

STRUCTURAL ANALYSIS REPORT

For

ME5001
SONESTA

157 High Street
Portland, ME 04101

Antennas Mounted to the Tower



Prepared for:

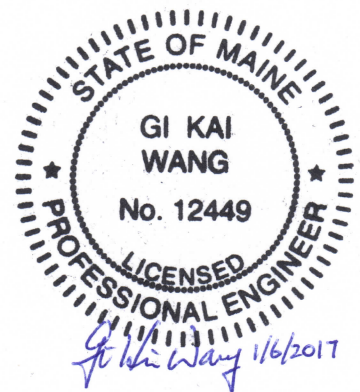


Dated: January 6, 2017

Prepared by:



1600 Osgood Street Bldg. 20N Suite 3090
North Andover, MA 01845
(P) 978.557.5553 (F) 978.336.5586
www.hudsondesigngroupllc.com





SCOPE OF WORK:

Hudson Design Group LLC (HDG) has been authorized by AT&T to conduct a structural evaluation of the 25' self-supporting tower supporting the proposed AT&T antennas located at elevation 181' above the ground level.

This report represents this office's findings, conclusions and recommendations pertaining to the support of AT&T's existing and proposed antennas listed below.

Record drawings of the existing tower were not available for our use. The previous structural analysis report prepared by Malouf Engineering Intl., Inc., dated September 2, 2008, was available and obtained for our use. Tower mapping report prepared by ProVertic LLC, dated April 22, 2016, was provided to this office.

CONCLUSION SUMMARY:

Based on our evaluation, we have determined that the existing tower is in conformance with the ANSI/TIA-222-G Standard for the loading considered under the criteria listed in this report. The tower structure is rated at 36.3% - (Diagonal at Tower Section T5 from EL.156' to EL.161' Controlling).



APPURTENANCES CONFIGURATION (RFDS 9/16/2016 Version 1.00):

| Tenant | Appurtenances | Elev. | Mount |
|--------|-------------------------------|-------|---------------------|
| AT&T | (3) Powerwave 7770 Antennas | 181' | T - Frame |
| AT&T | (3) Powerwave 7333 Antennas | 181' | T - Frame |
| AT&T | (3) SBNHH-1D65A Antennas | 181' | T - Frame |
| AT&T | (6) Powerwave LGP21401 | 181' | T - Frame |
| AT&T | (3) RRUS-11 | 181' | T - Frame |
| AT&T | DC6-48-60-18-8F | 181' | Tower Leg |
| AT&T | (3) QS46512-2 Antennas | 181' | T - Frame |
| AT&T | (6) TPX-070821 | 181' | T - Frame |
| AT&T | (3) RRUS-11 | 181' | T - Frame |
| AT&T | (3) A2 Module | 181' | T - Frame |
| AT&T | (3) RRUS-32 | 181' | T - Frame |
| AT&T | DC6-48-60-18-8F | 181' | Tower Leg |
| | 3' Dish | 163' | Tower Leg |
| | 6' Dish | 162' | Side Mount Standoff |

**Proposed AT&T Appurtenances shown in Bold.*

AT&T EXISTING/PROPOSED COAX CABLES:

| Tenant | Coax Cables | Elev. | Mount |
|--------|----------------------------|-------|------------|
| AT&T | (12) 7/8" Cables | 181' | Tower Face |
| AT&T | (2) DC Power Cables | 181' | Tower Face |
| AT&T | (1) Fiber Cable | 181' | Tower Face |
| AT&T | (2) DC Power Cables | 181' | Tower Face |
| AT&T | (1) Fiber Cable | 181' | Tower Face |

**Proposed AT&T Coax Cables shown in Bold.*

ANALYSIS RESULTS SUMMARY:

| Component | Max. Stress Ratio | Elev. of Component (ft) | Pass/Fail | Notes/Comments |
|---------------|-------------------|-------------------------|-----------|--------------------|
| Legs | 10.6 % | 156 - 161 | PASS | |
| Diagonals | 36.3 % | 156 - 161 | PASS | Controlling |
| Top Girts | 19.1 % | 176 - 181.4 | PASS | |
| Bottom Girts | 6.8 % | 176 - 181.4 | PASS | |
| Inner Bracing | 1.5 % | 176 - 181.4 | PASS | |



DESIGN CRITERIA:

1. EIA/TIA-222-G Structural Standards for Steel Antenna Towers and Antenna Supporting Structures

County: Cumberland
Wind Load: 100 mph (3 second gust)
Structural Class: II
Exposure Category: B
Topographic Category: 1
Ice Thickness: 1.0 inch

2. Approximate height above grade to proposed antennas: 181'

Calculations and referenced documents are attached

ASSUMPTIONS:

1. Material strength of the existing structure was not available for structural analysis, and was assumed as follows:
Pipes: $F_y=50$ ksi
Angles: $F_y=36$ ksi
2. The Tower and support are properly constructed and maintained. All structural members and their connections are assumed to be in good condition and are free from defects with no deterioration to its member capacities.
3. The appurtenances configuration is as stated in this report. All antennas, coax cables and waveguide cables are assumed to be properly installed and supported as per the manufacturer's requirements.
4. The support mounts and platforms are not analyzed and are considered adequate to support the loading. The analysis is limited to the primary support structure itself.
5. All prior structural modification, if any, are assumed to be as per the data supplied (if available), and installed properly.



SUPPORT RECOMMENDATIONS:

HDG recommends that the proposed antennas, triplexers and RRHs be mounted on the existing T-frame supported by the tower; the proposed surge arrester be mounted on the tower leg.

Reference HDG's Latest Construction Drawings for all component and connection requirements (attached).

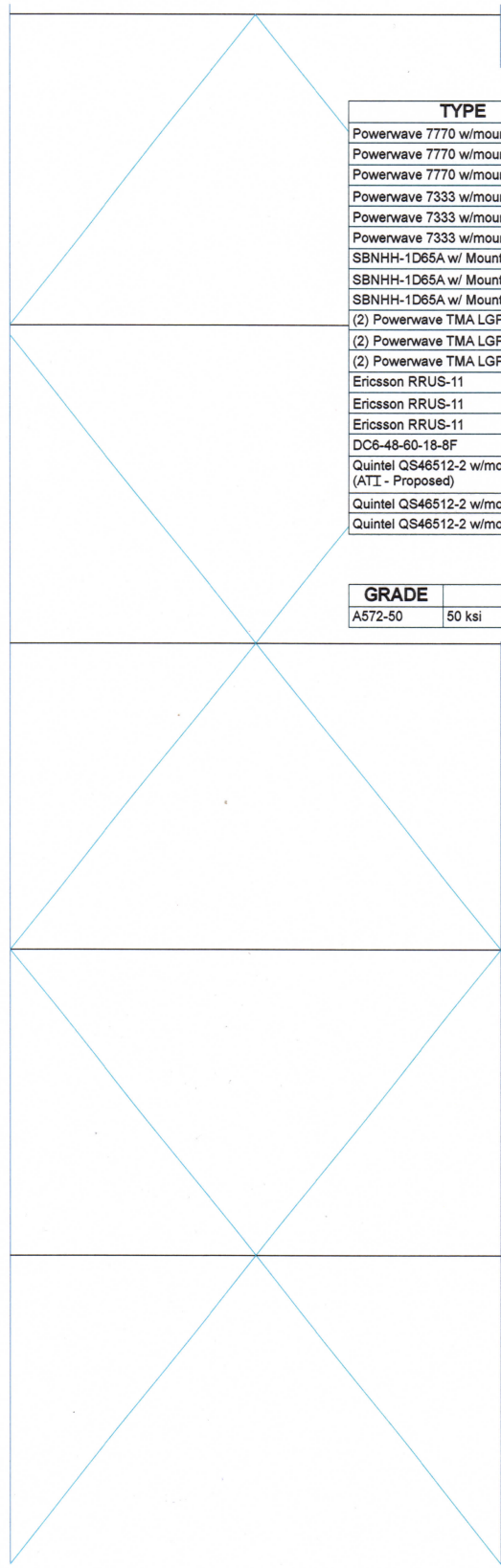


Photo 1: Photo illustrating the Tower with Appurtenances shown.



CALCULATIONS

| | | | | | | |
|-----------------|-------------------|-------|-----------|--------------------|-------|----------|
| Section | T1 | T2 | T3 | T4 | T5 | 181.4 ft |
| Legs | | | F4x.237 | | | |
| Leg Grade | | | A572-50 | | | |
| Diagonals | | | P1.5x.145 | | | |
| Diagonal Grade | | | A572-50 | | | |
| Top Girts | L1 3/4x1 3/4x3/16 | N.A. | | 2L1 3/4x1 3/4x3/16 | | |
| Bottom Girts | L1 3/4x1 3/4x3/16 | | N.A. | L1 3/4x1 3/4x3/16 | | |
| Inner Bracing | | | N.A. | | | |
| Face Width (ft) | | | 8 | | | |
| # Panels @ (ft) | | | 4 @ 5 | | | |
| Weight (lb) | 1 @ 5.04167 | 403.2 | 400.6 | 596.3 | 400.6 | 2573.9 |
| | 176.0 ft | | 166.0 ft | | | 161.0 ft |
| | | | | | | 156.0 ft |



DESIGNED APPURTENANCE LOADING

| TYPE | ELEVATION | TYPE | ELEVATION |
|---|-----------|------------------------------------|-----------|
| Powerwave 7770 w/mount pipe | 181 | (2) TPX-070821 Triplexer | 181 |
| Powerwave 7770 w/mount pipe | 181 | (2) TPX-070821 Triplexer | 181 |
| Powerwave 7770 w/mount pipe | 181 | (2) TPX-070821 Triplexer | 181 |
| Powerwave 7333 w/mount pipe | 181 | Ericsson RRUS-11 | 181 |
| Powerwave 7333 w/mount pipe | 181 | Ericsson RRUS-11 | 181 |
| Powerwave 7333 w/mount pipe | 181 | Ericsson RRUS-11 | 181 |
| SBNHH-1D65A w/ Mount Pipe | 181 | Ericsson A2 Module | 181 |
| SBNHH-1D65A w/ Mount Pipe | 181 | Ericsson A2 Module | 181 |
| SBNHH-1D65A w/ Mount Pipe | 181 | Ericsson A2 Module | 181 |
| (2) Powerwave TMA LGP21401 | 181 | Ericsson RRUS-32 | 181 |
| (2) Powerwave TMA LGP21401 | 181 | Ericsson RRUS-32 | 181 |
| (2) Powerwave TMA LGP21401 | 181 | Ericsson RRUS-32 | 181 |
| Ericsson RRUS-11 | 181 | DC6-48-60-18-8F | 181 |
| Ericsson RRUS-11 | 181 | PIROD 14' T-Frame | 180 |
| Ericsson RRUS-11 | 181 | PIROD 14' T-Frame (ATI - Existing) | 180 |
| DC6-48-60-18-8F | 181 | PIROD 14' T-Frame | 180 |
| Quintel QS46512-2 w/mount pipe (ATI - Proposed) | 181 | P3F-52 | 163 |
| Quintel QS46512-2 w/mount pipe | 181 | 1' Side Mount Standoff | 162 |
| Quintel QS46512-2 w/mount pipe | 181 | UHX6-59 | 162 |

MATERIAL STRENGTH

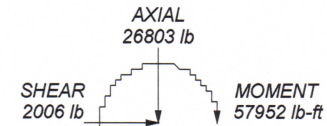
| GRADE | Fy | Fu | GRADE | Fy | Fu |
|---------|--------|--------|-------|----|----|
| A572-50 | 50 ksi | 65 ksi | | | |

ALL REACTIONS ARE FACTORED

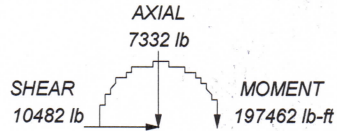
MAX. CORNER REACTIONS AT BASE:

DOWN: 19286 lb
SHEAR: 3350 lb

UPLIFT: -15911 lb
SHEAR: 3022 lb



TORQUE 2341 lb-ft
40 mph WIND - 1.0000 in ICE



TORQUE 13073 lb-ft
REACTIONS - 100 mph WIND

| | | | |
|---|---|-----------------------|-------------------|
| <p>Hudson Design Group LLC 1600 Osgood Street Bldg. 20N Suite 3090 North Andover, MA 01845 Phone: (978) 557-5553 FAX: (978) 336-5586</p> | Job: ME5001 Portland, ME | | |
| | Project: 25 ft Self Supporting Tower | | |
| | Client: AT&T | Drawn by: KW | App'd: |
| | Code: TIA-222-G | Date: 01/06/17 | Scale: NTS |
| | Path: | Dwg No. E-1 | |



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 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
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| | | | |
|----------------|-----------------------------|--------------------|-------------------|
| Job | ME5001 Portland, ME | Page | 1 of 9 |
| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

Tower Input Data

The main tower is a 4x free standing tower with an overall height of 181.38 ft above the ground line.

The base of the tower is set at an elevation of 156.00 ft above the ground line.

The face width of the tower is 8.00 ft at the top and 8.00 ft at the base.

This tower is designed using the TIA-222-G standard.

The following design criteria apply:

Tower is located in Cumberland County, Maine.

Basic wind speed of 100 mph.

Structure Class II.

Exposure Category B.

Topographic Category 1.

Crest Height 0.00 ft.

Nominal ice thickness of 1.0000 in.

Ice thickness is considered to increase with height.

Ice density of 56 pcf.

A wind speed of 40 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 tower member design is 1.

Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Tower Section Geometry

| <i>Tower Section</i> | <i>Tower Elevation</i> | <i>Assembly Database</i> | <i>Description</i> | <i>Section Width</i> | <i>Number of Sections</i> | <i>Section Length</i> |
|----------------------|------------------------|--------------------------|--------------------|----------------------|---------------------------|-----------------------|
| | <i>ft</i> | | | <i>ft</i> | | <i>ft</i> |
| T1 | 181.38-176.00 | | | 8.00 | 1 | 5.38 |
| T2 | 176.00-171.00 | | | 8.00 | 1 | 5.00 |
| T3 | 171.00-166.00 | | | 8.00 | 1 | 5.00 |
| T4 | 166.00-161.00 | | | 8.00 | 1 | 5.00 |
| T5 | 161.00-156.00 | | | 8.00 | 1 | 5.00 |

Tower Section Geometry (cont'd)

| <i>Tower Section</i> | <i>Tower Elevation</i> | <i>Diagonal Spacing</i> | <i>Bracing Type</i> | <i>Has K Brace End Panels</i> | <i>Has Horizontals</i> | <i>Top Girt Offset</i> | <i>Bottom Girt Offset</i> |
|----------------------|------------------------|-------------------------|---------------------|-------------------------------|------------------------|------------------------|---------------------------|
| | <i>ft</i> | <i>ft</i> | | | | <i>in</i> | <i>in</i> |
| T1 | 181.38-176.00 | 5.04 | K Brace Down | No | Yes | 2.0000 | 2.0000 |
| T2 | 176.00-171.00 | 5.00 | K Brace Up | No | Yes | 0.0000 | 0.0000 |
| T3 | 171.00-166.00 | 5.00 | K Brace Down | No | Yes | 0.0000 | 0.0000 |
| T4 | 166.00-161.00 | 5.00 | K Brace Up | No | Yes | 0.0000 | 0.0000 |
| T5 | 161.00-156.00 | 5.00 | K Brace Down | No | Yes | 0.0000 | 0.0000 |



Hudson Design Group LLC
 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
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|----------------|-----------------------------|--------------------|-------------------|
| Job | ME5001 Portland, ME | Page | 2 of 9 |
| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

Tower Section Geometry (cont'd)

| Tower Elevation ft | Leg Type | Leg Size | Leg Grade | Diagonal Type | Diagonal Size | Diagonal Grade |
|-----------------------|----------|----------|---------------------|---------------|---------------|---------------------|
| T1 181.38-176.00 | Pipe | P4x.237 | A572-50 (50 ksi) | Pipe | P1.5x.145 | A572-50 (50 ksi) |
| T2 176.00-171.00 | Pipe | P4x.237 | A572-50 (50 ksi) | Pipe | P1.5x.145 | A572-50 (50 ksi) |
| T3 171.00-166.00 | Pipe | P4x.237 | A572-50 (50 ksi) | Pipe | P1.5x.145 | A572-50 (50 ksi) |
| T4 166.00-161.00 | Pipe | P4x.237 | A572-50 (50 ksi) | Pipe | P1.5x.145 | A572-50 (50 ksi) |
| T5 161.00-156.00 | Pipe | P4x.237 | A572-50 (50 ksi) | Pipe | P1.5x.145 | A572-50 (50 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 181.38-176.00 | Single Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) | Equal Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) |
| T3 171.00-166.00 | Double Equal Angle | 2L1 3/4x1 3/4x3/16 | A36 (36 ksi) | Equal Angle | | A36 (36 ksi) |
| T4 166.00-161.00 | Double Equal Angle | 2L1 3/4x1 3/4x3/16 | A36 (36 ksi) | Equal Angle | | A36 (36 ksi) |
| T5 161.00-156.00 | Double Equal Angle | 2L1 3/4x1 3/4x3/16 | A36 (36 ksi) | Equal Angle | | A36 (36 ksi) |

Tower Section Geometry (cont'd)

| Tower Elevation ft | Secondary Horizontal Type | Secondary Horizontal Size | Secondary Horizontal Grade | Inner Bracing Type | Inner Bracing Size | Inner Bracing Grade |
|-----------------------|---------------------------|---------------------------|----------------------------|--------------------|--------------------|---------------------|
| T1 181.38-176.00 | Equal Angle | | A36 (36 ksi) | Equal Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) |
| T2 176.00-171.00 | Equal Angle | | A36 (36 ksi) | Equal Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) |
| T4 166.00-161.00 | Equal Angle | | A36 (36 ksi) | Equal Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) |
| T5 161.00-156.00 | Equal Angle | | A36 (36 ksi) | Equal Angle | L1 3/4x1 3/4x3/16 | A36 (36 ksi) |

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 |
|-------------|-------------|--------------|----------------|-----------------|-------------------|-----------------------------|---|-----------|---------------------|-------------------------|-----------------|---------------|
| EW52 | A | No | Ar (CaAa) | 163.00 - 156.00 | 0.0000 | 0 | 1 | 1 | 0.0000 | 1.7426 | | 0.59 |
| EW52 | D | No | Ar (CaAa) | 162.00 - 156.00 | 0.0000 | 0 | 1 | 1 | 0.0000 | 1.7426 | | 0.59 |



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| Job | ME5001 Portland, ME | Page | 3 of 9 |
| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

| 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 (AT&T - existing) | B | No | Ar (CaAa) | 181.00 - 156.00 | 0.0000 | 0 | 12 | 6 | 0.0000 | 1.1100 | | 0.54 |
| WR-VG122S T-BRDA | B | No | Ar (CaAa) | 181.00 - 156.00 | 0.0000 | 0.2 | 2 | 2 | 0.0000 | 0.4000 | | 0.25 |
| FB-L98B-002 ***** | B | No | Ar (CaAa) | 181.00 - 156.00 | 0.0000 | 0.25 | 1 | 1 | 0.0000 | 0.4000 | | 0.25 |
| WR-VG122S T-BRDA (AT&T - proposed) | B | No | Ar (CaAa) | 181.00 - 156.00 | 0.0000 | 0.2 | 2 | 2 | 0.0000 | 0.4000 | | 0.25 |
| FB-L98B-002 | B | No | Ar (CaAa) | 181.00 - 156.00 | 0.0000 | 0.25 | 1 | 1 | 0.0000 | 0.4000 | | 0.25 |

Discrete Tower Loads

| Description | Face or Leg | Offset Type | Offsets: Horz Lateral Vert ft ft ft | Azimuth Adjustment ° | Placement ft | C _A A _A Front ft ² | C _A A _A Side ft ² | Weight lb | |
|-------------------------------------|-------------|-------------|-------------------------------------|----------------------|--------------|---|--|-----------|--------|
| PiROD 14' T-Frame (AT&T - Existing) | A | From Leg | 1.00 | 0.0000 | 180.00 | No Ice | 15.00 | 15.00 | 500.00 |
| | | | 0.00 | | | 1/2" Ice | 20.60 | 20.60 | 650.00 |
| | | | 0.00 | | | 1" Ice | 26.20 | 26.20 | 800.00 |
| PiROD 14' T-Frame | C | From Leg | 1.00 | 0.0000 | 180.00 | No Ice | 15.00 | 15.00 | 500.00 |
| | | | 0.00 | | | 1/2" Ice | 20.60 | 20.60 | 650.00 |
| | | | 0.00 | | | 1" Ice | 26.20 | 26.20 | 800.00 |
| PiROD 14' T-Frame | D | From Leg | 1.00 | 0.0000 | 180.00 | No Ice | 15.00 | 15.00 | 500.00 |
| | | | 0.00 | | | 1/2" Ice | 20.60 | 20.60 | 650.00 |
| | | | 0.00 | | | 1" Ice | 26.20 | 26.20 | 800.00 |
| Powerwave 7770 w/mount pipe | A | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.02 | 4.10 | 57.25 |
| | | | 0.00 | | | 1/2" Ice | 6.47 | 4.75 | 103.17 |
| | | | 0.00 | | | 1" Ice | 6.94 | 5.42 | 155.38 |
| Powerwave 7770 w/mount pipe | C | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.02 | 4.10 | 57.25 |
| | | | 0.00 | | | 1/2" Ice | 6.47 | 4.75 | 103.17 |
| | | | 0.00 | | | 1" Ice | 6.94 | 5.42 | 155.38 |
| Powerwave 7770 w/mount pipe | D | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.02 | 4.10 | 57.25 |
| | | | 0.00 | | | 1/2" Ice | 6.47 | 4.75 | 103.17 |
| | | | 0.00 | | | 1" Ice | 6.94 | 5.42 | 155.38 |
| Powerwave 7333 w/mount pipe | A | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.04 | 4.22 | 54.90 |
| | | | 0.00 | | | 1/2" Ice | 6.60 | 5.06 | 102.32 |
| | | | 0.00 | | | 1" Ice | 7.12 | 5.77 | 156.08 |
| Powerwave 7333 w/mount pipe | C | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.04 | 4.22 | 54.90 |
| | | | 0.00 | | | 1/2" Ice | 6.60 | 5.06 | 102.32 |
| | | | 0.00 | | | 1" Ice | 7.12 | 5.77 | 156.08 |
| Powerwave 7333 w/mount pipe | D | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.04 | 4.22 | 54.90 |
| | | | 0.00 | | | 1/2" Ice | 6.60 | 5.06 | 102.32 |
| | | | 0.00 | | | 1" Ice | 7.12 | 5.77 | 156.08 |
| SBNHH-1D65A w/ Mount Pipe | A | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.76 | 5.34 | 55.90 |
| | | | 0.00 | | | 1/2" Ice | 7.31 | 6.20 | 111.21 |
| | | | 0.00 | | | 1" Ice | 7.85 | 6.96 | 173.23 |
| SBNHH-1D65A w/ Mount Pipe | C | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.76 | 5.34 | 55.90 |
| | | | 0.00 | | | 1/2" Ice | 7.31 | 6.20 | 111.21 |
| | | | 0.00 | | | 1" Ice | 7.85 | 6.96 | 173.23 |
| SBNHH-1D65A w/ Mount Pipe | D | From Leg | 2.00 | 0.0000 | 181.00 | No Ice | 6.76 | 5.34 | 55.90 |
| | | | 0.00 | | | 1/2" Ice | 7.31 | 6.20 | 111.21 |



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| Job | ME5001 Portland, ME | Page | 5 of 9 |
| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

| Description | Face or Leg | Offset Type | Offsets: Horz Lateral Vert | Azimuth Adjustment | Placement | C _{AA} Front | C _{AA} Side | Weight | |
|---------------------------------|-------------|-------------|----------------------------|--------------------|-----------|-----------------------|----------------------|--------|--------|
| | | | ft ft ft | ° | ft | ft ² | ft ² | lb | |
| Ericsson RRUS-32 | A | From Leg | 0.00 | 0.0000 | 181.00 | 1/2" Ice | 2.63 | 0.67 | 34.73 |
| | | | 0.00 | | | 1" Ice | 2.85 | 0.82 | 49.92 |
| | | | 1.00 | | | No Ice | 3.87 | 2.76 | 77.00 |
| | | | 0.00 | | | 1/2" Ice | 4.15 | 3.02 | 104.93 |
| Ericsson RRUS-32 | C | From Leg | 0.00 | 0.0000 | 181.00 | 1" Ice | 4.44 | 3.29 | 136.47 |
| | | | 1.00 | | | No Ice | 3.87 | 2.76 | 77.00 |
| | | | 0.00 | | | 1/2" Ice | 4.15 | 3.02 | 104.93 |
| | | | 0.00 | | | 1" Ice | 4.44 | 3.29 | 136.47 |
| Ericsson RRUS-32 | D | From Leg | 1.00 | 0.0000 | 181.00 | No Ice | 3.87 | 2.76 | 77.00 |
| | | | 0.00 | | | 1/2" Ice | 4.15 | 3.02 | 104.93 |
| | | | 0.00 | | | 1" Ice | 4.44 | 3.29 | 136.47 |
| | | | 0.00 | | | No Ice | 3.87 | 2.76 | 77.00 |
| DC6-48-60-18-8F | C | From Leg | 1.00 | 0.0000 | 181.00 | 1/2" Ice | 4.15 | 3.02 | 104.93 |
| | | | 0.00 | | | 1" Ice | 4.44 | 3.29 | 136.47 |
| | | | 0.00 | | | No Ice | 1.27 | 1.27 | 20.00 |
| | | | 0.00 | | | 1/2" Ice | 1.46 | 1.46 | 35.12 |
| ***** 1' Side Mount Standoff | C | From Leg | 0.00 | 0.0000 | 162.00 | 1" Ice | 1.66 | 1.66 | 52.57 |
| | | | 1.00 | | | No Ice | 1.00 | 1.00 | 30.00 |
| | | | 0.00 | | | 1/2" Ice | 1.50 | 1.50 | 50.00 |
| | | | 0.00 | | | 1" Ice | 2.00 | 2.00 | 70.00 |

Dishes

| Description | Face or Leg | Dish Type | Offset Type | Offsets: Horz Lateral Vert | Azimuth Adjustment | 3 dB Beam Width | Elevation | Outside Diameter | Aperture Area | Weight | |
|-------------|-------------|--------------------------|-------------|----------------------------|--------------------|-----------------|-----------|------------------|-----------------|--------|--------|
| | | | | ft ft ft | ° | ° | ft | ft | ft ² | lb | |
| P3F-52 | A | Paraboloid w/o Radome | From Leg | 1.00 | 0.0000 | | 163.00 | 3.00 | No Ice | 7.10 | 90.00 |
| | | | | 0.00 | | | | | 1/2" Ice | 7.46 | 128.31 |
| | | | | 0.00 | | | | | 1" Ice | 7.83 | 166.62 |
| UHX6-59 | C | Paraboloid w/Shroud (HP) | From Leg | 2.00 | 0.0000 | | 162.00 | 6.00 | No Ice | 28.27 | 143.00 |
| | | | | 0.00 | | | | | 1/2" Ice | 29.05 | 292.13 |
| | | | | 0.00 | | | | | 1" Ice | 29.83 | 441.25 |
| | | | | 0.00 | | | | | | | |

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 45 deg - No Ice |
| 5 | 0.9 Dead+1.6 Wind 45 deg - No Ice |
| 6 | 1.2 Dead+1.6 Wind 90 deg - No Ice |
| 7 | 0.9 Dead+1.6 Wind 90 deg - No Ice |
| 8 | 1.2 Dead+1.6 Wind 135 deg - No Ice |
| 9 | 0.9 Dead+1.6 Wind 135 deg - No Ice |
| 10 | 1.2 Dead+1.6 Wind 180 deg - No Ice |
| 11 | 0.9 Dead+1.6 Wind 180 deg - No Ice |
| 12 | 1.2 Dead+1.6 Wind 225 deg - No Ice |
| 13 | 0.9 Dead+1.6 Wind 225 deg - No Ice |



Hudson Design Group LLC
 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
 Phone: (978) 557-5553
 FAX: (978) 336-5586

| | | | |
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| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

| <i>Comb. No.</i> | <i>Description</i> |
|------------------|--|
| 14 | 1.2 Dead+1.6 Wind 270 deg - No Ice |
| 15 | 0.9 Dead+1.6 Wind 270 deg - No Ice |
| 16 | 1.2 Dead+1.6 Wind 315 deg - No Ice |
| 17 | 0.9 Dead+1.6 Wind 315 deg - No Ice |
| 18 | 1.2 Dead+1.0 Ice+1.0 Temp |
| 19 | 1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp |
| 20 | 1.2 Dead+1.0 Wind 45 deg+1.0 Ice+1.0 Temp |
| 21 | 1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp |
| 22 | 1.2 Dead+1.0 Wind 135 deg+1.0 Ice+1.0 Temp |
| 23 | 1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp |
| 24 | 1.2 Dead+1.0 Wind 225 deg+1.0 Ice+1.0 Temp |
| 25 | 1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp |
| 26 | 1.2 Dead+1.0 Wind 315 deg+1.0 Ice+1.0 Temp |
| 27 | Dead+Wind 0 deg - Service |
| 28 | Dead+Wind 45 deg - Service |
| 29 | Dead+Wind 90 deg - Service |
| 30 | Dead+Wind 135 deg - Service |
| 31 | Dead+Wind 180 deg - Service |
| 32 | Dead+Wind 225 deg - Service |
| 33 | Dead+Wind 270 deg - Service |
| 34 | Dead+Wind 315 deg - Service |

Maximum Reactions

| <i>Location</i> | <i>Condition</i> | <i>Gov. Load Comb.</i> | <i>Vertical lb</i> | <i>Horizontal, X lb</i> | <i>Horizontal, Z lb</i> |
|-----------------|---------------------|------------------------|--------------------|-------------------------|-------------------------|
| Leg D | Max. Vert | 12 | 19285.87 | 2484.56 | -2246.73 |
| | Max. H _x | 14 | 14216.85 | 2982.65 | -388.08 |
| | Max. H _z | 3 | -9848.52 | -174.76 | 2643.08 |
| | Min. Vert | 5 | -14917.46 | -2246.98 | 1939.29 |
| | Min. H _x | 7 | -9777.39 | -2738.48 | 36.54 |
| | Min. H _z | 10 | 14145.70 | 468.30 | -2859.76 |
| Leg C | Max. Vert | 8 | 19030.04 | -2893.27 | -2025.99 |
| | Max. H _x | 15 | -10748.23 | 2714.42 | 429.41 |
| | Max. H _z | 3 | -10748.42 | 973.63 | 2169.67 |
| | Min. Vert | 17 | -15816.45 | 2641.75 | 1861.97 |
| | Min. H _x | 6 | 14062.97 | -3019.01 | -609.02 |
| | Min. H _z | 10 | 14062.77 | -1241.87 | -2386.80 |
| Leg B | Max. Vert | 4 | 17960.52 | -2196.46 | 2434.31 |
| | Max. H _x | 15 | -10842.68 | 2098.67 | -794.88 |
| | Max. H _z | 4 | 17960.52 | -2196.46 | 2434.31 |
| | Min. Vert | 13 | -15911.47 | 1977.51 | -2285.22 |
| | Min. H _x | 6 | 12820.15 | -2227.99 | 999.92 |
| | Min. H _z | 13 | -15911.47 | 1977.51 | -2285.22 |
| Leg A | Max. Vert | 16 | 19017.48 | 2045.61 | 2912.90 |
| | Max. H _x | 14 | 13949.07 | 2287.42 | 1320.18 |
| | Max. H _z | 2 | 13949.24 | 687.34 | 2919.64 |
| | Min. Vert | 9 | -15813.24 | -1842.09 | -2621.88 |
| | Min. H _x | 7 | -10846.35 | -2050.71 | -1113.50 |
| | Min. H _z | 9 | -15813.24 | -1842.09 | -2621.88 |

Tower Mast Reaction Summary



Hudson Design Group LLC
 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
 Phone: (978) 557-5553
 FAX: (978) 336-5586

| | | | |
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| Load Combination | Vertical lb | Shear _x lb | Shear _z lb | Overturning Moment, M _x lb-ft | Overturning Moment, M _z lb-ft | Torque lb-ft |
|--|----------------|--------------------------|--------------------------|---|---|-----------------|
| Dead Only | 6109.70 | 0.00 | 0.00 | 4627.31 | 4206.43 | 0.00 |
| 1.2 Dead+1.6 Wind 0 deg - No Ice | 7331.64 | -566.56 | -10015.85 | -185397.76 | 8462.86 | -8243.86 |
| 0.9 Dead+1.6 Wind 0 deg - No Ice | 5498.73 | -566.56 | -10015.85 | -186770.42 | 7199.84 | -8243.35 |
| 1.2 Dead+1.6 Wind 45 deg - No Ice | 7331.64 | 6935.72 | -6792.90 | -128342.28 | -129701.25 | 4362.11 |
| 0.9 Dead+1.6 Wind 45 deg - No Ice | 5498.73 | 6935.72 | -6792.90 | -129719.97 | -130952.55 | 4362.10 |
| 1.2 Dead+1.6 Wind 90 deg - No Ice | 7331.64 | 9968.76 | 686.13 | 9941.80 | -185738.44 | 11735.66 |
| 0.9 Dead+1.6 Wind 90 deg - No Ice | 5498.73 | 9968.76 | 686.13 | 8552.43 | -186984.81 | 11735.21 |
| 1.2 Dead+1.6 Wind 135 deg - No Ice | 7331.64 | 7330.20 | 7330.20 | 142880.60 | -132274.75 | 13073.43 |
| 0.9 Dead+1.6 Wind 135 deg - No Ice | 5498.73 | 7330.20 | 7330.20 | 141480.10 | -133525.43 | 13072.80 |
| 1.2 Dead+1.6 Wind 180 deg - No Ice | 7331.64 | 686.13 | 9968.76 | 196341.16 | 664.30 | 6891.32 |
| 0.9 Dead+1.6 Wind 180 deg - No Ice | 5498.73 | 686.13 | 9968.76 | 194936.40 | -597.54 | 6890.82 |
| 1.2 Dead+1.6 Wind 225 deg - No Ice | 7331.64 | -6792.90 | 6935.72 | 140303.99 | 138945.62 | -4362.22 |
| 0.9 Dead+1.6 Wind 225 deg - No Ice | 5498.73 | -6792.90 | 6935.72 | 138904.19 | 137672.06 | -4362.21 |
| 1.2 Dead+1.6 Wind 270 deg - No Ice | 7331.64 | -10015.85 | -566.56 | 2143.00 | 196000.74 | -10383.15 |
| 0.9 Dead+1.6 Wind 270 deg - No Ice | 5498.73 | -10015.85 | -566.56 | 754.86 | 194722.21 | -10382.70 |
| 1.2 Dead+1.6 Wind 315 deg - No Ice | 7331.64 | -7411.58 | -7411.58 | -132174.23 | 142780.08 | -13073.28 |
| 0.9 Dead+1.6 Wind 315 deg - No Ice | 5498.73 | -7411.58 | -7411.58 | -133551.15 | 141505.83 | -13072.65 |
| 1.2 Dead+1.0 Ice+1.0 Temp | 26803.11 | 0.00 | 0.00 | 17212.59 | 13305.28 | -0.00 |
| 1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp | 26803.11 | -64.11 | -1888.83 | -18373.83 | 13691.71 | -1501.97 |
| 1.2 Dead+1.0 Wind 45 deg+1.0 Ice+1.0 Temp | 26803.11 | 1363.19 | -1347.10 | -8372.30 | -12375.67 | 558.36 |
| 1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp | 26803.11 | 1884.81 | 80.43 | 17728.80 | -22271.86 | 1989.67 |
| 1.2 Dead+1.0 Wind 135 deg+1.0 Ice+1.0 Temp | 26803.11 | 1410.01 | 1410.01 | 43233.05 | -12694.29 | 2340.85 |
| 1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp | 26803.11 | 80.43 | 1884.81 | 52836.64 | 12800.69 | 1341.57 |
| 1.2 Dead+1.0 Wind 225 deg+1.0 Ice+1.0 Temp | 26803.11 | -1347.10 | 1363.19 | 42930.89 | 38927.06 | -558.65 |
| 1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp | 26803.11 | -1888.83 | -64.11 | 16838.23 | 48938.31 | -1829.19 |
| 1.2 Dead+1.0 Wind 315 deg+1.0 Ice+1.0 Temp | 26803.11 | -1418.27 | -1418.27 | -8825.64 | 39364.44 | -2340.79 |
| Dead+Wind 0 deg - Service | 6109.70 | -127.48 | -2253.57 | -38329.58 | 4974.45 | -1854.79 |
| Dead+Wind 45 deg - Service | 6109.70 | 1560.54 | -1528.40 | -25494.31 | -26107.13 | 981.47 |
| Dead+Wind 90 deg - Service | 6109.70 | 2242.97 | 154.38 | 5614.36 | -38713.44 | 2640.52 |
| Dead+Wind 135 deg - Service | 6109.70 | 1649.29 | 1649.29 | 35521.19 | -26687.08 | 2941.52 |
| Dead+Wind 180 deg - Service | 6109.70 | 154.38 | 2242.97 | 47549.34 | 3220.76 | 1550.72 |
| Dead+Wind 225 deg - Service | 6109.70 | -1528.40 | 1560.54 | 34943.32 | 34330.42 | -981.76 |
| Dead+Wind 270 deg - Service | 6109.70 | -2253.57 | -127.48 | 3860.74 | 47165.44 | -2336.42 |
| Dead+Wind 315 deg - Service | 6109.70 | -1667.60 | -1667.60 | -26357.21 | 35191.31 | -2941.51 |



Hudson Design Group LLC
 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
 Phone: (978) 557-5553
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| | | | |
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Solution Summary

| Load Comb. | Sum of Applied Forces | | | Sum of Reactions | | | % Error |
|------------|-----------------------|-----------|-----------|------------------|----------|----------|---------|
| | PX lb | PY lb | PZ lb | PX lb | PY lb | PZ lb | |
| 1 | 0.00 | -6109.70 | 0.00 | 0.00 | 6109.70 | 0.00 | 0.000% |
| 2 | -566.56 | -7331.64 | -10015.85 | 566.56 | 7331.64 | 10015.85 | 0.000% |
| 3 | -566.56 | -5498.73 | -10015.85 | 566.56 | 5498.73 | 10015.85 | 0.000% |
| 4 | 6935.72 | -7331.64 | -6792.90 | -6935.72 | 7331.64 | 6792.90 | 0.000% |
| 5 | 6935.72 | -5498.73 | -6792.90 | -6935.72 | 5498.73 | 6792.90 | 0.000% |
| 6 | 9968.76 | -7331.64 | 686.13 | -9968.76 | 7331.64 | -686.13 | 0.000% |
| 7 | 9968.76 | -5498.73 | 686.13 | -9968.76 | 5498.73 | -686.13 | 0.000% |
| 8 | 7330.20 | -7331.64 | 7330.20 | -7330.20 | 7331.64 | -7330.20 | 0.000% |
| 9 | 7330.20 | -5498.73 | 7330.20 | -7330.20 | 5498.73 | -7330.20 | 0.000% |
| 10 | 686.13 | -7331.64 | 9968.76 | -686.13 | 7331.64 | -9968.76 | 0.000% |
| 11 | 686.13 | -5498.73 | 9968.76 | -686.13 | 5498.73 | -9968.76 | 0.000% |
| 12 | -6792.90 | -7331.64 | 6935.72 | 6792.90 | 7331.64 | -6935.72 | 0.000% |
| 13 | -6792.90 | -5498.73 | 6935.72 | 6792.90 | 5498.73 | -6935.72 | 0.000% |
| 14 | -10015.85 | -7331.64 | -566.56 | 10015.85 | 7331.64 | 566.56 | 0.000% |
| 15 | -10015.85 | -5498.73 | -566.56 | 10015.85 | 5498.73 | 566.56 | 0.000% |
| 16 | -7411.58 | -7331.64 | -7411.58 | 7411.58 | 7331.64 | 7411.58 | 0.000% |
| 17 | -7411.58 | -5498.73 | -7411.58 | 7411.58 | 5498.73 | 7411.58 | 0.000% |
| 18 | 0.00 | -26803.11 | 0.00 | 0.00 | 26803.11 | 0.00 | 0.000% |
| 19 | -64.11 | -26803.11 | -1888.83 | 64.11 | 26803.11 | 1888.83 | 0.000% |
| 20 | 1363.19 | -26803.11 | -1347.10 | -1363.19 | 26803.11 | 1347.10 | 0.000% |
| 21 | 1884.81 | -26803.11 | 80.43 | -1884.81 | 26803.11 | -80.43 | 0.000% |
| 22 | 1410.01 | -26803.11 | 1410.01 | -1410.01 | 26803.11 | -1410.01 | 0.000% |
| 23 | 80.43 | -26803.11 | 1884.81 | -80.43 | 26803.11 | -1884.81 | 0.000% |
| 24 | -1347.10 | -26803.11 | 1363.19 | 1347.10 | 26803.11 | -1363.19 | 0.000% |
| 25 | -1888.83 | -26803.11 | -64.11 | 1888.83 | 26803.11 | 64.11 | 0.000% |
| 26 | -1418.27 | -26803.11 | -1418.27 | 1418.27 | 26803.11 | 1418.27 | 0.000% |
| 27 | -127.48 | -6109.70 | -2253.57 | 127.48 | 6109.70 | 2253.57 | 0.000% |
| 28 | 1560.54 | -6109.70 | -1528.40 | -1560.54 | 6109.70 | 1528.40 | 0.000% |
| 29 | 2242.97 | -6109.70 | 154.38 | -2242.97 | 6109.70 | -154.38 | 0.000% |
| 30 | 1649.29 | -6109.70 | 1649.29 | -1649.29 | 6109.70 | -1649.29 | 0.000% |
| 31 | 154.38 | -6109.70 | 2242.97 | -154.38 | 6109.70 | -2242.97 | 0.000% |
| 32 | -1528.40 | -6109.70 | 1560.54 | 1528.40 | 6109.70 | -1560.54 | 0.000% |
| 33 | -2253.57 | -6109.70 | -127.48 | 2253.57 | 6109.70 | 127.48 | 0.000% |
| 34 | -1667.60 | -6109.70 | -1667.60 | 1667.60 | 6109.70 | 1667.60 | 0.000% |

Maximum Tower Deflections - Service Wind

| Section No. | Elevation ft | Horz. Deflection in | Gov. Load Comb. | Tilt ° | Twist ° |
|-------------|---------------|---------------------|-----------------|--------|---------|
| T1 | 181.375 - 176 | 0.038 | 32 | 0.0056 | 0.0050 |
| T2 | 176 - 171 | 0.028 | 32 | 0.0053 | 0.0038 |
| T3 | 171 - 166 | 0.019 | 32 | 0.0043 | 0.0028 |
| T4 | 166 - 161 | 0.012 | 32 | 0.0034 | 0.0019 |
| T5 | 161 - 156 | 0.005 | 34 | 0.0017 | 0.0009 |

Critical Deflections and Radius of Curvature - Service Wind



Hudson Design Group LLC
 1600 Osgood Street Bldg. 20N Suite 3090
 North Andover, MA 01845
 Phone: (978) 557-5553
 FAX: (978) 336-5586

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| Project | 25 ft Self Supporting Tower | Date | 14:05:38 01/06/17 |
| Client | AT&T | Designed by | kw |

| Elevation | Appurtenance | Gov. Load Comb. | Deflection in | Tilt ° | Twist ° | Radius of Curvature ft |
|-----------|-----------------------------|-----------------|---------------|--------|---------|------------------------|
| 181.00 | Powerwave 7770 w/mount pipe | 32 | 0.037 | 0.0056 | 0.0050 | Inf |
| 180.00 | PiROD 14' T-Frame | 32 | 0.035 | 0.0056 | 0.0047 | Inf |
| 163.00 | P3F-52 | 34 | 0.008 | 0.0024 | 0.0013 | 191927 |
| 162.00 | UHX6-59 | 34 | 0.006 | 0.0021 | 0.0011 | 127789 |

Section Capacity Table

| Section No. | Elevation ft | Component Type | Size | Critical Element | P lb | ϕP_{allow} lb | % Capacity | Pass Fail | |
|-------------|---------------|----------------|--------------------|------------------|-----------|---------------------|--------------------|-------------|-------------|
| T1 | 181.375 - 176 | Leg | P4x.237 | 1 | -6550.70 | 127004.00 | 5.2 | Pass | |
| T2 | 176 - 171 | Leg | P4x.237 | 27 | -6989.15 | 127250.00 | 5.5 | Pass | |
| T3 | 171 - 166 | Leg | P4x.237 | 47 | -7056.12 | 127250.00 | 5.5 | Pass | |
| T4 | 166 - 161 | Leg | P4x.237 | 59 | -13395.50 | 127250.00 | 10.5 | Pass | |
| T5 | 161 - 156 | Leg | P4x.237 | 85 | -13464.10 | 127250.00 | 10.6 | Pass | |
| T1 | 181.375 - 176 | Diagonal | P1.5x.145 | 19 | -2718.98 | 12921.10 | 21.0 | Pass | |
| T2 | 176 - 171 | Diagonal | P1.5x.145 | 32 | -3597.68 | 13052.90 | 27.6 | Pass | |
| T3 | 171 - 166 | Diagonal | P1.5x.145 | 58 | -3571.31 | 13052.90 | 27.4 | Pass | |
| T4 | 166 - 161 | Diagonal | P1.5x.145 | 70 | -4079.20 | 13052.90 | 31.3 | Pass | |
| T5 | 161 - 156 | Diagonal | P1.5x.145 | 90 | -4736.24 | 13052.90 | 36.3 | Pass | |
| T1 | 181.375 - 176 | Top Girt | L1 3/4x1 3/4x3/16 | 5 | -1665.64 | 8725.51 | 19.1 | Pass | |
| T3 | 171 - 166 | Top Girt | 2L1 3/4x1 3/4x3/16 | 37 | -26.97 | 23123.10 | 0.4 | Pass | |
| T4 | 166 - 161 | Top Girt | 2L1 3/4x1 3/4x3/16 | 67 | -850.72 | 12307.30 | 6.9 | Pass | |
| T5 | 161 - 156 | Top Girt | 2L1 3/4x1 3/4x3/16 | 72 | -407.60 | 23123.10 | 1.8 | Pass | |
| T1 | 181.375 - 176 | Bottom Girt | L1 3/4x1 3/4x3/16 | 16 | -215.95 | 3180.32 | 6.8 | Pass | |
| T1 | 181.375 - 176 | Inner Bracing | L1 3/4x1 3/4x3/16 | 13 | 180.16 | 20123.40 | 1.5 | Pass | |
| T2 | 176 - 171 | Inner Bracing | L1 3/4x1 3/4x3/16 | 44 | 0.27 | 20123.40 | 0.7 | Pass | |
| T4 | 166 - 161 | Inner Bracing | L1 3/4x1 3/4x3/16 | 82 | 0.89 | 20123.40 | 0.7 | Pass | |
| | | | | | | | Summary | | |
| | | | | | | | Leg (T5) | 10.6 | Pass |
| | | | | | | | Diagonal (T5) | 36.3 | Pass |
| | | | | | | | Top Girt (T1) | 19.1 | Pass |
| | | | | | | | Bottom Girt (T1) | 6.8 | Pass |
| | | | | | | | Inner Bracing (T1) | 1.5 | Pass |
| | | | | | | | Bracing (T1) | | |
| | | | | | | | RATING = | 36.3 | Pass |