = "Okay"$

### Shear Capacity in Pier:

Shear Resistance of Pier = $S_p := \frac{P_{ave} \cdot A_p + \mu \cdot WT_{tot}}{FS_{req}} = 80.058 \cdot kips$

$Shear\_Check := if(S_p > Shear, "Okay", "No Good")$

Shear_Check = "Okay"

### Bearing Pressure Caused by Footing:

Area of the Mat = $A_{mat} := W_f^2 = 289$

Section Modulus of Mat = $S := \frac{W_f^3}{6} = 818.83 \cdot ft^3$

Maximum Pressure in Mat = $P_{max} := \frac{WT_{tot}}{A_{mat}} + \frac{M_{ot}}{S} = 1.568 \cdot ksf$

$Max\_Pressure\_Check := if(P_{max} < .75 \cdot q_u, "Okay", "No Good")$

Max_Pressure_Check = "Okay"

Minimum Pressure in Mat = $P_{min} := \frac{WT_{tot}}{A_{mat}} - \frac{M_{ot}}{S} = -0.648 \cdot ksf$

$Min\_Pressure\_Check := if\left[(P_{min} \geq 0) \cdot (P_{min} < .75 \cdot q_u), "Okay", "No Good"\right]$

Min_Pressure_Check = "No Good"

Distance to Resultant of Pressure Distribution = $X_p := \frac{P_{max}}{\frac{P_{max} - P_{min}}{W_f}} \cdot \frac{1}{3} = 4.01$

Distance to Kern = $X_k := \frac{W_f}{6} = 2.833$

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

Eccentricity = $e := \frac{M_{ot}}{WT_{tot}} = 6.82$

Adjusted Soil Pressure = $P_a := \frac{2 \cdot WT_{tot}}{3 \cdot W_f \cdot \left(\frac{W_f}{2} - e\right)} = 3.105 \cdot ksf$

$q_{adj} := if(P_{min} < 0, P_a, P_{max}) = 3.105 \cdot ksf$

$Pressure\_Check := if(q_{adj} < .75 \cdot q_u, "Okay", "No Good")$

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 = $P_b := \Phi_c \cdot 0.85 \cdot f_c \cdot \frac{\pi \cdot d_p^2}{4} = 7.561 \times 10^3 \cdot kips$ (ACI-2008 10.14)

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

Bearing_Check = "Okay"

## Shear Strength of Concrete:

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

$\phi_c := 0.85$ (ACI 9.3.2.5)

$d := T_f - Cvr_{pad} - d_{bbot} = 1.167$

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

$d_2 := d_1 - d$

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

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

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

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

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

Beam_Shear_Check = "Okay"

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

Critical Perimeter of Punching Shear = $b_o := (d_p + d) \cdot \pi = 20.9$

Area Included Inside Perimeter = $A_{bo} := \frac{\pi \cdot (d_p + d)^2}{4} = 34.9$

Area Outside of Perimeter = $A_{out} := A_{mat} - A_{bo} = 254.1$

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

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

$v_u := Find(v_u) = 5.4 \cdot ksf$

$V_u := v_u \cdot d \cdot W_f = 107.9 \cdot kips$

Required Shear Strength = $V_{req} := V_u = 107.9 \cdot kips$

Available Shear Strength = $V_{Avail} := \phi_c \cdot 4 \cdot \sqrt{f_c \cdot psi} \cdot b_o \cdot d = 756.6 \cdot kip$ (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)

$q_b := q_{adj} - d_1 \cdot Slope = -0.438 \cdot ksf$

Maximum Bending at Face of Pier = $M_n := \frac{1}{\phi_m} \cdot \left[ (q_{adj} - q_b) \cdot \frac{d_1^2}{3} + q_b \cdot \frac{d_1^2}{2} \right] \cdot W_f = 600.7 \cdot kip \cdot ft$

$$\beta := \begin{cases} 0.85 & \text{if } 2500 \cdot psi \le f_c \le 4000 \cdot psi \\ 0.65 & \text{if } f_c > 8000 \cdot psi \\ \left[ 0.85 - \left[ \frac{\left( \frac{f_c}{psi} - 4000 \right)}{1000} \right] \cdot 0.5 \right] & \text{otherwise} \end{cases} = 0.85$$ (ACI-200810.2.7.3)

$R_n := \frac{M_n}{W_f \cdot d^2} = 180.3 \cdot psi$

$\rho := \frac{0.85 \cdot f_c}{f_y} \left( 1 - \sqrt{1 - \frac{2 \cdot R_n}{0.85 \cdot f_c}} \right) = 0.0031$

$\rho_{min} := \rho = 0.00309$

Required Reinforcement for Temperature and Shrinkage:

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

Check Bottom Bars:

$$As := \begin{cases} \rho_{min} \cdot W_f \cdot d & \text{if } \rho_{min} > \frac{\rho_{sh}}{2} \\ \rho_{sh} \cdot W_f \cdot \frac{d}{2} & \text{otherwise} \end{cases} = 8.822 \cdot in^2$$

$As_{prov} := A_{bbot} \cdot NB_{bot} = 14.1 \cdot in^2$

$Pad\_Reinforcement\_Bot := if(As_{prov} > As, "Okay", "No Good")$

$Pad\_Reinforcement\_Bot = "Okay"$

Check top Bars:

$As := \rho_{sh} \cdot \left(W_f \cdot \frac{d}{2}\right) = 2.6 \cdot in^2$

$As_{prov} := A_{btop} \cdot NB_{top} = 14.1 \cdot in^2$

$Pad\_Reinforcement\_Top := if(As_{prov} > As, "Okay", "No Good")$

$Pad\_Reinforcement\_Top = "Okay"$

## Developement Length Pad Reinforcement:

Bar Spacing =

$$B_{sPad} := \frac{W_f - 2 \cdot Cvr_{pad} - NB_{bot} \cdot d_{bbot}}{NB_{bot} - 1} = 10.59 \cdot in$$

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)

$$L_{dbt} := \frac{3 \cdot f_y \cdot \alpha_{pad} \cdot \beta_{pad} \cdot \gamma_{pad} \cdot \lambda_{pad}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \frac{c + k_{tr}}{d_{bbot}}} \cdot d_{bbot} = 23.7 \cdot in$$

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 =

$$L_{Pad} := \frac{W_f}{2} - \frac{d_p}{2} - Cvr_{pad} = 66 \cdot in$$

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

$Lpad\_Check = "Okay"$

## Steel Reinforcement in Pier:

Area of Pier =

$A_p := d_p^2 = 4356 \cdot in^2$

$A_{smin} := 0.0033 \cdot A_p = 14.37 \cdot in^2$ (ACI-2008 10.8.4 & 10.9.1)

$A_{sprov} := NB_{pier} \cdot A_{bpier} = 18.04 \cdot in^2$

$Steel\_Area\_Check := if\left(A_{sprov} > A_{smin}, "Okay", "No Good"\right)$

$Steel\_Area\_Check = "Okay"$

Bar Spacing In Pier =

$B_{sPier} := \frac{d_p \cdot \pi}{NB_{pier}} - d_{bpier} = 6.037 \cdot in$

Diameter of Reinforcement Cage =

$Diam_{cage} := d_p - 2 \cdot Cvr_{pier} = 60 \cdot in$

Maximum Moment in Pier =

$M_p := \left[OM + Shear \cdot \left(L_p + \frac{A_{BP}}{2}\right)\right] = 10740 \cdot in \cdot kips$

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

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

$\left(D \;\; N \;\; n \;\; P_u \;\; M_{xu}\right) = (66 \;\; 30 \;\; 7 \;\; 20 \;\; 10740)$

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

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

$\left(\phi P_n \;\; \phi M_{xn} \;\; f_{sp} \;\; \rho\right) = (51.7 \;\; 27791.5 \;\; -60 \;\; 0)$

$Axial\_Load\_Check := if\left(\phi P_n \geq P_u, "Okay", "No Good"\right)$

$Axial\_Load\_Check = "Okay"$

$Bending\_Check := if\left(\phi M_{xn} \geq M_{xu}, "Okay", "No Good"\right)$

$Bending\_Check = "Okay"$

## Development Length Pier Reinforcement:

Available Length in Foundation:

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

$L_{pad} := T_f - Cvr_{pad} = 15 \cdot in$

Tension: (ACI-2008 12.2.3)

Spacing or Cover Dimension =

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

Transverse Reinforcement =

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

$L_{dbt} := \frac{3 \cdot f_y \alpha_{pier} \cdot \beta_{pier} \cdot \gamma_{pier} \cdot \lambda_{pier}}{40 \cdot \sqrt{f_c \cdot psi} \cdot \left(\frac{c + k_{tr}}{d_{bpier}}\right)} \cdot d_{bpier} = 18.16 \cdot in$

Minimum Development Length =

$L_{dh} := \frac{1200 \cdot d_{bpier}}{\sqrt{\frac{f_c}{psi}}} \cdot .7 = 11.621 \cdot in$ (ACI 12.2.1)

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

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

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

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

Compression: (ACI-2008 12.3.2)

$L_{dbc1} := \frac{.02 \cdot d_{bpier} \cdot f_y}{\sqrt{f_c \cdot psi}} = 16.602 \cdot in$

$L_{dbmin} := 0.0003 \cdot \frac{in^2}{lb} \cdot \left(d_{bpier} \cdot f_y\right) = 15.75 \cdot in$

$L_{dbc} := if\left(L_{dbc1} \geq L_{dbmin}, L_{dbc1}, L_{dbmin}\right) = 16.602 \cdot in$

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

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

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

## Section 1 - Site Information

**Site ID:** CTNL801A
**Status:** Final
**Version:** 2.2
**Project Type:** L700
**Approved:** 8/19/2016 8:16:34 AM
**Approved By:** GSM1900\SCLEMONS
**Last Modified:** 8/19/2016 8:16:34 AM
**Last Modified By:** GSM1900\SCLEMONS

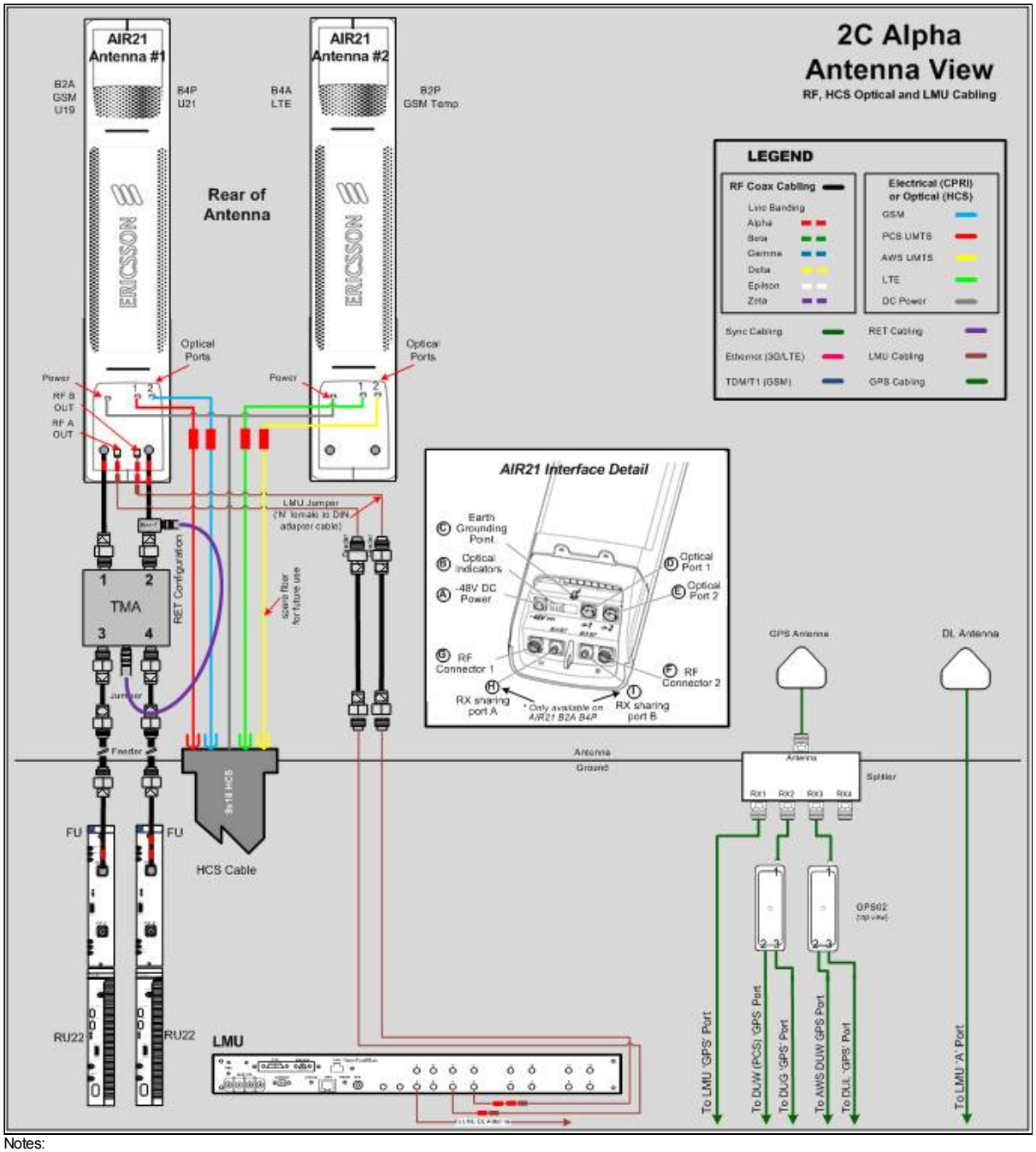
**Site Name:** Amtrak_OldLyme2
**Site Class:** Monopole
**Site Type:** Structure Non Building
**Solution Type:**
**Plan Year:**
**Market:** CONNECTICUT
**Vendor:** Ericsson
**Landlord:** T-Mobile USA Inc

**Latitude:** 41.29647200
**Longitude:** -72.30122200
**Address:** 61-1 Buttonball Road
**City, State:** Old Lyme, CT
**Region:** NORTHEAST

| RAN Template: 702Cc Outdoor | | | AL Template: 702Cc | |
|---|---|---|---|---|
| **Sector Count:** 3 | **Antenna Count:** 6 | **Coax Line Count:** 0 | **TMA Count:** 0 | **RRU Count:** 3 |

## Section 2 - Existing Template Images

AL_2C Outdoor.jpg

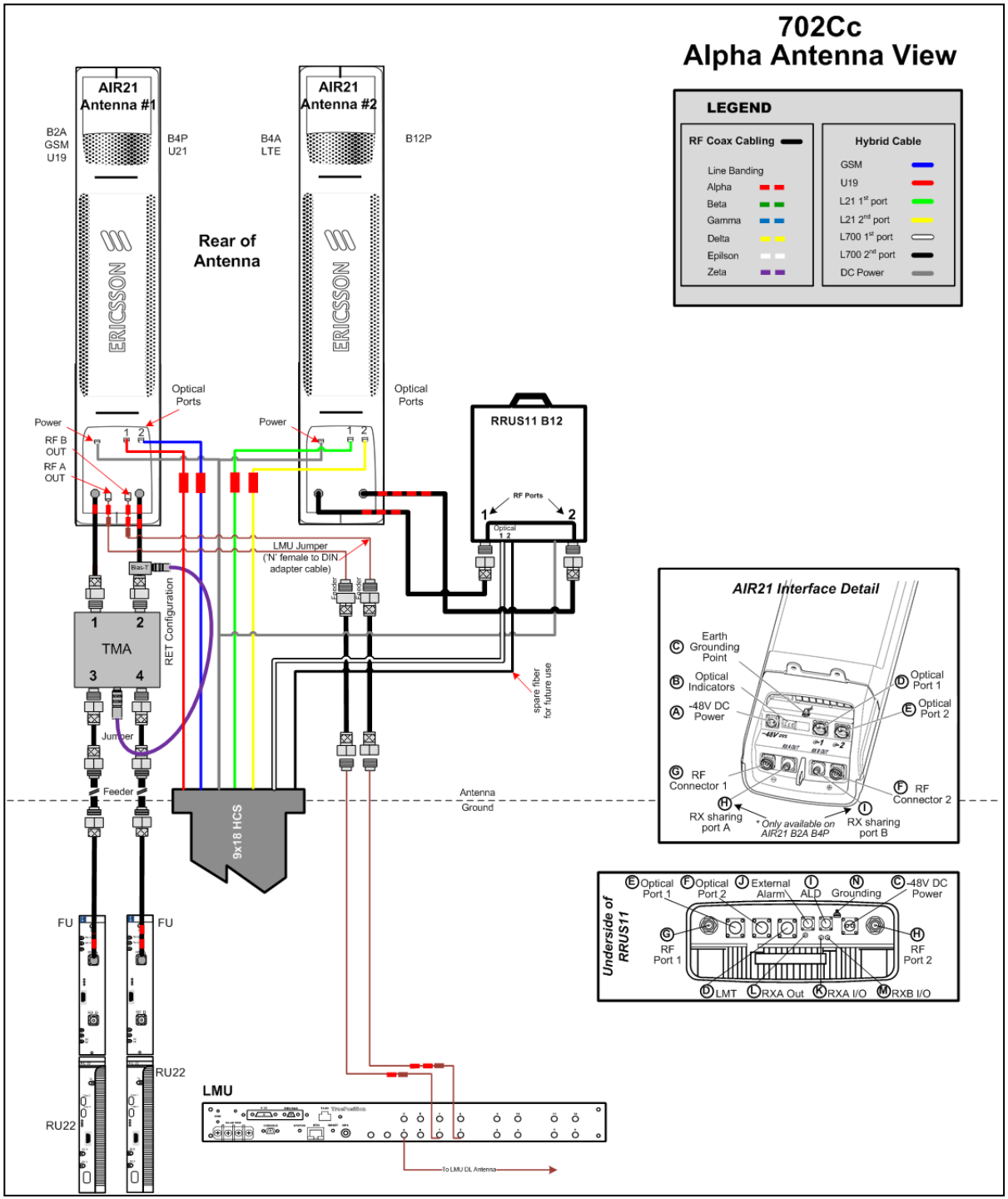

2C Alpha
Antenna View
RF, HCS Optical and LMU Cabling
AIR21
Antenna #1
AIR21
Antenna #2
B2A
GSM
U19
B4P
U21
B4A
LTE
B2P
GSM Temp
Rear of
Antenna
ERICSSON
LEGEND
RF Coax Cabling
Live Banding
Alpha
Beta
Gamma
Delta
Epilson
Zeta
Electrical (CPRI)
or Optical (HCS)
GSM
PCS UMTS
AWS UMTS
LTE
DC Power
Sync Cabling
Ethernet (3G/LTE)
TDM/T1 (GSM)
RET Cabling
LMU Cabling
GPS Cabling
Optical
Ports
Power
RF B
OUT
RF A
OUT
LMU Jumper
(N female to DIN
adapter cable)
TMA
RET Configuration
spare fiber
for future use
Jumper
Feeder
FU
FU
HCS Cable
RU22
RU22
LMU
AIR21 Interface Detail
Earth
Grounding
Port
Optical
Indicators
-48V DC
Power
Optical
Port 1
Optical
Port 2
RF
Connector 1
RF
Connector 2
RX sharing
port A
* Only available on
AIR21 B2A B4P
RX sharing
port B
Antenna
Ground
GPS Antenna
DL Antenna
Antenna
Splitter
Rx1
Rx2
Rx3
Rx4
GPS02
To LMU 'GPS' Port
To DUW (PCS) 'GPS' Port
To DUG 'GPS' Port
To AWS DUW 'GPS' Port
To DUE 'GPS' Port
To LMU 'A' Port

Notes:

## Section 3 - Proposed Template Images

AL_702Cc.png

# 702Cc
# Alpha Antenna View













Notes:

## Section 4 - Siteplan Images

----- This section is intentionally blank. -----

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |



## Section 5 - RAN Equipment

| Existing RAN Equipment | | |
|---|---|---|
| Template: 2C Outdoor | | |
| Enclosure | 1 | 2 |
| Enclosure Type | RBS 3106 | Tower Top Mount |
| Baseband | DUL20 L2100; DUG20 G1900; DUW30 U1900 | |
| Hybrid Cable System | | Ericsson 9x18 HCS *Select Length* |

| Proposed RAN Equipment | | |
|---|---|---|
| Template: 702Cc Outdoor | | |
| Enclosure | 1 | 2 |
| Enclosure Type | RBS 6131 | Tower Top Mount |
| Baseband | DUS41 L2100 L700; DUW30 U1900; DUG20 G1900 | |
| Hybrid Cable System | | Ericsson 9x18 HCS *Select Length* |
| Multiplexer | XMU | |

**RAN Scope of Work:**

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |



# Section 6 - A&L Equipment

**Existing Template:** 2C_2xAIR
**Proposed Template:** 702Cc

| Sector 1 (Existing) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | AIR21 B4A/B2P (Quad) | |
| Azimuth | 30 | | 30 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 87 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | |
| Sector Equipment | | | | |

**Unconnected Equipment:**

**Scope of Work:**

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

| Sector 1 (Proposed) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | KRC 118 048/1 (Quad) | |
| Azimuth | 30 | | 30 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 95 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | L700 |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | 2 |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | RRUS11 B12 |
| Sector Equipment | | | | |

Unconnected Equipment:

Scope of Work:

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

| Sector 2 (Existing) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | AIR21 B4A/B2P (Quad) | |
| Azimuth | 150 | | 150 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 87 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | |
| Sector Equipment | | | | |

Unconnected Equipment:

Scope of Work:

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

| Sector 2 (Proposed) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | KRC 118 048/1 (Quad) | |
| Azimuth | 150 | | 150 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 95 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | L700 |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | 2 |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | RRUS11 B12 |
| Sector Equipment | | | | |

Unconnected Equipment:

Scope of Work:

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

| Sector 3 (Existing) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | AIR21 B4A/B2P (Quad) | |
| Azimuth | 270 | | 270 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 87 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | |
| Sector Equipment | | | | |

Unconnected Equipment:

Scope of Work:

| RAN Template: | A&L Template: |
|---|---|
| 702Cc Outdoor | 702Cc |

CTNL801A_2.2_L700

| Sector 3 (Proposed) view from behind | | | | |
|---|---|---|---|---|
| Coverage Type | A - Outdoor Macro | | | |
| Antenna | 1 | | 2 | |
| Antenna Model | AIR21 B2A/B4P (Quad) | | KRC 118 048/1 (Quad) | |
| Azimuth | 270 | | 270 | |
| M. Tilt | 0 | | 0 | |
| Height | 97 | | 95 | |
| Ports | P1 | P2 | P3 | P4 |
| Active Tech. | U1900 G1900 | | L2100 | L700 |
| Dark Tech. | | | | |
| Restricted Tech. | | | | |
| Decomm. Tech. | | | | |
| E. Tilt | 2 | | 2 | 2 |
| Cables | | | | |
| TMAs | | | | |
| Diplexers / Combiners | | | | |
| Radio | | | | RRUS11 B12 |
| Sector Equipment | | | | |

Unconnected Equipment:

Scope of Work:

# 8FT, AWS ACTIVE
# AIR 21 B4A/B12P-B5P, 8 FT (KRC 118 048/1)

- Frequency bands:
  - AWS (1700/2100 MHz) active 2TX/4RX dual X-pol vert. stacked
  - 698 MHz - 894 MHz passive single X-pol.
- IBW (active part) = 20 MHz
- Gain (active/passive): 18/16 dB (15.7 on A block)
- Horiz. beamwidth (active/passive): 61º/68º
- Vertical beamwidth (active/passive): 7º/9º
- Integrated RET (AISG 2.0)
- Interfaces
  - Two optical fiber ports (CPRI) for active antenna/radio
  - One power connector, -48 V DC
  - Two 7/16 female connectors for passive antenna, with RET support
- Dimensions (H x W x D): 8.0’ x 12.1“ x 8.7”
- Weight: ~126 lbs
- Wind load: 1370 N @ 94 miles/hr

# RRUS 11

**Frequency (AT&T)**
- ✓ Band 12 (Lower 700 MHz)
- ✓ Band 4 (AWS, 17/2100 MHz) — 2Q2011

**RF Characteristics**
- ✓ Output power: 2x30 Watts
- ✓ 2x2 MIMO Capable
- ✓ IBW of 20 MHz
- ✓ Rx Sens.: Better than -105 dBm (5 MHz)

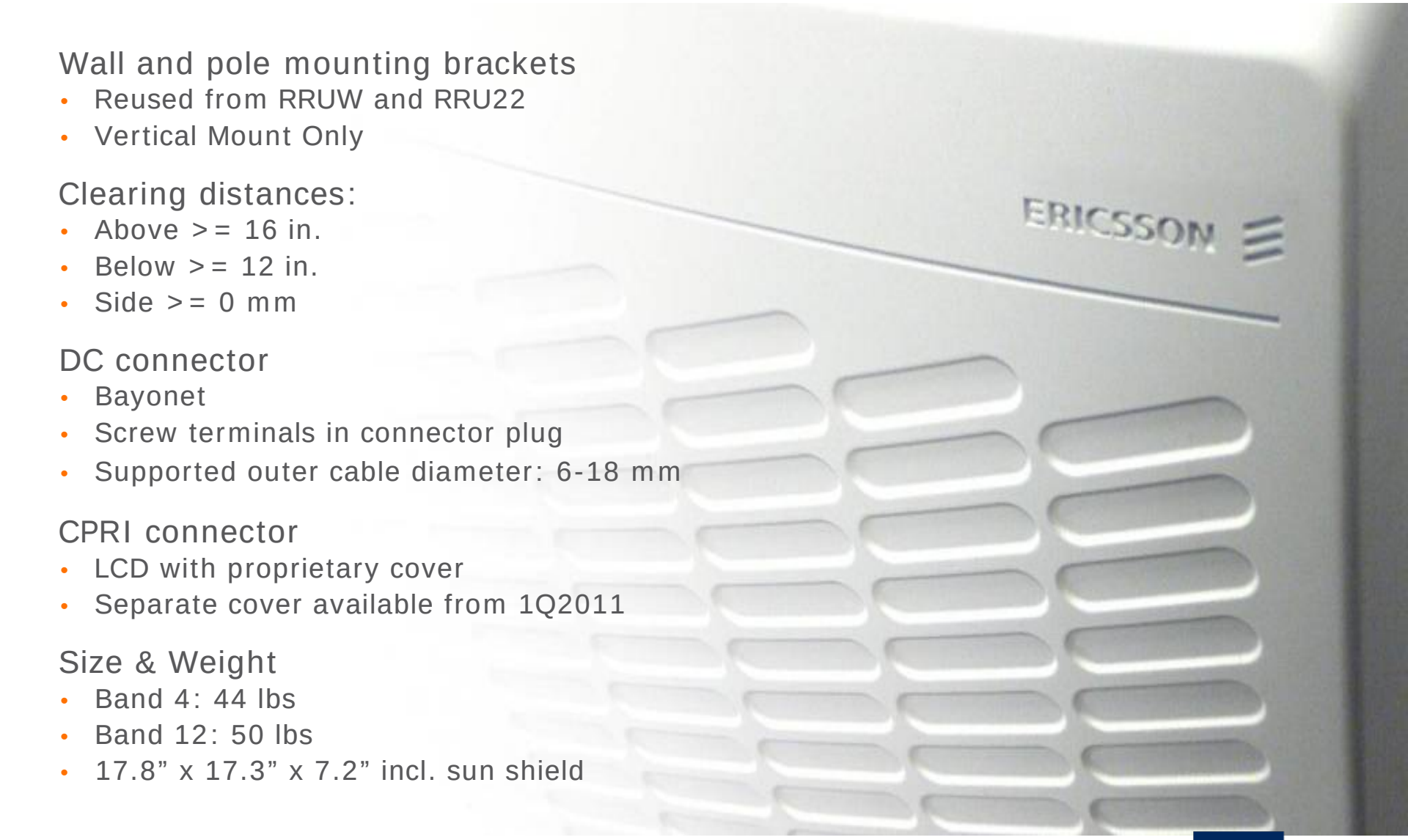
**RET/TMA Support**
- ✓ AISG 2.0 Compatible
- ✓ Via RET Port and Centre Conductor
- ✓ Cascading
- ✓ 30 VDC Bias

**Environmental**
- ✓ Self Convection
- ✓ Temperature -40 to 131 F

**Power**
- ✓ Input voltage:  -48 VDC or AC (exemption)
- ✓ Fuse size: 13 – 32 A
  - Recommended: 25 A
- ✓ Power Consumption:
  - Typical 200 Watts
  - Max  310 Watts
  - Excl. RET and TMA load

# RRUS 11 Mechanics




## Wall and pole mounting brackets
- Reused from RRUW and RRU22
- Vertical Mount Only

## Clearing distances:
- Above >= 16 in.
- Below >= 12 in.
- Side >= 0 mm

## DC connector
- Bayonet
- Screw terminals in connector plug
- Supported outer cable diameter: 6-18 mm

## CPRI connector
- LCD with proprietary cover
- Separate cover available from 1Q2011

## Size & Weight
- Band 4: 44 lbs
- Band 12: 50 lbs
- 17.8” x 17.3” x 7.2” incl. sun shield