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August 17, 2016

**BY EMAIL & OVERNIGHT DELIVERY**
Melanie Bachman, Esq.
Acting Executive Director
Connecticut Siting Council
10 Franklin Square
New Britain, CT 06051

Re: Connecticut Siting Council Docket No. 449
Telecommunications Facility at Redding Ridge Fire Department
186 Black Rock Turnpike, Redding, Connecticut

Dear Executive Director Bachman:

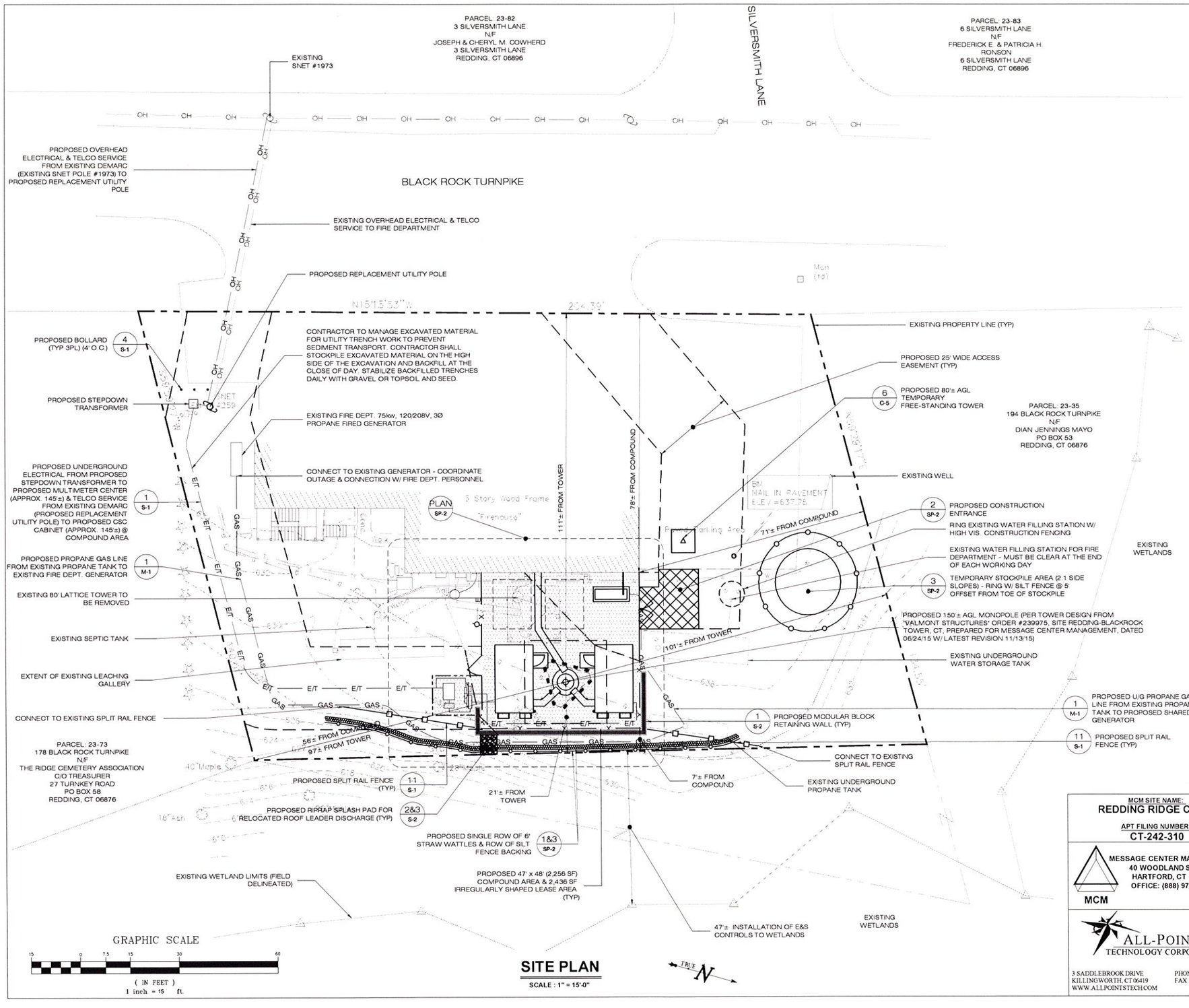
On behalf of Message Center Management, Inc. ("MCM"), and in furtherance of the captioned Certificate, please accept for review and Siting Council ("Council") approval this minor modification of the Development Management Plan ("D&M Plan") for the facility approved in Docket No. 449 ("Facility").

As you will recall, the construction sequencing for the Facility includes the removal of the existing tower and installation of a temporary freestanding tower until the approved Facility is completed. The Council originally approved a temporary tower utilizing a temporary foundation located behind (to the east) of the existing fire station and south of the approved Facility compound. Consultation and planning with the construction contractor CSB Communications revealed that the temporary tower available for deployment is an 80' AGL ballast mount structure and that the optimal location for this temporary tower is just north of the building in the paved parking area. This revised location and temporary tower type will reduce disturbance related to Facility construction. MCM currently estimates that the temporary tower will be in place for approximately four weeks and then removed. No changes to the approved permanent Facility as approved are proposed.

Please find enclosed 11" x 17" drawings filed for review of this minor modification of the temporary tower type and location and structural report. Should you have any questions or require further information please do not hesitate to contact me. Thank you for your consideration of the enclosed.

Very truly yours,

Daniel M. Laub
Enclosures
cc: Kenneth C. Baldwin, Esq.
MCM




## SURVEY NOTES

THIS SURVEY AND MAP HAS BEEN PREPARED IN ACCORDANCE WITH SECTIONS 20-300B-1 THRU 20-300B-20 OF THE REGULATIONS OF CONNECTICUT STATE AGENCIES - "MINIMUM STANDARDS FOR SURVEYS AND MAPS IN THE STATE OF CONNECTICUT" AS ENDORSED BY THE CONNECTICUT ASSOCIATION OF LAND SURVEYORS, INC. ON SEPT. 26, 1996. IT IS A IMPROVEMENT LOCATION SURVEY AND IS BASED UPON A DEPENDENT RESURVEY CONFORMING TO HORIZONTAL ACCURACY CLASS A-2 AND A VERTICAL ACCURACY OF CLASS T-2 AND IS INTENDED TO BE USED FOR THE PURPOSE OF SHOWING EXISTING CONDITIONS AND PROPERTY LINE INFORMATION.

MAP REFERENCES

1) MAP OF PROPERTY PREPARED FOR FIRE DISTRICT NO. 1, AT REDDING, CONN., SCALE 1"=30', DATED APRIL 29, 1965, JOHN M. FARNSWORTH.

2) PROPERTY DEPOSITION MAP, PREPARED FOR JENNINGS ESTATE, 194 BLACK ROCK TURNPIKE, REDDING, CONNECTICUT, SCALE 1"=100', DATED 8-21-2006, BY EDWARD SHELOMIS.

3) RIGHT OF WAY MAP, TOWN OF REDDING, BETHEL - BRIDGEPORT ROAD, FROM MEEKER HILL ROAD, NORTHERLY TO THE FIVE CORNERS, ROUTE NO. 58, SCALE 1"=40', DATED OCTOBER 29, 1937, BY CONNECTICUT STATE HIGHWAY DEPARTMENT.

NORTH ORIENTATION AND COORDINATES REFER TO CONNECTICUT GRID SYSTEM NAD 83.

ELEVATIONS BASED ON NAVD 1988 DATUM.

PARCEL ADDRESS: 186 BLACK ROCK TURNPIKE

PARCEL OWNER OF RECORD: REDDING FIRE DISTRICT NO. 1

MAP 23 LOT 72 REDDING ASSESSORS MAP.

PARCEL AREA = .624± ACRES.

PARCEL IS NOT IN A FLOOD HAZARD ZONE ON THE FLOOD INSURANCE RATE MAP, FAIRFIELD COUNTY, CONNECTICUT, ALL JURISDICTIONS, PANEL 265 OF 626, MAP NUMBER 09001C0265F, EFFECTIVE DATE JUNE 18, 2010, BY THE FEDERAL EMERGENCY MANAGEMENT AGENCY.

### SITE AREAS & VOLUMES OF EARTHWORK

SITEWORK SHALL ENTAIL APPROXIMATELY 20 CY OF FILL FOR THE COMPOUND AREA AND 55 CY OF TRENCH EXCAVATION. APPROXIMATELY 80 CUBIC YARDS OF CRUSHED STONE SHALL BE IMPORTED TO CONSTRUCT THE COMPOUND.

COMPOUND AREA SLOPES:
EXISTING - 9.0%
PROPOSED - 5.0%

TOTAL AREA OF DISTURBANCE = 4,150± SF

STORMWATER VELOCITY:
PRIOR TO GROUND COVER < 2 FT/SEC
FOLLOWING GROUND COVER < 2 FT/SEC

GROUND COVER TO BE ESTABLISHED AS FOLLOWS (U.O.N):
- WHITE CLOVER @ 0.20#/- SF
- TALL FESCUE @ 0.45#/- SF
- RYEGRASS @ 0.10#/- SF

NOTE: NO TREES WILL BE REMOVED IN CONSTRUCTING THE FACILITY

### LEGEND

- CURB
- DROP CURB
- WALL
- STONE WALL
- EDGE OF PAVEMENT
- OVERHEAD WIRES
- STRUCTURE - MANHOLE
- GAS VALVE
- WATER VALVE
- HANDICAP PARKING
- 20 PARKING STALL COUNT
- UNDERGROUND ELECTRICAL AND TELCO UTILITIES
- DRAINAGE INLET / STRUCTURE
- CATCH BASIN
- SIGN
- LIGHT POLE
- UTILITY POLE
- STOCKADE FENCE
- 23 CONTOURS
- 65
- TC 56.00 / BC 54.80 TOP/BOTTOM OF CURB
- 55.43 SPOT ELEVATION
- CONCRETE
- GUY WIRE
- NEW FENCE

MCM SITE NAME:
**REDDING RIDGE CT505**

APT FILING NUMBER:
**CT-242-310**


MESSAGE CENTER MANAGEMENT
40 WOODLAND STREET
HARTFORD, CT 06105
OFFICE: (888) 973-7483
MCM

ALL-POINTS TECHNOLOGY CORPORATION
3 SADDLEBROOK DRIVE
KILLINGWORTH, CT 06419
WWW.ALLPOINTSTECH.COM
PHONE: (860)-663-1697
FAX: (860)-663-0935


DEVELOPMENT & MANAGEMENT DOCUMENTS

**REDDING RIDGE**
**186 BLACK ROCK TURNPIKE**
**REDDING, CT 06896**

DESIGN TYPE:
**RAW LAND**

REVISIONS:
- REV.0: 08/11/15: FOR REVIEW: SMC
- REV.1: 08/12/15: FIRE DEPT. REVISIONS: SMC
- REV.2: 12/02/15: TOWER REVISIONS: SMC
- REV.3: 12/10/15: TEMP TOWER REVS: SMC
- REV.4: 08/16/16: TEMP TOWER RELOCATION: RCB
- REV.5:

**SITE PLAN**

APT FILING NUMBER: CT-242-310
APT DRAWING NUMBER: CT-505 SP-1
DRAWN BY: RCB
CHECKED BY: SMC
SCALE: AS NOTED
DATE: 08/03/15

SHEET NUMBER
**SP-1**

STATE OF CONNECTICUT — ROBERT C. BASSETT — LICENSED PROFESSIONAL ENGINEER

## DESIGN BASIS

GOVERNING CODE/STANDARD(S): 2003 INTERNATIONAL BUILDING CODE; (IBC) AS MODIFIED BY THE 2005 CT STATE SUPPLEMENT/ ASCE 7-02 / TIA/EIA-222-F

### WIND

| | | |
|---|---|---|
| BASIC WIND SPEED (FASTEST MILE) | 85 MPH | (TIA/EIA-222-F) |
| EXPOSURE CATEGORY | C | |
| STRUCTURE CLASSIFICATION | II | |
| IMPORTANCE FACTOR (Iw) | 1.0 | |
| WIND SPEED REDUCTION FACTOR | 0.8 | (TIA-1019) |

### INVENTORY

(3) 20-FT OMNI-DIRECTIONAL WHIP ANTENNAS
(3) 7/8" ø COAX CABLES

## STRUCTURAL STEEL NOTES

1. ALL STRUCTURAL STEEL IS DESIGNED BY ALLOWABLE STRESS DESIGN (ASD):

   A. STRUCTURAL STEEL (W SHAPES)---ASTM A992, (FY = 50 KSI)
   B. STRUCTURAL STEEL (OTHER SHAPES)---ASTM A36, (FY = 36 KSI)
   C. STRUCTURAL HSS (RECTANGULAR SHAPES)---ASTM A500 GRADE B, (FY = 46 KSI)
   D. STRUCTURAL HSS (ROUND SHAPES)---ASTM A500 GRADE B, (FY = 42 KSI)
   C. CONNECTION BOLTS---ASTM A325-N
   D. ANCHOR RODS---ASTM F 1554
   E. REBAR---ASTM A-615 GRADE 60, (FY = 60 KSI)
   E. WELDING ELECTRODE---ASTM E 70XX

2. EXISTING DIMENSIONS OF STRUCTURE SHOWN ON THESE PLANS ARE NOT GUARANTEED. CONTRACTOR SHALL TAKE FIELD MEASUREMENTS NECESSARY TO ASSURE PROPER FIT OF ALL FINISHED WORK AND SHALL ASSUME FULL RESPONSIBILITY FOR THEIR ACCURACY WHEN SHOP DRAWINGS BASED ON FIELD MEASUREMENTS ARE SUBMITTED FOR REVIEW TO THE ENGINEER.

3. CONTRACTOR TO REVIEW ALL SHOP DRAWINGS AND SUBMIT COPY TO ENGINEER FOR APPROVAL. DRAWINGS MUST BEAR THE REVIEWER'S INITIALS BEFORE SUBMITTING TO THE ENGINEER FOR REVIEW. SHOP DRAWINGS SHALL INCLUDE THE FOLLOWING: SECTION PROFILES, SIZES, CONNECTION ATTACHMENTS, REINFORCING, ANCHORAGE, SIZE AND TYPE OF FASTENERS AND ACCESSORIES. INCLUDE ERECTION DRAWINGS, ELEVATIONS AND DETAILS.

4. STRUCTURAL STEEL SHALL BE DETAILED, FABRICATED AND ERECTED IN ACCORDANCE WITH THE LATEST PROVISIONS OF AISC MANUAL OF STEEL CONSTRUCTION.

5. PROVIDE ALL PLATES, CLIP ANGLES, CLOSURE PIECES, STRAP ANCHORS, MISCELLANEOUS PIECES AND HOLES REQUIRED TO COMPLETE THE STRUCTURE.

6. CONNECTION ANGLES SHALL HAVE A MINIMUM THICKNESS OF 1/4 INCHES.

7. MILL BEARING ENDS OF COLUMNS, STIFFENERS, AND OTHER BEARING SURFACES TO TRANSFER LOAD OVER ENTIRE CROSS SECTION.

8. FABRICATE BEAMS WITH MILL CAMBER UP.

9. THE STRUCTURE IS DESIGNED TO BE SELF SUPPORTING AND STABLE AFTER THE WORK IS FULLY COMPLETED.

10. FIT AND SHOP ASSEMBLE FABRICATIONS IN THE LARGEST PRACTICAL SECTIONS FOR DELIVERY TO SITE.

11. BOLT HOLES SHALL BE PUNCHED OR DRILLED, FLAME CUT HOLES ARE NOT ACCEPTABLE.

12. LEVEL AND PLUMB INDIVIDUAL MEMBERS OF THE STRUCTURE TO AN ACCURACY OF 1:500, BUT NOT TO EXCEED 1/4" IN THE FULL HEIGHT OF THE COLUMN.

13. INSTALL FABRICATIONS PLUMB AND LEVEL, ACCURATELY FITTED, AND FREE FROM DISTORTIONS OR DEFECTS.

14. SHOP CONNECTIONS SHALL BE WELDED OR HIGH STRENGTH BOLTED.

15. STRUCTURAL CONNECTION BOLTS SHALL CONFORM TO ASTM A325-N. ALL BOLTS SHALL BE 3/4" DIAMETER MINIMUM AND SHALL HAVE A MINIMUM OF TWO BOLTS, UNLESS NOTED OTHERWISE ON THE DRAWINGS.

16. ALL BOLTED JOINTS SHALL BE SNUG TIGHT (ST) UNLESS OTHERWISE DESIGNATED AS PRETENSIONED (PT) OR SLIP CRITICAL (SC) ON THE DRAWINGS.

17. CONTRACTOR SHALL COMPLY WITH AWS CODE FOR PROCEDURES APPEARANCE AND QUALITY OF WELDS, AND WELDING PROCESSES SHALL BE QUALIFIED IN ACCORDANCE WITH AWS "STANDARD QUALIFICATION PROCEDURES". ALL WELDING SHALL BE DONE USING E70XX ELECTRODES AND WELDING SHALL CONFORM TO AISC AND D1.1 WHERE FILLET WELD SIZES ARE NOT SHOWN, PROVIDE THE MINIMUM SIZE PER TABLET J2.4 IN THE AISC "MANUAL OF STEEL CONSTRUCTION" 9TH EDITION. AT THE COMPLETION OF WELDING, ALL DAMAGE TO GALVANIZED COATING SHALL BE REPAIRED.

18. USE PRECAUTIONS & PROCEDURES PER AWS D1.1 WHEN WELDING GALVANIZED METALS.

19. ALL WELDING SHALL BE PERFORMED BY A CERTIFIED WELDER IN ACCORDANCE WITH AWS STANDARDS. SUBMIT WELDER CERTIFICATION FOR REVIEW BY ENGINEER.

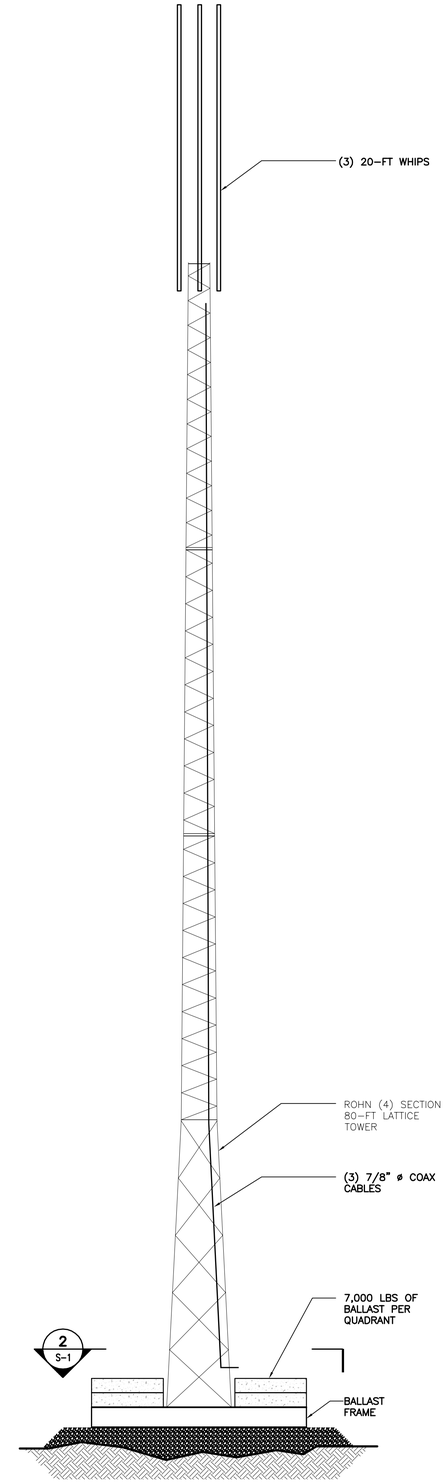
20. ALL STEEL MATERIAL (EXPOSED TO WEATHER) SHALL BE GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH ASTM A123 "ZINC (HOT DIPPED GALVANIZED) COATINGS" ON IRONS AND STEEL PRODUCTS.

21. ALL BOLTS, ANCHORS AND MISCELLANEOUS HARDWARE SHALL BE GALVANIZED IN ACCORDANCE WITH ASTM A153 "ZINC COATING (HOT-DIP) ON IRON AND STEEL HARDWARE".

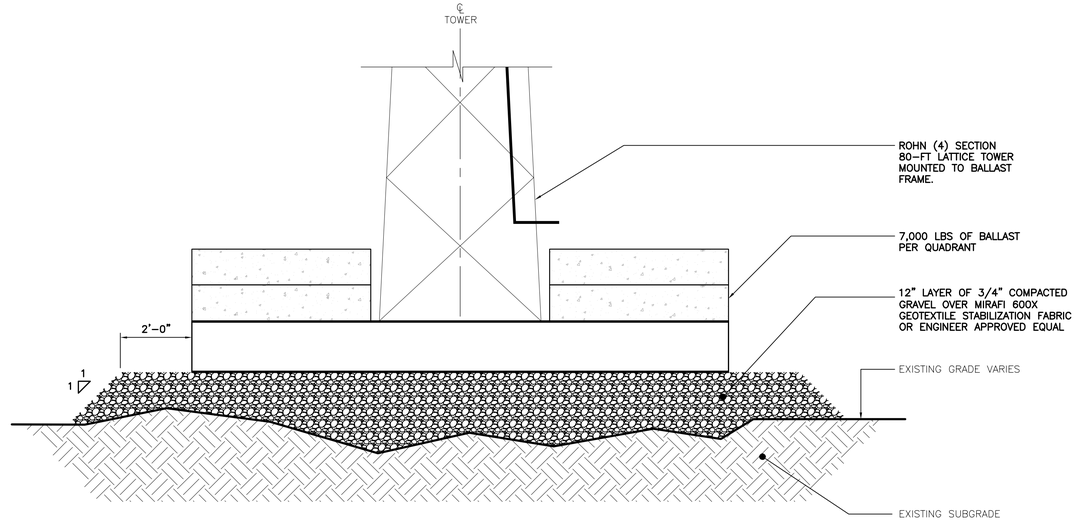
22. NOTIFY THE ENGINEER PRIOR TO FIELD CUTTING OR MODIFYING APPROVED FABRICATIONS.

23. THE ENGINEER SHALL BE NOTIFIED OF ANY INCORRECTLY FABRICATED, DAMAGED OR OTHERWISE MISFITTING OR NON CONFORMING MATERIALS OR CONDITIONS TO REMEDIAL OR CORRECTIVE ACTION. ANY SUCH ACTION SHALL REQUIRE ENGINEER REVIEW.

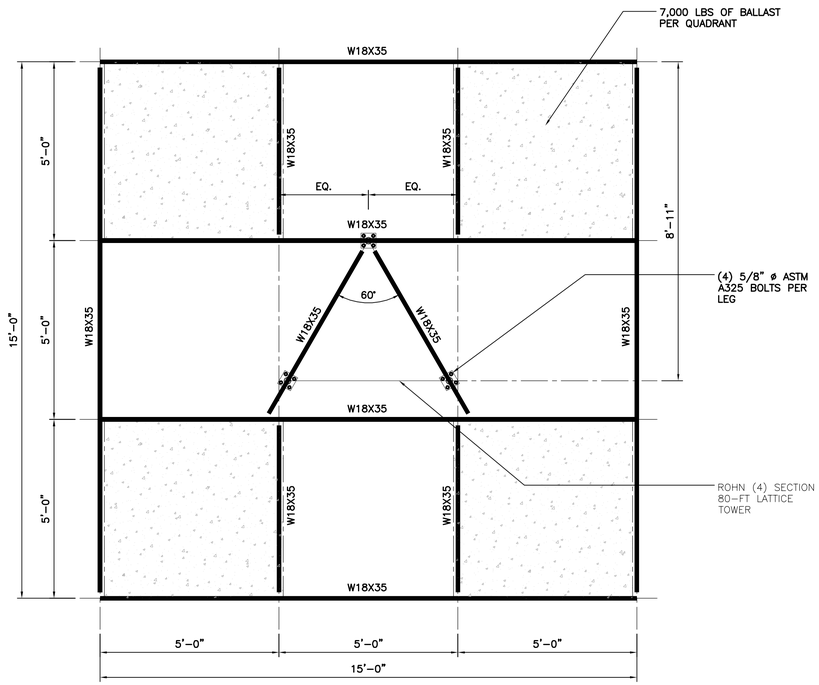
24. COMMENCEMENT OF STRUCTURAL STEEL WORK WITHOUT NOTIFYING THE ENGINEER OF ANY DISCREPANCIES WILL BE CONSIDERED ACCEPTANCE OF PRECEDING WORK.




1 S-1 **ELEVATION**
SCALE: 1" = 5'-0"




3 S-1 **BALLAST FRAME GRADE PREPARATION**
SCALE: 1/2" = 1'-0"




2 S-1 **FRAMING PLAN**
SCALE: 1/2" = 1'-0"

| REV. | DATE | DRAWN BY | CHK'D BY | DESCRIPTION |
|---|---|---|---|---|
| 0 | 04/1/16 | TJL | CFC | ISSUED FOR CLIENT REVIEW |

PROFESSIONAL ENGINEER SEAL

STATE OF CONNECTICUT — CHRISTOPHER F. CRONIN — LICENSED PROFESSIONAL ENGINEER


CENTEK engineering
Centered on Solutions℠
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(203) 488-8587 Fax
63-2 North Branford Road
Branford, CT 06405
www.CentekEng.com


CSB COMMUNICATIONS

# TEMP BALLAST TOWER

186 BLACKROCK TURNPIKE
REDDING, CT

| | |
|---|---|
| DATE: | 04/1/16 |
| SCALE: | AS NOTED |
| JOB NO. | 16047.00 |

BALLAST FRAME DETAILS

S-1

Sheet No. 1 of 1

CENTEK engineering

Centered on Solutions℠

# Structural Analysis Report

80-ft Ballast Lattice Tower

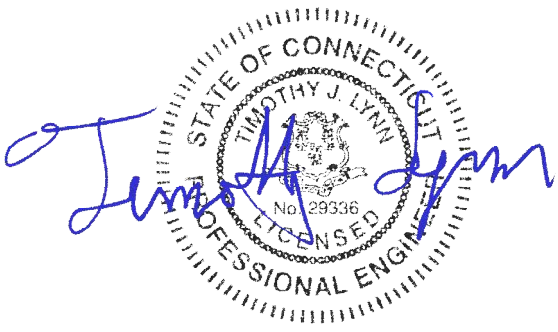
Proposed Temporary Antenna Installation

Site Ref: Redding FD

186 Black Rock Turnpike
Redding, CT

Centek Project No. 16047.00

Date: April 1, 2016




***Prepared for:***
*CSB Communications*
*63-3 North Branford Road*
*Branford, CT 06405*

# ***Table of Contents***

## *Introduction*

The purpose of this report is to summarize the results of the non-linear, P-Δ structural analysis of the temporary antenna installation on the ballast lattice tower located in Redding, CT.

The host tower is a 80-ft, three legged, tapered lattice tower originally designed and manufactured by ROHN. The tower geometry and structure member sizes were taken from ROHN SSV standard design documents.

The tower consists of three (3) tapered vertical sections consisting of solid round legs and one (1) tapered section consisting of pipe legs conforming to ASTM A572-50. Diagonal and horizontal lateral support bracing consists of solid rounds and steel angle shapes conforming to ASTM A7-33. The vertical tower sections are connected by bolted flange plates with the diagonal bracing to pipe legs consisting of bolted connections. The width of the tower face is 1.5-ft at the top and 4.52-ft at the base.

## *Antenna and Appurtenance Summary*

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

- **TOWN (Proposed):**
  **Antennas: Three (3) 20-ft whip antennas mounted to the top of the tower.**
  **Coax Cables: Three (3) 7/8" ∅ coax cables running on a face of the 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.
- 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 coax cables routed as specified in Section 3 of this report.

## *Analysis*

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

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

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

## *Tower Loading*

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

| | | |
|---|---|---|
| Basic Wind Speed: | Fairfield; v = 85 mph (fastest mile) | *[Section 16 of TIA/EIA-222-F-96]* |
| | Redding; v = 100 mph (3 second gust) equivalent to v = 80 mph (fastest mile) | *[Appendix K of the 2005 CT Building Code Supplement]* |
| | *TIA/EIA-222-F wind speed controls.* | |
| Load Cases: | Load Case 1; 68 mph wind speed w/ no ice plus gravity load – used in calculation of tower stresses and rotation. | *[Section 2.3.16 of TIA/EIA-222-F-96]* **Per TIA-1019 Construction Standard a 20% reduction in wind speed was considered for temporary loads experienced during construction durations of six weeks to six months** |
| | Load Case 2; 59 mph wind speed w/ ½" radial ice plus gravity load – used in calculation of tower stresses. The 59 mph wind speed velocity represents 75% of the wind pressure generated by the 68 mph wind speed. | *[Section 2.3.16 of TIA/EIA-222-F-96]* |
| | Load Case 3; Seismic – not checked | *[Section 1614.5 of State Bldg. Code 2005] does not control in the design of this structure type* |

[1] The 2005 Connecticut State Building Code as amended by the 2009 CT State Supplement. (CSBC)

## *Tower Capacity*

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

- Calculated stresses were found to be within allowable limits. In Load Case 1, per tnxTower "Section Capacity Table", this tower was found to be at **78.0%** of its total capacity.

| Tower Section | Elevation (AGL) | Stress Ratio (percentage of capacity) | Result |
|---|---|---|---|
| Leg (T4) | 0.00'-20.00' | 78.0% | **PASS** |

## *Anchors and Ballast*

The base of the tower is connected to the ballast frame by means of (4) 5/8"∅, ASTM A325 bolts per leg.

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

| Reactions | Vector | Proposed Base Reactions |
|---|---|---|
| Base | Shear | **2 kips** |
| | Compression | **3 kips** |
| | Moment | **89 kip-ft** |
| Leg | Shear | **2 kips** |
| | Compression | **24 kips** |
| | Uplift | **21 kips** |

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

| Tower Component | Component | Stress Ratio (percentage of capacity) | Result |
|---|---|---|---|
| Anchor Bolts | Tension | 29.6% | **PASS** |

- The ballast frame was found to be within allowable limits.

| Foundation | Design Limit | IBC 2003/2005 CT State Building Code Section 3108.4.2 (FS)[1] | Proposed Loading (FS)[1] | Result |
|---|---|---|---|---|
| Ballast frame w/ 28,000 lbs of conc. blocks | OTM[2] | 2.0 | 3.02 | **PASS** |

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

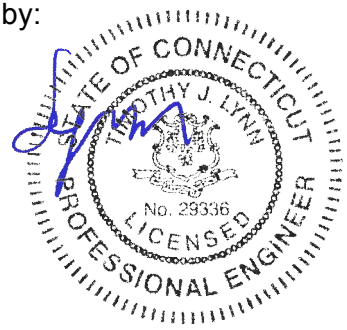
## *C o n c l u s i o n*

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 CSB. 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.

## DESIGNED APPURTENANCE LOADING

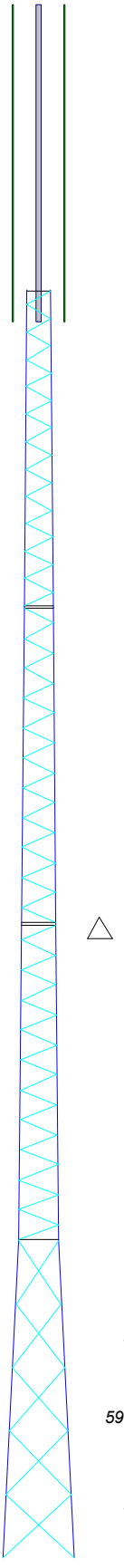
| TYPE | ELEVATION | TYPE | ELEVATION |
|---|---|---|---|
| 20' x 3" Dia Omni | 78 | 20' x 3" Dia Omni | 78 |
| 20' x 3" Dia Omni | 78 | | |

## MATERIAL STRENGTH

| GRADE | Fy | Fu | GRADE | Fy | Fu |
|---|---|---|---|---|---|
| A572-50 | 50 ksi | 65 ksi | A7-33 | 33 ksi | 60 ksi |

## TOWER DESIGN NOTES

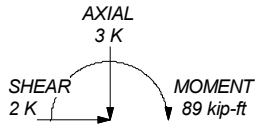
1. Tower designed for a 68 mph basic wind in accordance with the TIA/EIA-222-F Standard.
2. Tower is also designed for a 59 mph basic wind with 0.50 in ice.
3. Deflections are based upon a 50 mph wind.
4. Per TIA-1019 "Standard for Installation, Allteration and Maintenance of Antenna Supporting Structures and Antennas" a 20% reduction in wind speed was used for temporary loads during constuction duration of six weeks to six months
5. TOWER RATING: 78%



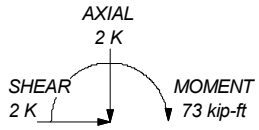

| Section | T1 | T2 | T3 | T4 | |
|---|---|---|---|---|---|
| Legs | SR 15/16 | SR 1 1/4 | SR 1 7/16 | ROHN 2 STD | |
| Leg Grade | A572-50 | | | | |
| Diagonals | SR 7/16 | SR 5/8 | | L1 1/2x1 1/2x1/8 | |
| Diagonal Grade | A7-33 | | | | |
| Top Girts | SR 7/16 | SR 5/8 | | N.A. | |
| Bottom Girts | SR 7/16 | SR 5/8 | | N.A. | |
| Face Width (ft) | 1.5 | 1.833 | 2.167 | 2.5 | 4.521 |
| # Panels @ (ft) | 23 @ 0.862319 | 42 @ 0.944444 | | 5 @ 4 | |
| Weight (K) | 0.2 | 0.4 | 0.5 | 0.4 | 1.5 |

*MAX. CORNER REACTIONS AT BASE:*
*DOWN: 24 K*
*SHEAR: 1 K*

*UPLIFT: -21 K*
*SHEAR: 2 K*




*TORQUE 0 kip-ft*
*59 mph WIND - 0.5000 in ICE*



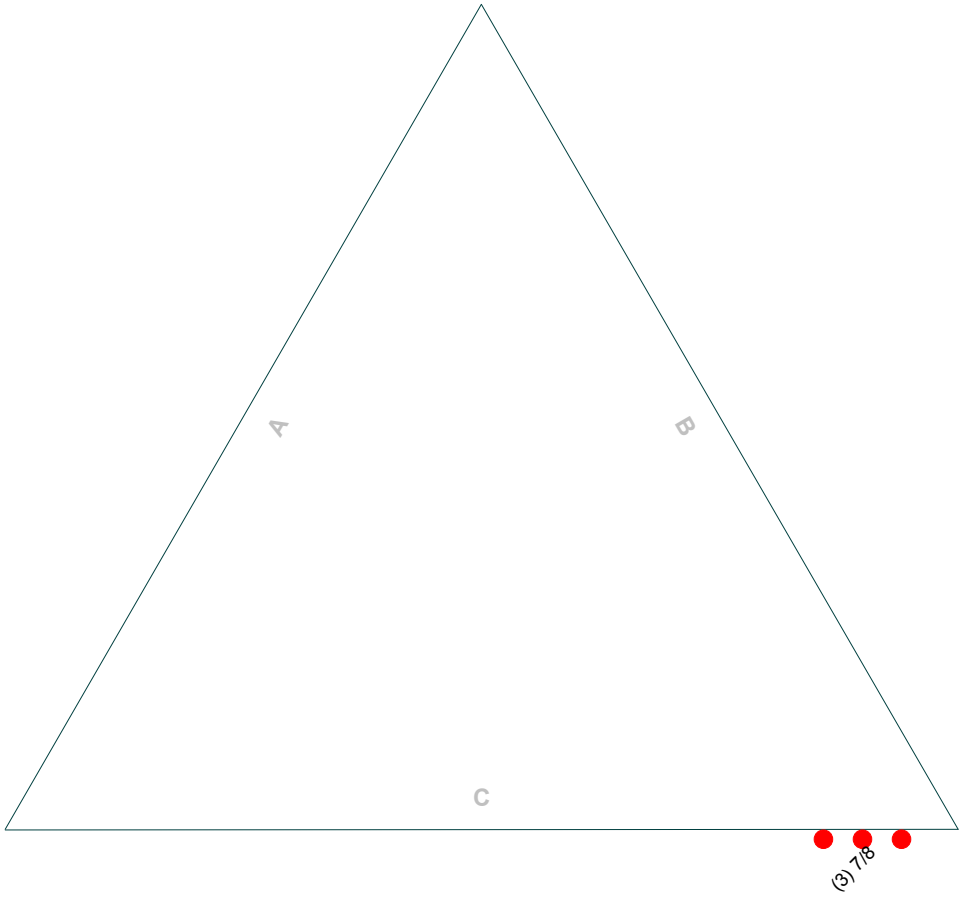

*TORQUE 0 kip-ft*
*REACTIONS - 68 mph WIND*


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


| | | |
|---|---|---|
| Job: ***16047.00 - Temp Tower*** | | |
| Project: ***80' ROHN Lattice Tower - Redding, CT*** | | |
| Client: CSB | Drawn by: TJL | App'd: |
| Code: TIA/EIA-222-F | Date: 04/04/16 | Scale: NTS |
| Path: J:\Jobs\1604700.WI\Calcs\ERI Files\100-ft ROHN Lattice Tower.eri | | Dwg No. E-1 |

# Feed Line Plan

Round  Flat  App In Face  App Out Face





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| | | |
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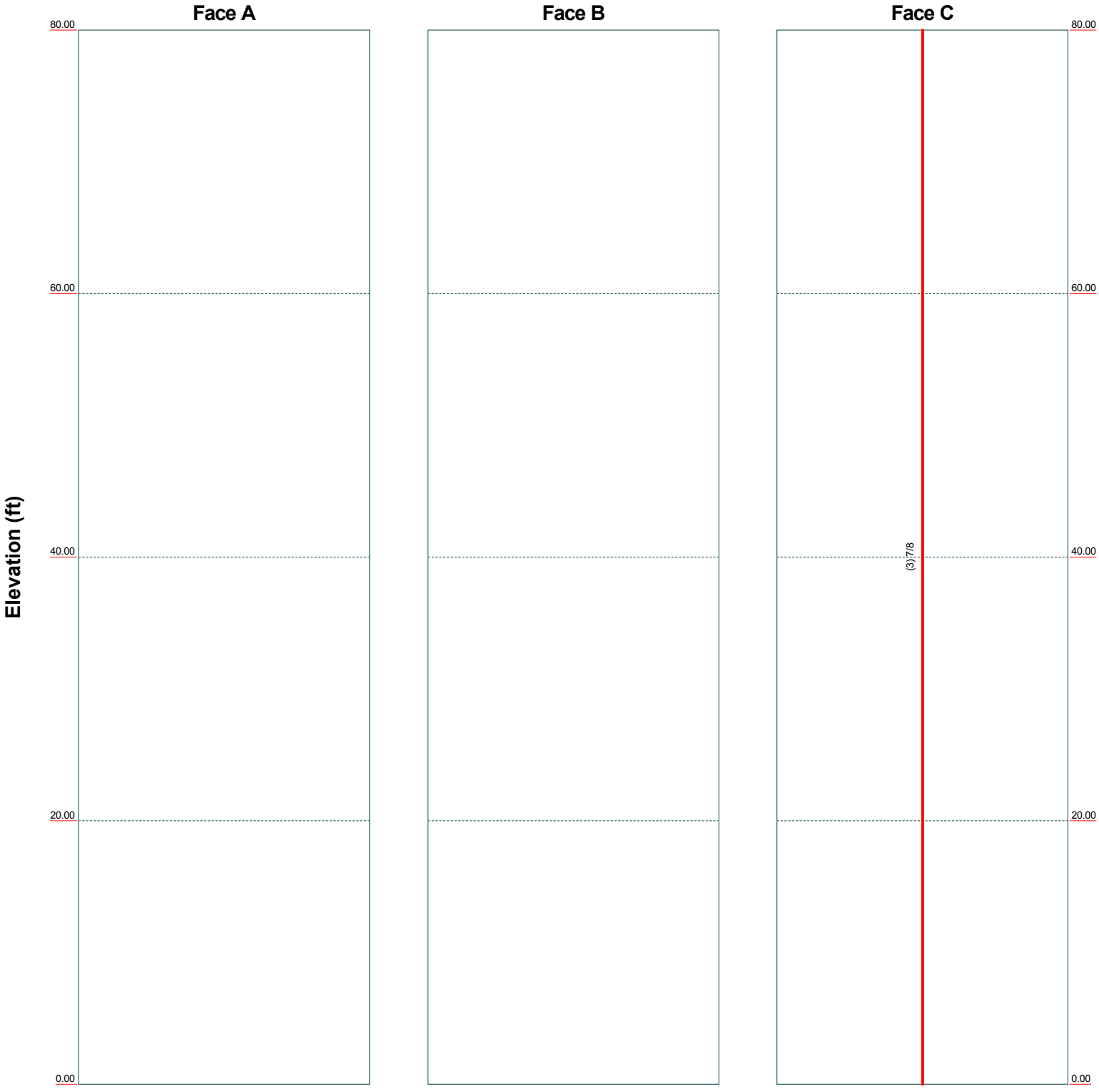
| Code: TIA/EIA-222-F | Date: 04/01/16 | Scale: NTS |
| Path: J:\Jobs\1604700.WI\Calcs\ERI Files\100-ft ROHN Lattice Tower.eri | | Dwg No. E-7 |

# Feed Line Distribution Chart
## 0' - 80'

Round | Flat | App In Face | App Out Face | Truss Leg





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| | | | |
|---|---|---|---|
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| Project: ***80' ROHN Lattice Tower - Redding, CT*** | | | |
| Client: CSB | Drawn by: TJL | App'd: | |
| Code: TIA/EIA-222-F | Date: 04/01/16 | Scale: NTS | |
| Path: J:\Jobs\1604700.WI\Calcs\ERI Files\100-ft ROHN Lattice Tower.eri | | Dwg No. E-7 | |

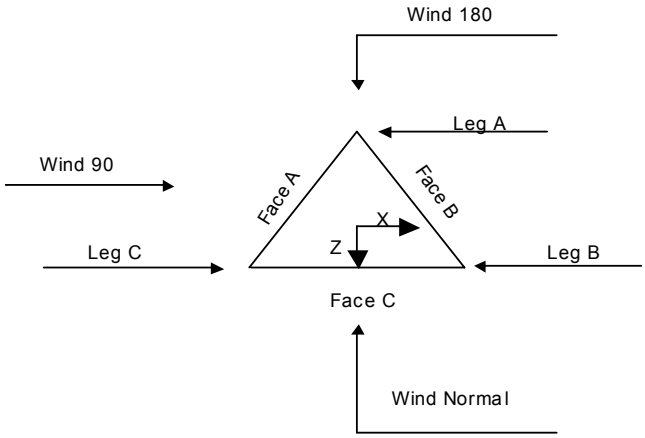
# Tower Input Data

The main tower is a 3x free standing tower with an overall height of 80.00 ft above the ground line.
The base of the tower is set at an elevation of 0.00 ft above the ground line.
The face width of the tower is 1.50 ft at the top and 4.52 ft at the base.
This tower is designed using the TIA/EIA-222-F standard.
The following design criteria apply:

Basic wind speed of 68 mph.
Nominal ice thickness of 0.5000 in.
Ice density of 56 pcf.
A wind speed of 59 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 50 mph.
Per TIA-1019 "Standard for Installation, Allteration and Maintenance of Antenna Supporting Structures and Antennas" a 20% reduction in wind speed was used for temporary loads during constuction duration of six weeks to six months.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in tower member design is 1.333.
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 | | | | |




***Triangular Tower***

## Tower Section Geometry

| Tower Section | Tower Elevation ft | Assembly Database | Description | Section Width ft | Number of Sections | Section Length ft |
|---|---|---|---|---|---|---|
| T1 | 80.00-60.00 | | | 1.50 | 1 | 20.00 |
| T2 | 60.00-40.00 | | | 1.83 | 1 | 20.00 |
| T3 | 40.00-20.00 | | | 2.17 | 1 | 20.00 |
| T4 | 20.00-0.00 | | | 2.50 | 1 | 20.00 |

## Tower Section Geometry *(cont'd)*

| Tower Section | Tower Elevation ft | Diagonal Spacing ft | Bracing Type | Has K Brace End Panels | Has Horizontals | Top Girt Offset in | Bottom Girt Offset in |
|---|---|---|---|---|---|---|---|
| T1 | 80.00-60.00 | 0.86 | K Brace Left | No | No | 1.0000 | 1.0000 |
| T2 | 60.00-40.00 | 0.94 | K Brace Right | No | No | 1.0000 | 1.0000 |
| T3 | 40.00-20.00 | 0.94 | K Brace Left | No | No | 1.0000 | 1.0000 |
| T4 | 20.00-0.00 | 4.00 | X Brace | No | No | 0.0000 | 0.0000 |

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Leg Type | Leg Size | Leg Grade | Diagonal Type | Diagonal Size | Diagonal Grade |
|---|---|---|---|---|---|---|
| T1 80.00-60.00 | Solid Round | 15/16 | A572-50 (50 ksi) | Solid Round | 7/16 | A7-33 (33 ksi) |
| T2 60.00-40.00 | Solid Round | 1 1/4 | A572-50 (50 ksi) | Solid Round | 5/8 | A7-33 (33 ksi) |
| T3 40.00-20.00 | Solid Round | 1 7/16 | A572-50 (50 ksi) | Solid Round | 5/8 | A7-33 (33 ksi) |
| T4 20.00-0.00 | Pipe | ROHN 2 STD | A572-50 (50 ksi) | Single Angle | L1 1/2x1 1/2x1/8 | A7-33 (33 ksi) |

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Top Girt Type | Top Girt Size | Top Girt Grade | Bottom Girt Type | Bottom Girt Size | Bottom Girt Grade |
|---|---|---|---|---|---|---|
| T1 80.00-60.00 | Solid Round | 7/16 | A7-33 (33 ksi) | Solid Round | 7/16 | A7-33 (33 ksi) |
| T2 60.00-40.00 | Solid Round | 5/8 | A7-33 (33 ksi) | Solid Round | 5/8 | A7-33 (33 ksi) |
| T3 40.00-20.00 | Solid Round | 5/8 | A7-33 (33 ksi) | Solid Round | 5/8 | A7-33 (33 ksi) |

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Gusset Area (per face) $ft^2$ | Gusset Thickness in | Gusset Grade | Adjust. Factor $A_f$ | Adjust. Factor $A_r$ | Weight Mult. | Double Angle Stitch Bolt Spacing Diagonals in | Double Angle Stitch Bolt Spacing Horizontals in | Double Angle Stitch Bolt Spacing Redundants in |
|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | 0.00 | 0.0000 | A36 (36 ksi) | 1 | 1 | 1 | 36.0000 | 36.0000 | 36.0000 |
| T2 60.00-40.00 | 0.00 | 0.0000 | A36 (36 ksi) | 1 | 1 | 1 | 36.0000 | 36.0000 | 36.0000 |
| T3 40.00-20.00 | 0.00 | 0.0000 | A36 (36 ksi) | 1 | 1 | 1 | 36.0000 | 36.0000 | 36.0000 |
| T4 20.00-0.00 | 0.00 | 0.0000 | A36 (36 ksi) | 1 | 1 | 1 | 36.0000 | 36.0000 | 36.0000 |

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Calc K Single Angles | Calc K Solid Rounds | K Factors[1] Legs | X Brace Diags X Y | K Brace Diags X Y | Single Diags X Y | Girts X Y | Horiz. X Y | Sec. Horiz. X Y | Inner Brace X Y |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | Yes | Yes | 1 | 1<br>1 | 1<br>1 | 1<br>1 | 1<br>1 | 1<br>1 | 1<br>1 | 1<br>1 |
| T2 | Yes | Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Tower Elevation ft | Calc K Single Angles | Calc K Solid Rounds | Legs | K Factors[1] X Brace Diags X Y | K Brace Diags X Y | Single Diags X Y | Girts X Y | Horiz. X Y | Sec. Horiz. X Y | Inner Brace X Y |
|---|---|---|---|---|---|---|---|---|---|---|
| 60.00-40.00 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| T3 | Yes | Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 40.00-20.00 | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| T4 20.00-0.00 | Yes | Yes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

[1]*Note: K factors are applied to member segment lengths. K-braces without inner supporting members will have the K factor in the out-of-plane direction applied to the overall length.*

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Leg Net Width Deduct in | Leg U | Diagonal Net Width Deduct in | Diagonal U | Top Girt Net Width Deduct in | Top Girt U | Bottom Girt Net Width Deduct in | Bottom Girt U | Mid Girt Net Width Deduct in | Mid Girt U | Long Horizontal Net Width Deduct in | Long Horizontal U | Short Horizontal Net Width Deduct in | Short Horizontal U |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 |
| T2 60.00-40.00 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 |
| T3 40.00-20.00 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 |
| T4 20.00-0.00 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 | 0.0000 | 1 |

## Tower Section Geometry *(cont'd)*

| Tower Elevation ft | Leg Connection Type | Leg Bolt Size in | Leg No. | Diagonal Bolt Size in | Diagonal No. | Top Girt Bolt Size in | Top Girt No. | Bottom Girt Bolt Size in | Bottom Girt No. | Mid Girt Bolt Size in | Mid Girt No. | Long Horizontal Bolt Size in | Long Horizontal No. | Short Horizontal Bolt Size in | Short Horizontal No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | Flange | 0.3750 SAEGR-5 | 4 | 0.5000 A325N | 0 | 0.5000 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 |
| T2 60.00-40.00 | Flange | 0.5000 A325N | 4 | 0.5000 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 |
| T3 40.00-20.00 | Flange | 0.6250 A325N | 4 | 0.3750 SAEGR-5 | 1 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 |
| T4 20.00-0.00 | Flange | 0.6250 A325N | 4 | 0.3750 SAEGR-5 | 1 | 0.5000 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 | 0.6250 A325N | 0 |

## Feed Line/Linear Appurtenances - Entered As Round Or Flat

| Description | Face or Leg | Allow Shield | Component Type | Placement ft | Face Offset in | Lateral Offset (Frac FW) | # | # Per Row | Clear Spacing in | Width or Diameter in | Perimeter in | Weight plf |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7/8 | C | Yes | Ar (CfAe) | 80.00 - 0.00 | 0.0000 | -0.4 | 3 | 3 | 1.1100 | 1.1100 | | 0.54 |

## Feed Line/Linear Appurtenances Section Areas

| Tower Section | Tower Elevation ft | Face | $A_R$ $ft^2$ | $A_F$ $ft^2$ | $C_AA_A$ In Face $ft^2$ | $C_AA_A$ Out Face $ft^2$ | Weight K |
|---|---|---|---|---|---|---|---|
| T1 | 80.00-60.00 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | 5.550 | 0.000 | 0.000 | 0.000 | 0.03 |
| T2 | 60.00-40.00 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | 5.550 | 0.000 | 0.000 | 0.000 | 0.03 |
| T3 | 40.00-20.00 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | 5.550 | 0.000 | 0.000 | 0.000 | 0.03 |
| T4 | 20.00-0.00 | A | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | 5.550 | 0.000 | 0.000 | 0.000 | 0.03 |

## 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 |
|---|---|---|---|---|---|---|---|---|
| T1 | 80.00-60.00 | A | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | | 10.550 | 0.000 | 0.000 | 0.000 | 0.09 |
| T2 | 60.00-40.00 | A | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | | 10.550 | 0.000 | 0.000 | 0.000 | 0.09 |
| T3 | 40.00-20.00 | A | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | | 10.550 | 0.000 | 0.000 | 0.000 | 0.09 |
| T4 | 20.00-0.00 | A | 0.500 | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | B | | 0.000 | 0.000 | 0.000 | 0.000 | 0.00 |
| | | C | | 10.550 | 0.000 | 0.000 | 0.000 | 0.09 |

## Feed Line Shielding

| Section | Elevation ft | Face | $A_R$ $ft^2$ | $A_R$ Ice $ft^2$ | $A_F$ $ft^2$ | $A_F$ Ice $ft^2$ |
|---|---|---|---|---|---|---|
| T1 | 80.00-60.00 | A | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.282 | 1.764 | 0.000 | 0.000 |
| T2 | 60.00-40.00 | A | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.365 | 1.803 | 0.000 | 0.000 |
| T3 | 40.00-20.00 | A | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.356 | 1.762 | 0.000 | 0.000 |
| T4 | 20.00-0.00 | A | 0.000 | 0.000 | 0.000 | 0.000 |
| | | B | 0.000 | 0.000 | 0.000 | 0.000 |
| | | C | 0.000 | 0.679 | 0.536 | 1.018 |

## Feed Line Center of Pressure

| Section | Elevation | $CP_X$ | $CP_Z$ | $CP_X$ Ice | $CP_Z$ Ice |
|---|---|---|---|---|---|
| | ft | in | in | in | in |
| T1 | 80.00-60.00 | 2.1619 | 1.7102 | 1.5940 | 1.2610 |
| T2 | 60.00-40.00 | 1.9786 | 1.5423 | 1.6570 | 1.2916 |
| T3 | 40.00-20.00 | 2.0703 | 1.5967 | 1.7788 | 1.3719 |
| T4 | 20.00-0.00 | 1.7699 | 1.3356 | 2.0099 | 1.5168 |

## Discrete Tower Loads

| Description | Face or Leg | Offset Type | Offsets: Horz Lateral Vert<br>ft<br>ft<br>ft | Azimuth Adjustment<br>° | Placement<br>ft | | $C_AA_A$ Front<br>$ft^2$ | $C_AA_A$ Side<br>$ft^2$ | Weight<br>K |
|---|---|---|---|---|---|---|---|---|---|
| 20' x 3" Dia Omni | A | From Leg | 1.00<br>0.00<br>10.00 | 0.0000 | 78.00 | No Ice<br>1/2" Ice | 6.00<br>8.03 | 6.00<br>8.03 | 0.05<br>0.09 |
| 20' x 3" Dia Omni | B | From Leg | 1.00<br>0.00<br>10.00 | 0.0000 | 78.00 | No Ice<br>1/2" Ice | 6.00<br>8.03 | 6.00<br>8.03 | 0.05<br>0.09 |
| 20' x 3" Dia Omni | C | From Leg | 1.00<br>0.00<br>10.00 | 0.0000 | 78.00 | No Ice<br>1/2" Ice | 6.00<br>8.03 | 6.00<br>8.03 | 0.05<br>0.09 |

## Tower Pressures - No Ice

$G_H = 1.179$

| Section Elevation | z | $K_Z$ | $q_z$ | $A_G$ | Face | $A_F$ | $A_R$ | $A_{leg}$ | Leg % | $C_AA_A$ In Face | $C_AA_A$ Out Face |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ft | ft | | psf | $ft^2$ | | $ft^2$ | $ft^2$ | $ft^2$ | | $ft^2$ | $ft^2$ |
| T1 80.00-60.00 | 70.00 | 1.24 | 15 | 34.893 | A | 0.000 | 4.741 | 3.125 | 65.92 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 4.741 | | 65.92 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 10.008 | | 31.22 | 0.000 | 0.000 |
| T2 60.00-40.00 | 50.00 | 1.126 | 13 | 42.083 | A | 0.000 | 6.658 | 4.167 | 62.59 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 6.658 | | 62.59 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 11.843 | | 35.18 | 0.000 | 0.000 |
| T3 40.00-20.00 | 30.00 | 1 | 12 | 49.066 | A | 0.000 | 7.635 | 4.792 | 62.76 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 7.635 | | 62.76 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 12.828 | | 37.35 | 0.000 | 0.000 |
| T4 20.00-0.00 | 10.00 | 1 | 12 | 74.173 | A | 6.311 | 7.930 | 7.930 | 55.68 | 0.000 | 0.000 |
| | | | | | B | 6.311 | 7.930 | | 55.68 | 0.000 | 0.000 |

| Section Elevation ft | z ft | $K_Z$ | $q_z$ psf | $A_G$ ft² | Face | $A_F$ ft² | $A_R$ ft² | $A_{leg}$ ft² | Leg % | $C_AA_A$ In Face ft² | $C_AA_A$ Out Face ft² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | C | 5.775 | 13.480 | | 41.18 | 0.000 | 0.000 |

## Tower Pressure - With Ice

$G_H = 1.179$

| Section Elevation ft | z ft | $K_Z$ | $q_z$ psf | $t_Z$ in | $A_G$ ft² | Face | $A_F$ ft² | $A_R$ ft² | $A_{leg}$ ft² | Leg % | $C_AA_A$ In Face ft² | $C_AA_A$ Out Face ft² |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | 70.00 | 1.24 | 11 | 0.5000 | 36.559 | A | 0.000 | 11.768 | 6.459 | 54.88 | 0.000 | 0.000 |
| | | | | | | B | 0.000 | 11.768 | | 54.88 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 20.553 | | 31.42 | 0.000 | 0.000 |
| T2 60.00-40.00 | 50.00 | 1.126 | 10 | 0.5000 | 43.750 | A | 0.000 | 13.977 | 7.500 | 53.66 | 0.000 | 0.000 |
| | | | | | | B | 0.000 | 13.977 | | 53.66 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 22.724 | | 33.01 | 0.000 | 0.000 |
| T3 40.00-20.00 | 30.00 | 1 | 9 | 0.5000 | 50.733 | A | 0.000 | 15.517 | 8.125 | 52.36 | 0.000 | 0.000 |
| | | | | | | B | 0.000 | 15.517 | | 52.36 | 0.000 | 0.000 |
| | | | | | | C | 0.000 | 24.305 | | 33.43 | 0.000 | 0.000 |
| T4 20.00-0.00 | 10.00 | 1 | 9 | 0.5000 | 75.842 | A | 6.311 | 15.477 | 11.269 | 51.72 | 0.000 | 0.000 |
| | | | | | | B | 6.311 | 15.477 | | 51.72 | 0.000 | 0.000 |
| | | | | | | C | 5.293 | 25.348 | | 36.78 | 0.000 | 0.000 |

## Tower Pressure - Service

$G_H = 1.179$

| Section Elevation ft | z ft | $K_Z$ | $q_z$ psf | $A_G$ ft² | Face | $A_F$ ft² | $A_R$ ft² | $A_{leg}$ ft² | Leg % | $C_AA_A$ In Face ft² | $C_AA_A$ Out Face ft² |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 80.00-60.00 | 70.00 | 1.24 | 8 | 34.893 | A | 0.000 | 4.741 | 3.125 | 65.92 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 4.741 | | 65.92 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 10.008 | | 31.22 | 0.000 | 0.000 |
| T2 60.00-40.00 | 50.00 | 1.126 | 7 | 42.083 | A | 0.000 | 6.658 | 4.167 | 62.59 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 6.658 | | 62.59 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 11.843 | | 35.18 | 0.000 | 0.000 |
| T3 40.00-20.00 | 30.00 | 1 | 6 | 49.066 | A | 0.000 | 7.635 | 4.792 | 62.76 | 0.000 | 0.000 |
| | | | | | B | 0.000 | 7.635 | | 62.76 | 0.000 | 0.000 |
| | | | | | C | 0.000 | 12.828 | | 37.35 | 0.000 | 0.000 |
| T4 20.00-0.00 | 10.00 | 1 | 6 | 74.173 | A | 6.311 | 7.930 | 7.930 | 55.68 | 0.000 | 0.000 |
| | | | | | B | 6.311 | 7.930 | | 55.68 | 0.000 | 0.000 |
| | | | | | C | 5.775 | 13.480 | | 41.18 | 0.000 | 0.000 |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 1 | 1 | 2.747 | 0.25 | 12.35 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 1 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 1 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 1 | 1 | 3.880 | 0.27 | 13.33 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 1 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 1 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 1 | 1 | 4.446 | 0.26 | 13.01 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 1 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 1 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 1 | 1 | 10.980 | 0.47 | 23.40 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 1 | 1 | 10.980 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 1 | 1 | 13.922 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 43.10 kip-ft | 1.24 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.825 | 1 | 2.747 | 0.25 | 12.35 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.825 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.825 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.825 | 1 | 3.880 | 0.27 | 13.33 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.825 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.825 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.825 | 1 | 4.446 | 0.26 | 13.01 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.825 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.825 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.825 | 1 | 9.876 | 0.43 | 21.70 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.825 | 1 | 9.876 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.825 | 1 | 12.912 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 42.76 kip-ft | 1.21 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.8 | 1 | 2.747 | 0.25 | 12.35 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.8 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.8 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.8 | 1 | 3.880 | 0.27 | 13.33 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.8 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.8 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.8 | 1 | 4.446 | 0.26 | 13.01 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.8 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.8 | 1 | 7.759 | | | |

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.8 | 1 | 9.718 | 0.43 | 21.46 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.8 | 1 | 9.718 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.8 | 1 | 12.767 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 42.72 kip-ft | 1.20 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.85 | 1 | 2.747 | 0.25 | 12.35 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.85 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.85 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.85 | 1 | 3.880 | 0.27 | 13.33 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.85 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.85 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.85 | 1 | 4.446 | 0.26 | 13.01 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.85 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.85 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.85 | 1 | 10.034 | 0.44 | 21.94 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.85 | 1 | 10.034 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.85 | 1 | 13.056 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 42.81 kip-ft | 1.21 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.09 | 0.34 | A | 0.322 | 2.239 | 0.623 | 1 | 1 | 7.329 | 0.36 | 17.86 | C |
| 80.00-60.00 | | | B | 0.322 | 2.239 | 0.623 | 1 | 1 | 7.329 | | | |
| | | | C | 0.562 | 1.832 | 0.731 | 1 | 1 | 15.029 | | | |
| T2 | 0.09 | 0.58 | A | 0.319 | 2.245 | 0.622 | 1 | 1 | 8.694 | 0.36 | 17.77 | C |
| 60.00-40.00 | | | B | 0.319 | 2.245 | 0.622 | 1 | 1 | 8.694 | | | |
| | | | C | 0.519 | 1.876 | 0.708 | 1 | 1 | 16.079 | | | |
| T3 | 0.09 | 0.70 | A | 0.306 | 2.281 | 0.618 | 1 | 1 | 9.585 | 0.34 | 16.85 | C |
| 40.00-20.00 | | | B | 0.306 | 2.281 | 0.618 | 1 | 1 | 9.585 | | | |
| | | | C | 0.479 | 1.929 | 0.687 | 1 | 1 | 16.699 | | | |
| T4 20.00-0.00 | 0.09 | 0.77 | A | 0.287 | 2.33 | 0.612 | 1 | 1 | 15.784 | 0.47 | 23.51 | C |
| | | | B | 0.287 | 2.33 | 0.612 | 1 | 1 | 15.784 | | | |
| | | | C | 0.404 | 2.056 | 0.653 | 1 | 1 | 21.851 | | | |
| Sum Weight: | 0.37 | 2.39 | | | | | | OTM | 57.59 kip-ft | 1.52 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.09 | 0.34 | A | 0.322 | 2.239 | 0.623 | 0.825 | 1 | 7.329 | 0.36 | 17.86 | C |
| 80.00-60.00 | | | B | 0.322 | 2.239 | 0.623 | 0.825 | 1 | 7.329 | | | |
| | | | C | 0.562 | 1.832 | 0.731 | 0.825 | 1 | 15.029 | | | |
| T2 | 0.09 | 0.58 | A | 0.319 | 2.245 | 0.622 | 0.825 | 1 | 8.694 | 0.36 | 17.77 | C |
| 60.00-40.00 | | | B | 0.319 | 2.245 | 0.622 | 0.825 | 1 | 8.694 | | | |
| | | | C | 0.519 | 1.876 | 0.708 | 0.825 | 1 | 16.079 | | | |
| T3 | 0.09 | 0.70 | A | 0.306 | 2.281 | 0.618 | 0.825 | 1 | 9.585 | 0.34 | 16.85 | C |
| 40.00-20.00 | | | B | 0.306 | 2.281 | 0.618 | 0.825 | 1 | 9.585 | | | |
| | | | C | 0.479 | 1.929 | 0.687 | 0.825 | 1 | 16.699 | | | |
| T4 20.00-0.00 | 0.09 | 0.77 | A | 0.287 | 2.33 | 0.612 | 0.825 | 1 | 14.680 | 0.45 | 22.51 | C |
| | | | B | 0.287 | 2.33 | 0.612 | 0.825 | 1 | 14.680 | | | |
| | | | C | 0.404 | 2.056 | 0.653 | 0.825 | 1 | 20.925 | | | |
| Sum Weight: | 0.37 | 2.39 | | | | | | OTM | 57.39 kip-ft | 1.50 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.09 | 0.34 | A | 0.322 | 2.239 | 0.623 | 0.8 | 1 | 7.329 | 0.36 | 17.86 | C |
| 80.00-60.00 | | | B | 0.322 | 2.239 | 0.623 | 0.8 | 1 | 7.329 | | | |
| | | | C | 0.562 | 1.832 | 0.731 | 0.8 | 1 | 15.029 | | | |
| T2 | 0.09 | 0.58 | A | 0.319 | 2.245 | 0.622 | 0.8 | 1 | 8.694 | 0.36 | 17.77 | C |
| 60.00-40.00 | | | B | 0.319 | 2.245 | 0.622 | 0.8 | 1 | 8.694 | | | |
| | | | C | 0.519 | 1.876 | 0.708 | 0.8 | 1 | 16.079 | | | |
| T3 | 0.09 | 0.70 | A | 0.306 | 2.281 | 0.618 | 0.8 | 1 | 9.585 | 0.34 | 16.85 | C |
| 40.00-20.00 | | | B | 0.306 | 2.281 | 0.618 | 0.8 | 1 | 9.585 | | | |
| | | | C | 0.479 | 1.929 | 0.687 | 0.8 | 1 | 16.699 | | | |
| T4 20.00-0.00 | 0.09 | 0.77 | A | 0.287 | 2.33 | 0.612 | 0.8 | 1 | 14.522 | 0.45 | 22.37 | C |
| | | | B | 0.287 | 2.33 | 0.612 | 0.8 | 1 | 14.522 | | | |
| | | | C | 0.404 | 2.056 | 0.653 | 0.8 | 1 | 20.792 | | | |
| Sum Weight: | 0.37 | 2.39 | | | | | | OTM | 57.36 kip-ft | 1.50 | | |

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

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.09 | 0.34 | A | 0.322 | 2.239 | 0.623 | 0.85 | 1 | 7.329 | 0.36 | 17.86 | C |
| 80.00-60.00 | | | B | 0.322 | 2.239 | 0.623 | 0.85 | 1 | 7.329 | | | |
| | | | C | 0.562 | 1.832 | 0.731 | 0.85 | 1 | 15.029 | | | |
| T2 | 0.09 | 0.58 | A | 0.319 | 2.245 | 0.622 | 0.85 | 1 | 8.694 | 0.36 | 17.77 | C |
| 60.00-40.00 | | | B | 0.319 | 2.245 | 0.622 | 0.85 | 1 | 8.694 | | | |
| | | | C | 0.519 | 1.876 | 0.708 | 0.85 | 1 | 16.079 | | | |

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T3 | 0.09 | 0.70 | A | 0.306 | 2.281 | 0.618 | 0.85 | 1 | 9.585 | 0.34 | 16.85 | C |
| 40.00-20.00 | | | B | 0.306 | 2.281 | 0.618 | 0.85 | 1 | 9.585 | | | |
| | | | C | 0.479 | 1.929 | 0.687 | 0.85 | 1 | 16.699 | | | |
| T4 20.00-0.00 | 0.09 | 0.77 | A | 0.287 | 2.33 | 0.612 | 0.85 | 1 | 14.838 | 0.45 | 22.65 | C |
| | | | B | 0.287 | 2.33 | 0.612 | 0.85 | 1 | 14.838 | | | |
| | | | C | 0.404 | 2.056 | 0.653 | 0.85 | 1 | 21.057 | | | |
| Sum Weight: | 0.37 | 2.39 | | | | | | OTM | 57.42 kip-ft | 1.50 | | |

## Tower Forces - Service - Wind Normal To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 1 | 1 | 2.747 | 0.13 | 6.68 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 1 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 1 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 1 | 1 | 3.880 | 0.14 | 7.20 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 1 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 1 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 1 | 1 | 4.446 | 0.14 | 7.03 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 1 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 1 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 1 | 1 | 10.980 | 0.25 | 12.65 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 1 | 1 | 10.980 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 1 | 1 | 13.922 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 23.30 kip-ft | 0.67 | | |

## Tower Forces - Service - Wind 45 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ ft² | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.825 | 1 | 2.747 | 0.13 | 6.68 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.825 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.825 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.825 | 1 | 3.880 | 0.14 | 7.20 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.825 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.825 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.825 | 1 | 4.446 | 0.14 | 7.03 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.825 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.825 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.825 | 1 | 9.876 | 0.23 | 11.73 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.825 | 1 | 9.876 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.825 | 1 | 12.912 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 23.12 kip-ft | 0.65 | | |

## Tower Forces - Service - Wind 60 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.8 | 1 | 2.747 | 0.13 | 6.68 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.8 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.8 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.8 | 1 | 3.880 | 0.14 | 7.20 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.8 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.8 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.8 | 1 | 4.446 | 0.14 | 7.03 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.8 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.8 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.8 | 1 | 9.718 | 0.23 | 11.60 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.8 | 1 | 9.718 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.8 | 1 | 12.767 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 23.09 kip-ft | 0.65 | | |

## Tower Forces - Service - Wind 90 To Face

| Section Elevation ft | Add Weight K | Self Weight K | Face | e | $C_F$ | $R_R$ | $D_F$ | $D_R$ | $A_E$ $ft^2$ | F K | w plf | Ctrl. Face |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 0.03 | 0.21 | A | 0.136 | 2.824 | 0.579 | 0.85 | 1 | 2.747 | 0.13 | 6.68 | C |
| 80.00-60.00 | | | B | 0.136 | 2.824 | 0.579 | 0.85 | 1 | 2.747 | | | |
| | | | C | 0.287 | 2.332 | 0.612 | 0.85 | 1 | 6.125 | | | |
| T2 | 0.03 | 0.41 | A | 0.158 | 2.742 | 0.583 | 0.85 | 1 | 3.880 | 0.14 | 7.20 | C |
| 60.00-40.00 | | | B | 0.158 | 2.742 | 0.583 | 0.85 | 1 | 3.880 | | | |
| | | | C | 0.281 | 2.347 | 0.61 | 0.85 | 1 | 7.229 | | | |
| T3 | 0.03 | 0.51 | A | 0.156 | 2.751 | 0.582 | 0.85 | 1 | 4.446 | 0.14 | 7.03 | C |
| 40.00-20.00 | | | B | 0.156 | 2.751 | 0.582 | 0.85 | 1 | 4.446 | | | |
| | | | C | 0.261 | 2.404 | 0.605 | 0.85 | 1 | 7.759 | | | |
| T4 20.00-0.00 | 0.03 | 0.42 | A | 0.192 | 2.623 | 0.589 | 0.85 | 1 | 10.034 | 0.24 | 11.86 | C |
| | | | B | 0.192 | 2.623 | 0.589 | 0.85 | 1 | 10.034 | | | |
| | | | C | 0.26 | 2.409 | 0.604 | 0.85 | 1 | 13.056 | | | |
| Sum Weight: | 0.13 | 1.55 | | | | | | OTM | 23.15 kip-ft | 0.66 | | |

## Force Totals

| Load Case | Vertical Forces K | Sum of Forces X K | Sum of Forces Z K | Sum of Overturning Moments, $M_x$ kip-ft | Sum of Overturning Moments, $M_z$ kip-ft | Sum of Torques kip-ft |
|---|---|---|---|---|---|---|
| Leg Weight | 0.94 | | | | | |
| Bracing Weight | 0.61 | | | | | |
| Total Member Self-Weight | 1.55 | | | 0.09 | -0.12 | |
| Total Weight | 1.83 | | | 0.09 | -0.12 | |

| 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 0 deg - No Ice | | 0.00 | -1.57 | -72.26 | -0.12 | 0.20 |
| Wind 30 deg - No Ice | | 0.77 | -1.34 | -62.31 | -36.15 | 0.25 |
| Wind 45 deg - No Ice | | 1.09 | -1.09 | -50.83 | -51.04 | 0.25 |
| Wind 60 deg - No Ice | | 1.33 | -0.77 | -35.89 | -62.45 | 0.23 |
| Wind 90 deg - No Ice | | 1.54 | 0.00 | 0.09 | -72.19 | 0.15 |
| Wind 120 deg - No Ice | | 1.36 | 0.79 | 36.27 | -62.78 | 0.03 |
| Wind 135 deg - No Ice | | 1.09 | 1.09 | 51.02 | -51.04 | -0.03 |
| Wind 150 deg - No Ice | | 0.77 | 1.34 | 62.50 | -36.15 | -0.10 |
| Wind 180 deg - No Ice | | 0.00 | 1.54 | 72.06 | -0.12 | -0.20 |
| Wind 210 deg - No Ice | | -0.77 | 1.34 | 62.50 | 35.91 | -0.25 |
| Wind 225 deg - No Ice | | -1.09 | 1.09 | 51.02 | 50.80 | -0.25 |
| Wind 240 deg - No Ice | | -1.36 | 0.79 | 36.27 | 62.54 | -0.24 |
| Wind 270 deg - No Ice | | -1.54 | 0.00 | 0.09 | 71.94 | -0.15 |
| Wind 300 deg - No Ice | | -1.33 | -0.77 | -35.89 | 62.20 | -0.03 |
| Wind 315 deg - No Ice | | -1.09 | -1.09 | -50.83 | 50.80 | 0.03 |
| Wind 330 deg - No Ice | | -0.77 | -1.34 | -62.31 | 35.91 | 0.10 |
| Member Ice | 0.84 | | | | | |
| Total Weight Ice | 3.04 | | | 0.27 | -0.35 | |
| Wind 0 deg - Ice | | 0.00 | -1.85 | -86.70 | -0.35 | 0.23 |
| Wind 30 deg - Ice | | 0.92 | -1.59 | -74.90 | -43.74 | 0.28 |
| Wind 45 deg - Ice | | 1.30 | -1.30 | -61.08 | -61.70 | 0.28 |
| Wind 60 deg - Ice | | 1.59 | -0.92 | -43.10 | -75.46 | 0.26 |
| Wind 90 deg - Ice | | 1.84 | 0.00 | 0.27 | -87.14 | 0.17 |
| Wind 120 deg - Ice | | 1.61 | 0.93 | 43.75 | -75.66 | 0.04 |
| Wind 135 deg - Ice | | 1.30 | 1.30 | 61.62 | -61.70 | -0.04 |
| Wind 150 deg - Ice | | 0.92 | 1.59 | 75.43 | -43.74 | -0.11 |
| Wind 180 deg - Ice | | 0.00 | 1.83 | 87.00 | -0.35 | -0.22 |
| Wind 210 deg - Ice | | -0.92 | 1.59 | 75.43 | 43.05 | -0.28 |
| Wind 225 deg - Ice | | -1.30 | 1.30 | 61.62 | 61.00 | -0.28 |
| Wind 240 deg - Ice | | -1.61 | 0.93 | 43.75 | 74.96 | -0.26 |
| Wind 270 deg - Ice | | -1.84 | 0.00 | 0.27 | 86.44 | -0.17 |
| Wind 300 deg - Ice | | -1.59 | -0.92 | -43.10 | 74.77 | -0.04 |
| Wind 315 deg - Ice | | -1.30 | -1.30 | -61.08 | 61.00 | 0.04 |
| Wind 330 deg - Ice | | -0.92 | -1.59 | -74.90 | 43.05 | 0.11 |
| Total Weight | 1.83 | | | 0.09 | -0.12 | |
| Wind 0 deg - Service | | 0.00 | -0.85 | -39.12 | 0.00 | 0.11 |
| Wind 30 deg - Service | | 0.42 | -0.72 | -33.74 | -19.48 | 0.13 |
| Wind 45 deg - Service | | 0.59 | -0.59 | -27.53 | -27.53 | 0.13 |
| Wind 60 deg - Service | | 0.72 | -0.42 | -19.45 | -33.70 | 0.12 |
| Wind 90 deg - Service | | 0.84 | 0.00 | 0.00 | -38.96 | 0.08 |
| Wind 120 deg - Service | | 0.74 | 0.43 | 19.56 | -33.88 | 0.02 |
| Wind 135 deg - Service | | 0.59 | 0.59 | 27.53 | -27.53 | -0.02 |
| Wind 150 deg - Service | | 0.42 | 0.72 | 33.74 | -19.48 | -0.05 |
| Wind 180 deg - Service | | 0.00 | 0.83 | 38.91 | 0.00 | -0.11 |
| Wind 210 deg - Service | | -0.42 | 0.72 | 33.74 | 19.48 | -0.13 |
| Wind 225 deg - Service | | -0.59 | 0.59 | 27.53 | 27.53 | -0.13 |
| Wind 240 deg - Service | | -0.74 | 0.43 | 19.56 | 33.88 | -0.13 |
| Wind 270 deg - Service | | -0.84 | 0.00 | 0.00 | 38.96 | -0.08 |
| Wind 300 deg - Service | | -0.72 | -0.42 | -19.45 | 33.70 | -0.02 |
| Wind 315 deg - Service | | -0.59 | -0.59 | -27.53 | 27.53 | 0.02 |
| Wind 330 deg - Service | | -0.42 | -0.72 | -33.74 | 19.48 | 0.05 |

## Load Combinations

| Comb. No. | Description |
|---|---|

| Comb. No. | Description |
|---|---|
| 1 | Dead Only |
| 2 | Dead+Wind 0 deg - No Ice |
| 3 | Dead+Wind 30 deg - No Ice |
| 4 | Dead+Wind 45 deg - No Ice |
| 5 | Dead+Wind 60 deg - No Ice |
| 6 | Dead+Wind 90 deg - No Ice |
| 7 | Dead+Wind 120 deg - No Ice |
| 8 | Dead+Wind 135 deg - No Ice |
| 9 | Dead+Wind 150 deg - No Ice |
| 10 | Dead+Wind 180 deg - No Ice |
| 11 | Dead+Wind 210 deg - No Ice |
| 12 | Dead+Wind 225 deg - No Ice |
| 13 | Dead+Wind 240 deg - No Ice |
| 14 | Dead+Wind 270 deg - No Ice |
| 15 | Dead+Wind 300 deg - No Ice |
| 16 | Dead+Wind 315 deg - No Ice |
| 17 | Dead+Wind 330 deg - No Ice |
| 18 | Dead+Ice+Temp |
| 19 | Dead+Wind 0 deg+Ice+Temp |
| 20 | Dead+Wind 30 deg+Ice+Temp |
| 21 | Dead+Wind 45 deg+Ice+Temp |
| 22 | Dead+Wind 60 deg+Ice+Temp |
| 23 | Dead+Wind 90 deg+Ice+Temp |
| 24 | Dead+Wind 120 deg+Ice+Temp |
| 25 | Dead+Wind 135 deg+Ice+Temp |
| 26 | Dead+Wind 150 deg+Ice+Temp |
| 27 | Dead+Wind 180 deg+Ice+Temp |
| 28 | Dead+Wind 210 deg+Ice+Temp |
| 29 | Dead+Wind 225 deg+Ice+Temp |
| 30 | Dead+Wind 240 deg+Ice+Temp |
| 31 | Dead+Wind 270 deg+Ice+Temp |
| 32 | Dead+Wind 300 deg+Ice+Temp |
| 33 | Dead+Wind 315 deg+Ice+Temp |
| 34 | Dead+Wind 330 deg+Ice+Temp |
| 35 | Dead+Wind 0 deg - Service |
| 36 | Dead+Wind 30 deg - Service |
| 37 | Dead+Wind 45 deg - Service |
| 38 | Dead+Wind 60 deg - Service |
| 39 | Dead+Wind 90 deg - Service |
| 40 | Dead+Wind 120 deg - Service |
| 41 | Dead+Wind 135 deg - Service |
| 42 | Dead+Wind 150 deg - Service |
| 43 | Dead+Wind 180 deg - Service |
| 44 | Dead+Wind 210 deg - Service |
| 45 | Dead+Wind 225 deg - Service |
| 46 | Dead+Wind 240 deg - Service |
| 47 | Dead+Wind 270 deg - Service |
| 48 | Dead+Wind 300 deg - Service |
| 49 | Dead+Wind 315 deg - Service |
| 50 | Dead+Wind 330 deg - Service |

## Maximum Member Forces

| Section No. | Elevation ft | Component Type | Condition | Gov. Load Comb. | Force K | Major Axis Moment kip-ft | Minor Axis Moment kip-ft |
|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | Leg | Max Tension | 27 | 8.05 | 0.01 | 0.00 |
| | | | Max. Compression | 24 | -8.53 | 0.02 | 0.00 |
| | | | Max. Mx | 26 | -0.10 | -0.03 | -0.02 |

| Section No. | Elevation ft | Component Type | Condition | Gov. Load Comb. | Force K | Major Axis Moment kip-ft | Minor Axis Moment kip-ft |
|---|---|---|---|---|---|---|---|
| | | | Max. My | 27 | -0.04 | -0.03 | -0.03 |
| | | | Max. Vy | 33 | 0.27 | -0.02 | -0.00 |
| | | | Max. Vx | 27 | -0.17 | 0.01 | 0.01 |
| | | Diagonal | Max Tension | 23 | 0.46 | 0.00 | 0.00 |
| | | | Max. Compression | 31 | -0.47 | 0.00 | 0.00 |
| | | | Max. Mx | 23 | 0.46 | 0.00 | 0.00 |
| | | | Max. My | 22 | -0.03 | 0.00 | -0.00 |
| | | | Max. Vy | 23 | 0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 22 | 0.00 | 0.00 | 0.00 |
| | | Top Girt | Max Tension | 14 | 0.02 | 0.00 | 0.00 |
| | | | Max. Compression | 21 | -0.02 | 0.00 | 0.00 |
| | | | Max. Mx | 18 | 0.00 | 0.00 | 0.00 |
| | | | Max. Vy | 18 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 21 | 0.00 | 0.00 | 0.00 |
| | | Bottom Girt | Max Tension | 30 | 0.14 | 0.00 | 0.00 |
| | | | Max. Compression | 22 | -0.13 | 0.00 | 0.00 |
| | | | Max. Mx | 18 | 0.00 | 0.00 | 0.00 |
| | | | Max. Vy | 18 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 21 | 0.00 | 0.00 | 0.00 |
| T2 | 60 - 40 | Leg | Max Tension | 27 | 16.03 | 0.01 | -0.01 |
| | | | Max. Compression | 24 | -16.97 | 0.02 | -0.00 |
| | | | Max. Mx | 33 | 7.89 | -0.04 | -0.01 |
| | | | Max. My | 19 | 3.83 | -0.03 | -0.02 |
| | | | Max. Vy | 23 | -0.41 | 0.02 | -0.01 |
| | | | Max. Vx | 22 | 0.25 | 0.02 | -0.01 |
| | | Diagonal | Max Tension | 31 | 0.67 | 0.00 | 0.00 |
| | | | Max. Compression | 23 | -0.68 | 0.00 | 0.00 |
| | | | Max. Mx | 26 | 0.65 | 0.00 | 0.00 |
| | | | Max. My | 22 | -0.06 | 0.00 | -0.00 |
| | | | Max. Vy | 26 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 22 | 0.00 | 0.00 | 0.00 |
| | | Top Girt | Max Tension | 22 | 0.14 | 0.00 | 0.00 |
| | | | Max. Compression | 30 | -0.16 | 0.00 | 0.00 |
| | | | Max. Mx | 18 | 0.00 | 0.00 | 0.00 |
| | | | Max. My | 20 | -0.13 | 0.00 | -0.00 |
| | | | Max. Vy | 18 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 20 | 0.00 | 0.00 | 0.00 |
| | | Bottom Girt | Max Tension | 19 | 0.16 | 0.00 | 0.00 |
| | | | Max. Compression | 27 | -0.14 | 0.00 | 0.00 |
| | | | Max. Mx | 18 | 0.00 | 0.00 | 0.00 |
| | | | Max. Vy | 18 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 20 | 0.00 | 0.00 | 0.00 |
| T3 | 40 - 20 | Leg | Max Tension | 27 | 24.94 | -0.07 | 0.01 |
| | | | Max. Compression | 24 | -26.43 | 0.12 | -0.02 |
| | | | Max. Mx | 19 | -26.22 | 0.12 | -0.02 |
| | | | Max. My | 21 | -7.49 | 0.04 | -0.03 |
| | | | Max. Vy | 30 | -0.47 | 0.11 | -0.01 |
| | | | Max. Vx | 28 | -0.36 | 0.02 | 0.03 |
| | | Diagonal | Max Tension | 31 | 0.78 | 0.00 | 0.00 |
| | | | Max. Compression | 23 | -0.80 | 0.00 | 0.00 |
| | | | Max. Mx | 23 | 0.72 | 0.00 | 0.00 |
| | | | Max. My | 27 | -0.09 | 0.00 | 0.00 |
| | | | Max. Vy | 23 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 27 | -0.00 | 0.00 | 0.00 |
| | | Top Girt | Max Tension | 27 | 0.14 | 0.00 | 0.00 |
| | | | Max. Compression | 23 | -0.15 | 0.00 | 0.00 |
| | | | Max. Mx | 18 | 0.00 | 0.00 | 0.00 |
| | | | Max. Vy | 18 | -0.00 | 0.00 | 0.00 |
| | | | Max. Vx | 20 | 0.00 | 0.00 | 0.00 |
| | | Bottom Girt | Max Tension | 29 | 0.32 | 0.00 | 0.00 |
| | | | Max. Compression | 21 | -0.43 | 0.00 | 0.00 |

| Section No. | Elevation ft | Component Type | Condition | Gov. Load Comb. | Force K | Major Axis Moment kip-ft | Minor Axis Moment kip-ft |
|---|---|---|---|---|---|---|---|
| | | | Max. Mx | 18 | -0.05 | 0.00 | 0.00 |
| | | | Max. Vy | 18 | 0.00 | 0.00 | 0.00 |
| T4 | 20 - 0 | Leg | Max Tension | 27 | 23.75 | -0.05 | -0.00 |
| | | | Max. Compression | 24 | -25.18 | 0.01 | 0.01 |
| | | | Max. Mx | 19 | -24.96 | 0.12 | -0.02 |
| | | | Max. My | 23 | -0.82 | -0.02 | 0.15 |
| | | | Max. Vy | 19 | 0.03 | 0.12 | -0.02 |
| | | | Max. Vx | 28 | 0.04 | -0.02 | 0.15 |
| | | Diagonal | Max Tension | 23 | 1.07 | 0.00 | 0.00 |
| | | | Max. Compression | 31 | -0.94 | 0.01 | -0.00 |
| | | | Max. Mx | 25 | 0.08 | 0.03 | 0.00 |
| | | | Max. My | 23 | -0.41 | 0.02 | -0.01 |
| | | | Max. Vy | 25 | -0.01 | 0.03 | 0.00 |
| | | | Max. Vx | 23 | 0.00 | 0.02 | -0.01 |

## Maximum Reactions

| Location | Condition | Gov. Load Comb. | Vertical K | Horizontal, X K | Horizontal, Z K |
|---|---|---|---|---|---|
| Leg C | Max. Vert | 30 | 23.46 | 1.21 | -0.66 |
| | Max. $H_x$ | 30 | 23.46 | 1.21 | -0.66 |
| | Max. $H_z$ | 23 | -18.47 | -1.11 | 0.76 |
| | Min. Vert | 22 | -21.46 | -1.34 | 0.74 |
| | Min. $H_x$ | 22 | -21.46 | -1.34 | 0.74 |
| | Min. $H_z$ | 31 | 20.41 | 0.97 | -0.66 |
| Leg B | Max. Vert | 24 | 23.62 | -1.20 | -0.69 |
| | Max. $H_x$ | 32 | -21.31 | 1.33 | 0.76 |
| | Max. $H_z$ | 32 | -21.31 | 1.33 | 0.76 |
| | Min. Vert | 32 | -21.31 | 1.33 | 0.76 |
| | Min. $H_x$ | 24 | 23.62 | -1.20 | -0.69 |
| | Min. $H_z$ | 24 | 23.62 | -1.20 | -0.69 |
| Leg A | Max. Vert | 19 | 23.43 | 0.03 | 1.38 |
| | Max. $H_x$ | 23 | 0.95 | 0.25 | -0.09 |
| | Max. $H_z$ | 19 | 23.43 | 0.03 | 1.38 |
| | Min. Vert | 27 | -21.49 | -0.03 | -1.54 |
| | Min. $H_x$ | 31 | 0.94 | -0.25 | -0.09 |
| | Min. $H_z$ | 27 | -21.49 | -0.03 | -1.54 |

## 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 | 1.83 | 0.00 | 0.00 | 0.09 | -0.12 | 0.00 |
| Dead+Wind 0 deg - No Ice | 1.83 | 0.00 | -1.57 | -72.82 | -0.12 | 0.20 |
| Dead+Wind 30 deg - No Ice | 1.83 | 0.77 | -1.34 | -62.80 | -36.43 | 0.25 |
| Dead+Wind 45 deg - No Ice | 1.83 | 1.09 | -1.09 | -51.23 | -51.44 | 0.25 |
| Dead+Wind 60 deg - No Ice | 1.83 | 1.33 | -0.77 | -36.17 | -62.93 | 0.23 |
| Dead+Wind 90 deg - No Ice | 1.83 | 1.54 | 0.00 | 0.09 | -72.74 | 0.15 |
| Dead+Wind 120 deg - No Ice | 1.83 | 1.36 | 0.79 | 36.55 | -63.27 | 0.03 |
| Dead+Wind 135 deg - No Ice | 1.83 | 1.09 | 1.09 | 51.41 | -51.44 | -0.03 |
| Dead+Wind 150 deg - No Ice | 1.83 | 0.77 | 1.34 | 62.99 | -36.43 | -0.10 |

| Load Combination | Vertical | $Shear_x$ | $Shear_z$ | Overturning Moment, $M_x$ | Overturning Moment, $M_z$ | Torque |
|---|---|---|---|---|---|---|
| | K | K | K | kip-ft | kip-ft | kip-ft |
| Dead+Wind 180 deg - No Ice | 1.83 | 0.00 | 1.54 | 72.62 | -0.12 | -0.20 |
| Dead+Wind 210 deg - No Ice | 1.83 | -0.77 | 1.34 | 62.98 | 36.19 | -0.25 |
| Dead+Wind 225 deg - No Ice | 1.83 | -1.09 | 1.09 | 51.41 | 51.19 | -0.25 |
| Dead+Wind 240 deg - No Ice | 1.83 | -1.36 | 0.79 | 36.55 | 63.02 | -0.24 |
| Dead+Wind 270 deg - No Ice | 1.83 | -1.54 | -0.00 | 0.09 | 72.50 | -0.15 |
| Dead+Wind 300 deg - No Ice | 1.83 | -1.33 | -0.77 | -36.17 | 62.68 | -0.03 |
| Dead+Wind 315 deg - No Ice | 1.83 | -1.09 | -1.09 | -51.22 | 51.19 | 0.03 |
| Dead+Wind 330 deg - No Ice | 1.83 | -0.77 | -1.34 | -62.79 | 36.19 | 0.09 |
| Dead+Ice+Temp | 3.04 | 0.00 | 0.00 | 0.27 | -0.35 | 0.00 |
| Dead+Wind 0 deg+Ice+Temp | 3.04 | 0.00 | -1.85 | -87.79 | -0.35 | 0.23 |
| Dead+Wind 30 deg+Ice+Temp | 3.04 | 0.92 | -1.59 | -75.85 | -44.29 | 0.28 |
| Dead+Wind 45 deg+Ice+Temp | 3.04 | 1.30 | -1.30 | -61.86 | -62.48 | 0.28 |
| Dead+Wind 60 deg+Ice+Temp | 3.04 | 1.59 | -0.92 | -43.65 | -76.41 | 0.26 |
| Dead+Wind 90 deg+Ice+Temp | 3.04 | 1.84 | 0.00 | 0.26 | -88.24 | 0.17 |
| Dead+Wind 120 deg+Ice+Temp | 3.04 | 1.61 | 0.93 | 44.30 | -76.61 | 0.04 |
| Dead+Wind 135 deg+Ice+Temp | 3.04 | 1.30 | 1.30 | 62.40 | -62.48 | -0.04 |
| Dead+Wind 150 deg+Ice+Temp | 3.04 | 0.92 | 1.59 | 76.39 | -44.29 | -0.11 |
| Dead+Wind 180 deg+Ice+Temp | 3.04 | 0.00 | 1.83 | 88.10 | -0.35 | -0.23 |
| Dead+Wind 210 deg+Ice+Temp | 3.04 | -0.92 | 1.59 | 76.38 | 43.59 | -0.28 |
| Dead+Wind 225 deg+Ice+Temp | 3.04 | -1.30 | 1.30 | 62.39 | 61.78 | -0.28 |
| Dead+Wind 240 deg+Ice+Temp | 3.04 | -1.61 | 0.93 | 44.30 | 75.91 | -0.27 |
| Dead+Wind 270 deg+Ice+Temp | 3.04 | -1.84 | 0.00 | 0.27 | 87.54 | -0.17 |
| Dead+Wind 300 deg+Ice+Temp | 3.04 | -1.59 | -0.92 | -43.64 | 75.71 | -0.04 |
| Dead+Wind 315 deg+Ice+Temp | 3.04 | -1.30 | -1.30 | -61.85 | 61.78 | 0.04 |
| Dead+Wind 330 deg+Ice+Temp | 3.04 | -0.92 | -1.59 | -75.84 | 43.60 | 0.11 |
| Dead+Wind 0 deg - Service | 1.83 | 0.00 | -0.85 | -39.33 | -0.12 | 0.11 |
| Dead+Wind 30 deg - Service | 1.83 | 0.42 | -0.72 | -33.91 | -19.76 | 0.13 |
| Dead+Wind 45 deg - Service | 1.83 | 0.59 | -0.59 | -27.65 | -27.87 | 0.13 |
| Dead+Wind 60 deg - Service | 1.83 | 0.72 | -0.42 | -19.51 | -34.08 | 0.12 |
| Dead+Wind 90 deg - Service | 1.83 | 0.84 | 0.00 | 0.09 | -39.39 | 0.08 |
| Dead+Wind 120 deg - Service | 1.83 | 0.74 | 0.43 | 19.81 | -34.26 | 0.02 |
| Dead+Wind 135 deg - Service | 1.83 | 0.59 | 0.59 | 27.84 | -27.87 | -0.02 |
| Dead+Wind 150 deg - Service | 1.83 | 0.42 | 0.72 | 34.10 | -19.76 | -0.05 |
| Dead+Wind 180 deg - Service | 1.83 | 0.00 | 0.83 | 39.31 | -0.12 | -0.11 |
| Dead+Wind 210 deg - Service | 1.83 | -0.42 | 0.72 | 34.10 | 19.51 | -0.13 |
| Dead+Wind 225 deg - Service | 1.83 | -0.59 | 0.59 | 27.84 | 27.62 | -0.13 |
| Dead+Wind 240 deg - Service | 1.83 | -0.74 | 0.43 | 19.81 | 34.02 | -0.13 |
| Dead+Wind 270 deg - Service | 1.83 | -0.84 | 0.00 | 0.09 | 39.14 | -0.08 |
| Dead+Wind 300 deg - Service | 1.83 | -0.72 | -0.42 | -19.51 | 33.84 | -0.02 |
| Dead+Wind 315 deg - Service | 1.83 | -0.59 | -0.59 | -27.65 | 27.62 | 0.02 |
| Dead+Wind 330 deg - Service | 1.83 | -0.42 | -0.72 | -33.91 | 19.51 | 0.05 |

# Solution Summary

| | Sum of Applied Forces | | | Sum of Reactions | | | |
|---|---|---|---|---|---|---|---|
| Load Comb. | PX | PY | PZ | PX | PY | PZ | % Error |
| | K | K | K | K | K | K | |
| 1 | 0.00 | -1.83 | 0.00 | 0.00 | 1.83 | 0.00 | 0.000% |
| 2 | 0.00 | -1.83 | -1.57 | 0.00 | 1.83 | 1.57 | 0.000% |
| 3 | 0.77 | -1.83 | -1.34 | -0.77 | 1.83 | 1.34 | 0.000% |
| 4 | 1.09 | -1.83 | -1.09 | -1.09 | 1.83 | 1.09 | 0.001% |
| 5 | 1.33 | -1.83 | -0.77 | -1.33 | 1.83 | 0.77 | 0.000% |
| 6 | 1.54 | -1.83 | 0.00 | -1.54 | 1.83 | 0.00 | 0.000% |
| 7 | 1.36 | -1.83 | 0.79 | -1.36 | 1.83 | -0.79 | 0.000% |
| 8 | 1.09 | -1.83 | 1.09 | -1.09 | 1.83 | -1.09 | 0.000% |
| 9 | 0.77 | -1.83 | 1.34 | -0.77 | 1.83 | -1.34 | 0.000% |
| 10 | 0.00 | -1.83 | 1.54 | 0.00 | 1.83 | -1.54 | 0.000% |
| 11 | -0.77 | -1.83 | 1.34 | 0.77 | 1.83 | -1.34 | 0.000% |

| | Sum of Applied Forces | | | Sum of Reactions | | | |
|---|---|---|---|---|---|---|---|
| Load Comb. | PX K | PY K | PZ K | PX K | PY K | PZ K | % Error |
| 12 | -1.09 | -1.83 | 1.09 | 1.09 | 1.83 | -1.09 | 0.000% |
| 13 | -1.36 | -1.83 | 0.79 | 1.36 | 1.83 | -0.79 | 0.000% |
| 14 | -1.54 | -1.83 | 0.00 | 1.54 | 1.83 | 0.00 | 0.000% |
| 15 | -1.33 | -1.83 | -0.77 | 1.33 | 1.83 | 0.77 | 0.000% |
| 16 | -1.09 | -1.83 | -1.09 | 1.09 | 1.83 | 1.09 | 0.000% |
| 17 | -0.77 | -1.83 | -1.34 | 0.77 | 1.83 | 1.34 | 0.000% |
| 18 | 0.00 | -3.04 | 0.00 | 0.00 | 3.04 | 0.00 | 0.000% |
| 19 | 0.00 | -3.04 | -1.85 | -0.00 | 3.04 | 1.85 | 0.000% |
| 20 | 0.92 | -3.04 | -1.59 | -0.92 | 3.04 | 1.59 | 0.000% |
| 21 | 1.30 | -3.04 | -1.30 | -1.30 | 3.04 | 1.30 | 0.000% |
| 22 | 1.59 | -3.04 | -0.92 | -1.59 | 3.04 | 0.92 | 0.000% |
| 23 | 1.84 | -3.04 | 0.00 | -1.84 | 3.04 | -0.00 | 0.000% |
| 24 | 1.61 | -3.04 | 0.93 | -1.61 | 3.04 | -0.93 | 0.000% |
| 25 | 1.30 | -3.04 | 1.30 | -1.30 | 3.04 | -1.30 | 0.000% |
| 26 | 0.92 | -3.04 | 1.59 | -0.92 | 3.04 | -1.59 | 0.000% |
| 27 | 0.00 | -3.04 | 1.83 | 0.00 | 3.04 | -1.83 | 0.000% |
| 28 | -0.92 | -3.04 | 1.59 | 0.92 | 3.04 | -1.59 | 0.000% |
| 29 | -1.30 | -3.04 | 1.30 | 1.30 | 3.04 | -1.30 | 0.000% |
| 30 | -1.61 | -3.04 | 0.93 | 1.61 | 3.04 | -0.93 | 0.000% |
| 31 | -1.84 | -3.04 | 0.00 | 1.84 | 3.04 | 0.00 | 0.000% |
| 32 | -1.59 | -3.04 | -0.92 | 1.59 | 3.04 | 0.92 | 0.000% |
| 33 | -1.30 | -3.04 | -1.30 | 1.30 | 3.04 | 1.30 | 0.000% |
| 34 | -0.92 | -3.04 | -1.59 | 0.92 | 3.04 | 1.59 | 0.000% |
| 35 | 0.00 | -1.83 | -0.85 | 0.00 | 1.83 | 0.85 | 0.000% |
| 36 | 0.42 | -1.83 | -0.72 | -0.42 | 1.83 | 0.72 | 0.000% |
| 37 | 0.59 | -1.83 | -0.59 | -0.59 | 1.83 | 0.59 | 0.000% |
| 38 | 0.72 | -1.83 | -0.42 | -0.72 | 1.83 | 0.42 | 0.000% |
| 39 | 0.84 | -1.83 | 0.00 | -0.84 | 1.83 | 0.00 | 0.000% |
| 40 | 0.74 | -1.83 | 0.43 | -0.74 | 1.83 | -0.43 | 0.000% |
| 41 | 0.59 | -1.83 | 0.59 | -0.59 | 1.83 | -0.59 | 0.000% |
| 42 | 0.42 | -1.83 | 0.72 | -0.42 | 1.83 | -0.72 | 0.000% |
| 43 | 0.00 | -1.83 | 0.83 | 0.00 | 1.83 | -0.83 | 0.000% |
| 44 | -0.42 | -1.83 | 0.72 | 0.42 | 1.83 | -0.72 | 0.000% |
| 45 | -0.59 | -1.83 | 0.59 | 0.59 | 1.83 | -0.59 | 0.000% |
| 46 | -0.74 | -1.83 | 0.43 | 0.74 | 1.83 | -0.43 | 0.000% |
| 47 | -0.84 | -1.83 | 0.00 | 0.84 | 1.83 | 0.00 | 0.000% |
| 48 | -0.72 | -1.83 | -0.42 | 0.72 | 1.83 | 0.42 | 0.000% |
| 49 | -0.59 | -1.83 | -0.59 | 0.59 | 1.83 | 0.59 | 0.000% |
| 50 | -0.42 | -1.83 | -0.72 | 0.42 | 1.83 | 0.72 | 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 | 0.00000001 |
| 3 | Yes | 4 | 0.00000001 | 0.00000001 |
| 4 | Yes | 4 | 0.00000001 | 0.00000001 |
| 5 | Yes | 4 | 0.00000001 | 0.00000001 |
| 6 | Yes | 4 | 0.00000001 | 0.00000001 |
| 7 | Yes | 4 | 0.00000001 | 0.00000001 |
| 8 | Yes | 4 | 0.00000001 | 0.00000001 |
| 9 | Yes | 4 | 0.00000001 | 0.00000001 |
| 10 | Yes | 4 | 0.00000001 | 0.00000001 |
| 11 | Yes | 4 | 0.00000001 | 0.00000001 |
| 12 | Yes | 4 | 0.00000001 | 0.00000001 |

| | | | | |
|---|---|---|---|---|
| 13 | Yes | 4 | 0.00000001 | 0.00000001 |
| 14 | Yes | 4 | 0.00000001 | 0.00000001 |
| 15 | Yes | 4 | 0.00000001 | 0.00000001 |
| 16 | Yes | 4 | 0.00000001 | 0.00000001 |
| 17 | Yes | 4 | 0.00000001 | 0.00000001 |
| 18 | Yes | 4 | 0.00000001 | 0.00000001 |
| 19 | Yes | 4 | 0.00000001 | 0.00000524 |
| 20 | Yes | 4 | 0.00000001 | 0.00000574 |
| 21 | Yes | 4 | 0.00000001 | 0.00000568 |
| 22 | Yes | 4 | 0.00000001 | 0.00000554 |
| 23 | Yes | 4 | 0.00000001 | 0.00000550 |
| 24 | Yes | 4 | 0.00000001 | 0.00000512 |
| 25 | Yes | 4 | 0.00000001 | 0.00000541 |
| 26 | Yes | 4 | 0.00000001 | 0.00000571 |
| 27 | Yes | 4 | 0.00000001 | 0.00000559 |
| 28 | Yes | 4 | 0.00000001 | 0.00000528 |
| 29 | Yes | 4 | 0.00000001 | 0.00000498 |
| 30 | Yes | 4 | 0.00000001 | 0.00000497 |
| 31 | Yes | 4 | 0.00000001 | 0.00000572 |
| 32 | Yes | 4 | 0.00000001 | 0.00000556 |
| 33 | Yes | 4 | 0.00000001 | 0.00000551 |
| 34 | Yes | 4 | 0.00000001 | 0.00000545 |
| 35 | Yes | 4 | 0.00000001 | 0.00000001 |
| 36 | Yes | 4 | 0.00000001 | 0.00000001 |
| 37 | Yes | 4 | 0.00000001 | 0.00000001 |
| 38 | Yes | 4 | 0.00000001 | 0.00000001 |
| 39 | Yes | 4 | 0.00000001 | 0.00000001 |
| 40 | Yes | 4 | 0.00000001 | 0.00000001 |
| 41 | Yes | 4 | 0.00000001 | 0.00000001 |
| 42 | Yes | 4 | 0.00000001 | 0.00000001 |
| 43 | Yes | 4 | 0.00000001 | 0.00000001 |
| 44 | Yes | 4 | 0.00000001 | 0.00000001 |
| 45 | Yes | 4 | 0.00000001 | 0.00000001 |
| 46 | Yes | 4 | 0.00000001 | 0.00000001 |
| 47 | Yes | 4 | 0.00000001 | 0.00000001 |
| 48 | Yes | 4 | 0.00000001 | 0.00000001 |
| 49 | Yes | 4 | 0.00000001 | 0.00000001 |
| 50 | Yes | 4 | 0.00000001 | 0.00000001 |

## Maximum Tower Deflections - Service Wind

| Section No. | Elevation<br>ft | Horz. Deflection<br>in | Gov. Load Comb. | Tilt<br>° | Twist<br>° |
|---|---|---|---|---|---|
| T1 | 80 - 60 | 6.107 | 40 | 0.6680 | 0.0627 |
| T2 | 60 - 40 | 3.513 | 40 | 0.5295 | 0.0472 |
| T3 | 40 - 20 | 1.588 | 40 | 0.3697 | 0.0300 |
| T4 | 20 - 0 | 0.359 | 40 | 0.1986 | 0.0068 |

## 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 |
|---|---|---|---|---|---|---|
| 78.00 | 20' x 3" Dia Omni | 40 | 5.833 | 0.6547 | 0.0611 | 22046 |

## Maximum Tower Deflections - Design Wind

| Section No. | Elevation<br>ft | Horz. Deflection<br>in | Gov. Load Comb. | Tilt<br>° | Twist<br>° |
|---|---|---|---|---|---|
| T1 | 80 - 60 | 13.424 | 26 | 1.4350 | 0.1283 |
| T2 | 60 - 40 | 7.806 | 26 | 1.1620 | 0.0976 |
| T3 | 40 - 20 | 3.552 | 26 | 0.8231 | 0.0625 |
| T4 | 20 - 0 | 0.804 | 26 | 0.4452 | 0.0142 |

## 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 |
|---|---|---|---|---|---|---|
| 78.00 | 20' x 3" Dia Omni | 26 | 12.834 | 1.4093 | 0.1252 | 10949 |

## Bolt Design Data

| Section No. | Elevation<br>ft | Component Type | Bolt Grade | Bolt Size<br>in | Number Of Bolts | Maximum Load per Bolt<br>K | Allowable Load<br>K | Ratio Load / Allowable | Allowable Ratio | Criteria |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 | Leg | SAEGR-5 | 0.3750 | 4 | 2.01 | 4.37 | 0.460 ✔ | 1.333 | Bolt Tension |
| T2 | 60 | Leg | A325N | 0.5000 | 4 | 4.01 | 8.64 | 0.464 ✔ | 1.333 | Bolt Tension |
| T3 | 40 | Leg | A325N | 0.6250 | 4 | 6.23 | 13.50 | 0.462 ✔ | 1.333 | Bolt Tension |
| | | Diagonal | SAEGR-5 | 0.3750 | 1 | 0.80 | 2.92 | 0.274 ✔ | 1.333 | Bolt Shear |
| T4 | 20 | Leg | A325N | 0.6250 | 4 | 5.32 | 13.50 | 0.394 ✔ | 1.333 | Bolt Tension |
| | | Diagonal | SAEGR-5 | 0.3750 | 1 | 1.07 | 2.11 | 0.507 ✔ | 1.333 | Member Bearing |

## *Compression Checks*

## Leg Design Data (Compression)

| Section No. | Elevation<br>ft | Size | L<br>ft | $L_u$<br>ft | Kl/r | $F_a$<br>ksi | A<br>$in^2$ | Actual P<br>K | Allow. $P_a$<br>K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 15/16 | 20.00 | 0.86 | 88.3<br>K=2.00 | 17.300 | 0.6903 | -8.53 | 11.94 | 0.714 ✔ |

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T2 | 60 - 40 | 1 1/4 | 20.00 | 0.94 | 72.5<br>K=2.00 | 20.463 | 1.2272 | -16.97 | 25.11 | 0.676 ✔ |
| T3 | 40 - 20 | 1 7/16 | 20.00 | 0.94 | 63.1<br>K=2.00 | 22.186 | 1.6229 | -26.43 | 36.01 | 0.734 ✔ |
| T4 | 20 - 0 | ROHN 2 STD | 20.03 | 4.01 | 61.1<br>K=1.00 | 22.531 | 1.0745 | -25.18 | 24.21 | 1.040 ✔ |

## Diagonal Design Data (Compression)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 2.02 | 1.93 | 148.3<br>K=0.70 | 6.786 | 0.1503 | -0.47 | 1.02 | 0.459 ✔ |
| T2 | 60 - 40 | 5/8 | 2.36 | 2.24 | 120.5<br>K=0.70 | 10.024 | 0.3068 | -0.68 | 3.08 | 0.221 ✔ |
| T3 | 40 - 20 | 5/8 | 2.65 | 2.52 | 135.5<br>K=0.70 | 8.130 | 0.3068 | -0.80 | 2.49 | 0.320 ✔ |
| T4 | 20 - 0 | L1 1/2x1 1/2x1/8 | 4.83 | 2.37 | 102.1<br>K=1.06 | 12.160 | 0.3594 | -0.94 | 4.37 | 0.216 ✔ |

## Top Girt Design Data (Compression)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 1.50 | 1.42 | 109.3<br>K=0.70 | 11.349 | 0.1503 | -0.02 | 1.71 | 0.013 ✔ |
| T2 | 60 - 40 | 5/8 | 1.83 | 1.73 | 93.0<br>K=0.70 | 13.123 | 0.3068 | -0.16 | 4.03 | 0.039 ✔ |
| T3 | 40 - 20 | 5/8 | 2.17 | 2.05 | 110.1<br>K=0.70 | 11.254 | 0.3068 | -0.15 | 3.45 | 0.045 ✔ |

## Bottom Girt Design Data (Compression)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 1.83 | 1.75 | 134.7<br>K=0.70 | 8.234 | 0.1503 | -0.13 | 1.24 | 0.103 ✔ |
| T2 | 60 - 40 | 5/8 | 2.17 | 2.06 | 110.8<br>K=0.70 | 11.174 | 0.3068 | -0.14 | 3.43 | 0.042 ✔ |
| T3 | 40 - 20 | 5/8 | 2.50 | 2.38 | 127.9<br>K=0.70 | 9.102 | 0.3068 | -0.43 | 2.79 | 0.155 ✔ |

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|

# Tension Checks

## Leg Design Data (Tension)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 15/16 | 20.00 | 0.86 | 44.2 | 30.000 | 0.6903 | 8.05 | 20.71 | 0.389 ✔ |
| T2 | 60 - 40 | 1 1/4 | 20.00 | 0.94 | 36.3 | 30.000 | 1.2272 | 16.03 | 36.82 | 0.435 ✔ |
| T3 | 40 - 20 | 1 7/16 | 20.00 | 0.94 | 31.5 | 30.000 | 1.6229 | 24.94 | 48.69 | 0.512 ✔ |
| T4 | 20 - 0 | ROHN 2 STD | 20.03 | 4.01 | 61.1 | 30.000 | 1.0745 | 23.75 | 32.24 | 0.737 ✔ |

## Diagonal Design Data (Tension)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 2.02 | 1.93 | 211.9 | 19.800 | 0.1503 | 0.46 | 2.98 | 0.156 ✔ |
| T2 | 60 - 40 | 5/8 | 2.36 | 2.24 | 172.2 | 19.800 | 0.3068 | 0.67 | 6.07 | 0.111 ✔ |
| T3 | 40 - 20 | 5/8 | 2.65 | 2.52 | 193.6 | 19.800 | 0.3068 | 0.78 | 6.07 | 0.129 ✔ |
| T4 | 20 - 0 | L1 1/2x1 1/2x1/8 | 4.83 | 2.37 | 63.5 | 19.800 | 0.3594 | 1.07 | 7.12 | 0.150 ✔ |

## Top Girt Design Data (Tension)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 1.50 | 1.42 | 156.2 | 19.800 | 0.1503 | 0.02 | 2.98 | 0.006 ✔ |
| T2 | 60 - 40 | 5/8 | 1.83 | 1.73 | 132.9 | 19.800 | 0.3068 | 0.14 | 6.07 | 0.023 ✔ |
| T3 | 40 - 20 | 5/8 | 2.17 | 2.05 | 157.3 | 19.800 | 0.3068 | 0.14 | 6.07 | 0.023 ✔ |

## Bottom Girt Design Data (Tension)

| Section No. | Elevation ft | Size | L ft | $L_u$ ft | Kl/r | $F_a$ ksi | A $in^2$ | Actual P K | Allow. $P_a$ K | Ratio $\frac{P}{P_a}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | 7/16 | 1.83 | 1.75 | 192.4 | 19.800 | 0.1503 | 0.14 | 2.98 | 0.046 ✔ |
| T2 | 60 - 40 | 5/8 | 2.17 | 2.06 | 158.3 | 19.800 | 0.3068 | 0.16 | 6.07 | 0.026 ✔ |
| T3 | 40 - 20 | 5/8 | 2.50 | 2.38 | 182.7 | 19.800 | 0.3068 | 0.32 | 6.07 | 0.053 ✔ |

## Section Capacity Table

| Section No. | Elevation ft | Component Type | Size | Critical Element | P K | $SF*P_{allow}$ K | % Capacity | Pass Fail |
|---|---|---|---|---|---|---|---|---|
| T1 | 80 - 60 | Leg | 15/16 | 2 | -8.53 | 15.92 | 53.6 | Pass |
| T2 | 60 - 40 | Leg | 1 1/4 | 80 | -16.97 | 33.47 | 50.7 | Pass |
| T3 | 40 - 20 | Leg | 1 7/16 | 152 | -26.43 | 48.00 | 55.1 | Pass |
| T4 | 20 - 0 | Leg | ROHN 2 STD | 224 | -25.18 | 32.27 | 78.0 | Pass |
| T1 | 80 - 60 | Diagonal | 7/16 | 10 | -0.47 | 1.36 | 34.4 | Pass |
| T2 | 60 - 40 | Diagonal | 5/8 | 88 | -0.68 | 4.10 | 16.6 | Pass |
| T3 | 40 - 20 | Diagonal | 5/8 | 163 | -0.80 | 3.32 | 24.0 | Pass |
| T4 | 20 - 0 | Diagonal | L1 1/2x1 1/2x1/8 | 254 | -0.94 | 5.83 | 16.2<br>38.0 (b) | Pass |
| T1 | 80 - 60 | Top Girt | 7/16 | 6 | -0.02 | 2.27 | 1.0 | Pass |
| T2 | 60 - 40 | Top Girt | 5/8 | 82 | -0.16 | 5.37 | 2.9 | Pass |
| T3 | 40 - 20 | Top Girt | 5/8 | 154 | -0.15 | 4.60 | 3.4 | Pass |
| T1 | 80 - 60 | Bottom Girt | 7/16 | 7 | -0.13 | 1.65 | 7.7 | Pass |
| T2 | 60 - 40 | Bottom Girt | 5/8 | 86 | -0.14 | 4.57 | 3.2 | Pass |
| T3 | 40 - 20 | Bottom Girt | 5/8 | 157 | -0.43 | 3.72 | 11.7 | Pass |
| | | | | | | Summary | | |
| | | | | | | Leg (T4) | 78.0 | Pass |
| | | | | | | Diagonal (T4) | 38.0 | Pass |
| | | | | | | Top Girt (T3) | 3.4 | Pass |
| | | | | | | Bottom Girt (T3) | 11.7 | Pass |
| | | | | | | Bolt Checks | 38.0 | Pass |
| | | | | | | **RATING =** | **78.0** | **Pass** |

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| | |
|---|---|
| Subject: | Ballast Calculation |
| Location: | 80-ft Temporary Ballast Tower<br>Redding, CT |
| Rev. 0: 4/1/16 | Prepared by: T.J.L. Checked by: C.F.C.<br>Job No. 16047.00 |

## Ballast Calculation:

### Input Data:

Tower Reactions:

| | | |
|---|---|---|
| Overturning Moment = | $OM := 89 \cdot ft \cdot kips$ | (Input From tnxTower) |
| Shear Force = | $Shear := 2 \cdot kips$ | (Input From tnxTower) |
| Axial Force = | $Axial := 3 \cdot kips$ | (Input From tnxTower) |
| Overturning Factor of Safety Required = | $FS_{req} := 2.0$ | (User Input) |

Ballast Data:

| | | |
|---|---|---|
| Weight of Base Frame = | $WT_{frame} := 5kips$ | (User Input) |
| Distance From Center of Tower to Extreme Edge of Base Frame = | $c := 7.5 \cdot ft$ | (User Input) |
| Distance From Frame Toe to Front Ballast String = | $d_1 := 2.5 \cdot ft$ | (User Input) |
| Distance From Frame Toe to Back Ballast String = | $d_2 := 12.5 \cdot ft$ | (User Input) |
| Depth of Ballast Frame = | $d_f := 1.50 \cdot ft$ | (User Input) |
| Weight of Concrete = | $\gamma_c := 145 \cdot pcf$ | (User Input) |
| Block Width = | $w_b := 5 \cdot ft$ | (User Input) |
| Block Length = | $l_b := 5 \cdot ft$ | (User Input) |
| Block Thickness = | $t_b := 1 \cdot ft$ | (User Input) |
| Individual Block Weight = | $W_b := w_b \cdot l_b \cdot t_b \cdot \gamma_c = 3625 \cdot lb$ | |
| Total Overturning Moment About Toe of Base Frame = | $M_{tot} := OM + Shear \cdot d_f = 92 \cdot ft \cdot kips$ | |
| Total Dead Weight = | $P_{tot} := Axial + WT_{frame} = 8 \cdot kips$ | |
| Net Resisting Moment Required = | $M_{rnet} := \left(FS_{req} \cdot M_{tot}\right) - \left(P_{tot} \cdot c\right) = 124 \cdot kip \cdot ft$ | |
| Ballast Required Per Side of Base Frame = | $W_{req} := \frac{M_{rnet}}{\left(d_1 + d_2\right)} = 8.27 \cdot kips$ | |
| Total Ballast Weight Required = | $W_{totreq} := W_{req} \cdot 2 = 16.53 \cdot kips$ | |
| Ballast Weight Required Per Quadrant = | $W_{reqquad} := \frac{W_{req}}{2} = 4.13 \cdot kips$ | |
| Number of Blocks Required per Quadrant = | $N_b := \frac{W_{totreq}}{W_b \cdot (4) \cdot (0.9)} = 1.27$ | |
| | $N_{buse} := 2$ | |

Resisting Moment = $M_r := \left[\left(W_b\right)\cdot N_{buse}\cdot 2.0\cdot\left(d_1 + d_2\right)\right] + \left(P_{tot}\cdot c\right) = 277.5\cdot kip\cdot ft$

Actual Factor of Safety = $FS := \frac{M_r}{M_{tot}} = 3.02$

$FOS\_Check := if\left(FS \geq FS_{req}, "Okay", "No\ Good"\right)$

$FOS\_Check = "Okay"$