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COUNTY FACILITIES PLANNING
WORK INITIATION REQUEST FORM

Please complete a form for each new proposal review request.

Work Proposal Name:
US Cellular Lease Amendment

Date of Request:
2/20/20

Requesting Department:
DAS-ED

Department Contact Name:
Adam Stehly

High Org: 1191 **Low Org:** 115

Approval Signature of Department Head:

DESCRIPTION

Please provide a detailed description of the request:

US Cellular is requesting the right to place additional equipment on the east watertower at County Grounds. This change requires an amendment to the existing lease. Commencing July 1, 2020, annual rent will increase from $51,542 to $65,744 (approximately 25.5% increase) with annual 3% escalations thereafter. The amendment also extends the current term to July 1, 2026 with two additional five-year options to extend.

How will this proposal improve your operations, enhance customer service or otherwise benefit your department and the County?

This amendment increases revenue by approximately $14,200 annually and $91,864 in aggregate through the proposed term.

Desired Timeline:

Begin Date:

End Date:

Duration:

Anticipated Funding Source *(check all that apply and include amount allocated under each category)*:

Operating Budget:

Capital Budget:

Other *(i.e. grants, donations, etc.; please describe)*:

Request Involves:

Parks Property **BHD Property**

COUNTY FACILITIES PLANNING
WORK INITIATION REQUEST DETERMINATION

CFPSC ACTION

FOR CFPSC USE ONLY

CFPSC Project Tracking #:

2020-004

TYPE OF REQUEST (Refer to paragraph 4.3 of the CFPSC charter for more details)

- ✔ **1. Property Management**
- ☐ **2. Move Management**
- ☐ **3. Property Improvements**
- ☐ **4. New Footprint**
- ☐ **5. Contractural Obligations**
- ☐ **6. Centralized Facilities Management Process Improvement**

CFPSC Review Comments:

FOR EASEMENTS ONLY

Reviewed & Recommended for Approval:

DAS — FM, AE&ES (Legal Description)

Director, DAS

Corporation Counsel

Note:
1. Easements affecting lands zoned "Parks" require County Board approval.
2. Forward a copy of the recorded easement to AE&ES.

CFPSC RECOMMENDATION

The County Facilities Planning Steering Committee reviewed this proposal on ______. As evidenced by the authorized signature below, the County Facilities Planning Steering Committee recommends approval of this proposal.

Chair or Vice-Chair:

Date:

County Facilities Planning Steering Committee

Amendment IV

This Amendment IV (this "Amendment"), dated this ____ day of ________________________, 2020 ("Effective Date"), is made to the Milwaukee County Wireless Communication Facility Lease Agreement dated June 6, 2001 as amended by Amendment I dated August 24, 2011, Amendment II dated November 26, 2014 and Amendment III dated March 29, 2016 (collectively, the "Agreement") by and between **UNITED STATES CELLULAR OPERATING COMPANY LLC**, a Delaware limited liability company ("Lessee"), and **MILWAUKEE COUNTY**, a municipal corporation ("Lessor"), with respect to the site known as County Grounds-East Watertower located at 9250 Watertown Plank Road, City of Wauwatosa, County of Milwaukee, Wisconsin 53226 ("Premises").

Lessor's managing agent with respect to the Agreement is SBA Site Management, LLC ("SBAM"), a Florida limited liability company, having an address at 900 South Highway Drive, Suite 201, Fenton, Missouri 63026.

Lessee and Lessor desire to amend the Agreement for the purpose of adding and/or modifying equipment at the Premises as further described herein ("Additional Equipment"), extending the term of the Agreement and for other purposes as may be set forth in this Amendment.

In consideration of the foregoing and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, Lessee and Lessor agree as follows:

1. Capitalized Terms. Capitalized terms used in this Amendment will have the meanings set forth in the Agreement unless otherwise indicated.

2. Equipment. Notwithstanding anything to the contrary in the Agreement, from and after the Effective Date of this Amendment, Exhibit B-3 to the Agreement is deleted in its entirety and superseded and replaced with Exhibit B-4 attached hereto.

3. Rent. Beginning upon the earlier of the first full month after the commencement of the installation of the Additional Equipment on the Premises or June 1, 2020, Lessee will pay an increase in Rent of Fifteen Thousand Seven Hundred Eighty and No/100 Dollars ($15,780.00) a year pro-rated for any partial year. The increased Rent amount shall be subject to the same escalations, in amount and frequency, to which the rent is subject in accordance with the Agreement. Payments under this Paragraph 3 shall be in addition to any other amounts required under the Agreement.

4. Term. Notwithstanding anything to the contrary in the Agreement, upon the expiration of the Renewal Term of the Agreement on June 30, 2026 and provided that, (i) Lessee is not in default hereunder and (ii) this Agreement has not been terminated, this Agreement shall automatically renew under the same terms and conditions for two (2) additional five (5) year terms, subject to the increase in the Rent provided in Section V. c) to the Agreement, unless Lessee provides Lessor with notice of its intent not to renew at least 120 days before the end of the then current term.

5. Escalation. Notwithstanding anything to the contrary in the Agreement, upon the Effective Date of this Amendment, Section V. c) to the Agreement is hereby deleted and superseded and replaced with the following:

The Rental amount shall automatically increase annually by three percent (3%) over the preceding year's fee.

6. Confirmation. Except as expressly amended by this Amendment, the Agreement shall remain in full force and effect without modification or amendment. This Amendment will form a part of the Agreement for all purposes and the Agreement and this Amendment will hereafter be read together. In case of any inconsistencies between the terms and conditions of the Agreement and the terms and conditions of this Amendment, the terms and conditions of this Amendment will control.

7. Counterparts. This Amendment may be executed in counterparts, each of which shall be deemed an original, but all of which taken together shall constitute but one and the same instrument.

[The next page is the signature page to this Amendment]

IN WITNESS WHEREOF, the parties have executed this Amendment as of the Effective Date.

COUNTY OF MILWAUKEE, through the Department of Administration

By: ______________________________

Name: Aaron Hertzberg

Title: Director, Economic Development

Date: ______________________________

UNITED STATES CELLULAR OPERATING COMPANY LLC

By: ______________________________

Name: ______________________________

Title: ______________________________

Date: ______________________________

[Signature page to this Amendment]

Approved with regards to County Ordinance Chapter 42:

By: ____________________ Date: _______
Community Business Development Partners

Reviewed by:

By: ____________________ Date: _______
Risk Management

Approved for execution:

By: ____________________ Date: _______
Corporation Counsel

Approved:

By: ____________________ Date: _______
Comptroller

Approved:

By: ____________________ Date: _______
County Executive

Approved as to Wis. Stats. 59.42:

By: ____________________ Date: _______
Corporation Counsel

[Signature page to this Amendment]

Exhibit B-4

Equipment

Note: Any Equipment of Lessee not listed on Exhibit B-4 may not be installed by Lessee, unless the Agreement provides otherwise.

Antennas: Total Twelve (12)
Quantity: Three (3)
Type: Panel
Manufacturer: Amphenol Antel
Model: BXA-70063-8CF-EDIN-X
Dimensions: 94.7"x11.2"x5.2"
Weight: 24 lbs.
Mounting: 73'

Quantity: Six (6)
Type: Panel
Manufacturer: Amphenol
Model: TWIN658LU000G
Dimensions: 95.8"x26"x8.4"
Weight: 70 lbs.
Mounting: 73'

Quantity: Three (3)
Type: Other
Manufacturer: Ericsson
Model:
Dimensions: 7.9"x7.9"x3.9"
Weight: 9.9 lbs.
Mounting: 73'

Cables: Total Nine (9)
Number of Lines: Six (6)
Type: Coax
Size: 7/8"

Number of Lines: Three (3)
Type: Hybrid
Size: 1 1/4"

Mounts: Total Three (3)
Quantity: Three (3)
Type: Sabre
Manufacturer: Sabre
Model: C10857111
Dimensions: 12'x3'
Weight: 523 lbs.
Mounting: 73'

Surge Suppressors: Total Three (3)
Quantity: Three (3)
Manufacturer: Raycap
Model: RUSDC-6267-PF-48
Dimensions: 18.85"x16.1"x5.83"
Weight: 19.95 lbs.
Mounting: 73'

Remote Radio Units: Total Nine (9)
Quantity: Three (3)
Manufacturer: Ericsson
Model: RRU 11
Dimensions: 24"x18"x9"
Weight: 44 lbs.
Mounting: 73'

Quantity: Three (3)
Manufacturer: Ericsson
Model: 4449 B71 + B12
Dimensions: 13.1"x14.9"x9.2"
Weight: 74 lbs.
Mounting: 73'

Quantity: Three (3)
Manufacturer: Ericsson
Model: 8843
Dimensions: 15"x13.2"x11.1"
Weight: 75 lbs.
Mounting: 73'

Ground Space Requirements:
Square Feet: 240
Tenant Provided Shelter:
Dimensions: 12' x 20'
Shelter Type: Shelter

Frequencies:
Transmit: 642-652, 728-740, 824-835, 1930-1935, 2155-2160, 5160-5875 MHz
Receive: 688-698, 698-710, 869-880, 1755-1760, 1850-1855 MHz

COUNTY GROUNDS WT

9250 W. Watertown Plank Rd

Wauwatosa, Wisconsin

STRUCTURAL ANALYSIS REPORT FOR US CELLULAR (784454)

October 31, 2019

KOA PROJECT NO.: 192080.04

EDGE CONSULTING PROJECT NO: 21284

PREPARED BY:

KRECH OJARD & ASSOCIATES, INC.

101 PUTNAM ST.

EAU CLAIRE, WI 54703

715-552-7374

PROFESSIONAL SEAL:

WISCONSIN

SARAH M. BROST

E-42411

EAU CLAIRE

WI

PROFESSIONAL ENGINEER

Sarah M. Brost

11.4.2019

Krech Ojard & Associates
101 Putnam St.
Eau Claire, WI
715-552-7374

Site Name: County Grounds WT
Site Number: 784454
Edge Project Number: 21284
Date: 11.4.2019

US CELLULAR ANTENNA SUPPORT FRAME RESULTS SUMMARY:

US Cellular is proposing to install new antennas and equipment at County Grounds water tower site. The proposed antennas and equipment are listed below. Each proposed antenna will be mounted to a 2-7/8" sch. 40 x 10'-0" long mounting pipe attached to (3) welded plate brackets. The brackets/mounts are shown on Edge Consulting drawings S501. The proposed mounts were determined to be adequate for the US Cellular antenna and equipment loading.

The existing and proposed equipment will be mounted to the inside of the tank with a 2-3/8" OD, Sch 40 x 8'-0" pipe. The pipe will be secured to the inside tank shell with 3/8" x 6-1/2" x 4" shear tabs spaced 48" oc vertically. Provide 3/16" fillet welds. The proposed interior mounts were determined to be adequate for the US Cellular equipment loading.

<u>Existing US Cellular Antenna and Equipment to be removed (RAD = 73')</u>

(3) Kathrein 800 10766 Antennas
(3) RRUS11

<u>Existing US Cellular Antenna and Equipment to remain (RAD = 73')</u>

(3) BXA-70063-8CF-EDIN
(3) RRUS11
(9) Sector Mounts

<u>Proposed US Cellular Antenna and Equipment (RAD = 73')</u>

(3) RRU2205 with Built-in Directional Antenna
(6) Amphenol TWIN658L000G Antenna
(3) RRU 4449
(3) RRU 8843
(3) RRU11
(RUSDC-6267-PF-48 Raycap
(6) Sector Mounts

<u>Existing Other Carrier Equipment to remain:</u>

Existing T-Mobile Antennas (RAD = 105')
- (9) 48"x7"x3" Antennas
- (6) 6"x6"x3" TMA's
- (3) Sector Frames

Existing AT&T Antennas on handrail (RAD = 183')
- (3) Commscope DCBLH-8585A B2M Antennas
- (9) Commscope SBNHH-1D65B Antennas
- (3) DC6-48-60-18 Raycpas
- (9) RRUS32
- (3) RRUS12
- (3) RRUs11
- (6) 14"x12"x3.5" Diplexers
- (6) Andrew CBC819-DF Diplexers

Existing Other Carrier on handrail (RAD = 194')
- (1) 60" x 1" OMNI

<u>Referenced Documents:</u>

Edge Consulting Tower Inventory dated 3/12/2019
Edge Consulting Mapping dated 2/26/2019
Original tank drawings dated 2/1979
Edge Consulting Drawings for US Cellular installation dated 10/15/2019
Edge Consulting Drawings for US Cellular installation dated 12/10/2015

WATER TANK ANALYSIS RESULTS SUMMARY:

The water tower has been analyzed for the original and proposed new antenna loading. The new antenna layout will increase the tanks overturning from the previous antenna arrangement by approximately 1.48%. The total increase in overturning from the tank's original design is approximately 14%.

The anchor bolts are stressed at approximately 92% of their allowable steel tensile capacity.

The water tower is capable of safely resisting the resultant forces from increased overturning.

ASSUMPTIONS:

- Any reinforcement or modifications are assumed to be fully installed and functional.

- All welds are assumed to have been performed to current welding standards and are assumed to develop their full capacity and to be in good condition. All bolts and bolt-like anchors are assumed to be fully tightened, fastened or bonded to the manufacturers' specifications and are assumed to have full capacity.

- Soil conditions and foundations are not considered unless specified in the analysis and have no deterioration or defects.

- The information provided to Krech Ojard & Associates for analysis is assumed accurate and up to date. This report is considered void if the listed information or assumptions stated herein is inaccurate.

- The tower is assumed to be properly maintained and monitored and this analysis can not be considered to be a condition assessment of the tower. No accommodations are taken for damaged, rusted, deteriorated, or otherwise compromised member conditions.

Site Name: County Grounds WT

DESIGN CRITERIA

Where the local jurisdiction adopted building code makes reference to additional technical standards, we have used the more current and updated versions of the subsidiary standards where appropriate.

1. Referenced Building Codes:

-2015 International Building Code (IBC)
-AWWA-D100-11

Wind Loading on Tank, per AWWA

Ultimate Wind Speed per IBC: $V_{ult} := 120 \ MPH$

Nominal wind speed Conversion: $V_{nom} := V_{ult} \cdot \sqrt{.6} = 92.952 \quad MPH$

Exposure C

Risk Category: IV

Gust Factor $G := 1.0$ (Per AWWA 3.1.4)

Importance Factor $I := 1.15$ (Per AWWA 3.1.4)

Force Coefficient (Per AWWA Table 2) $C_{f1} := 1.0$ (Flat) $C_{f2} := 0.6$ (round) $C_{f3} := 0.5$ (Spherical)

At Height 0' - 50'

Velocity Pressure Coefficient $K_{z1} := 1.09$ (Per AWWA Table 3)

$q_{z1} := .00256 \cdot K_{z1} \cdot I \cdot \left(V_{nom}^{2}\right) = 27.725 \quad psf$ (Per AWWA Eq 3- 2)

$P_{wl1} := q_{z1} \cdot G \cdot C_{f2} = 16.635 \, psf$ $\qquad P_{wmin1} := 30 \cdot C_{f2} = 18 \, psf$

$P_{w1} := 18 \ \boldsymbol{psf}$

At Height 51' - 100'

Velocity Pressure Coefficient $K_{z2} := 1.27$ (Per AWWA Table 3)

$q_{z2} := .00256 \cdot K_{z2} \cdot I \cdot \left(V_{nom}^{2}\right) = 32.304 \quad psf$ (Per AWWA Eq 3- 2)

$P_{w12} := q_{z2} \cdot G \cdot C_{f2} = 19.382 \quad psf$ $\qquad P_{wmin2} := 30 \cdot C_{f2} = 18 \quad psf$

$P_{w2} := 19.382 \ \boldsymbol{psf}$

At Height 101' - 150'

Velocity Pressure Coefficient $K_{z3} := 1.38$ (Per AWWA Table 3)

$q_{z3} := .00256 \cdot K_{z3} \cdot I \cdot \left(V_{nom}^{2}\right) = 35.102 \quad psf$ (Per AWWA Eq 3- 2)

$P_{w13} := q_{z3} \cdot G \cdot C_{f2} = 21.061 \quad psf$ $\qquad P_{wmin3} := 30 \cdot C_{f2} = 18 \quad psf$

$P_{w3} := 21.06 \ \boldsymbol{psf}$

At Height 151' - 200'

Velocity Pressure Coefficient $K_{z4} := 1.46$ (Per AWWA Table 3)

$q_{z4} := .00256 \cdot K_{z4} \cdot I \cdot \left(V_{nom}^{\ 2}\right) = 37.137 \quad psf$ (Per AWWA Eq 3- 2)

$P_{w14} := q_{z4} \cdot G \cdot C_{f2} = 22.282 \quad psf$ $P_{wmin4} := 30 \cdot C_{f2} = 18 \quad psf$

$P_{w4} := 22.3 \ \boldsymbol{psf}$

Reservoir Wind Load:

Velocity Pressure Coefficient $K_{z5} := 1.38$ (Per AWWA Table 3)

$q_{z5} := .00256 \cdot K_{z5} \cdot I \cdot \left(V_{nom}^{\ 2}\right) = 35.102 \quad psf$ (Per AWWA Eq 3- 2)

$P_{w15} := q_{z5} \cdot G \cdot C_{f3} = 17.551 \quad psf$ $P_{wmin5} := 30 \cdot C_{f3} = 15 \quad psf$

$P_{w5} := 17.551 \ \boldsymbol{psf}$

Design Load Combinations:

Baisc Load Combinations (AWWA D100-11 w/ ASCE 7-05):

1. DL
2. Dl + LL + 0.7Ice
3. DL + 0.7Ice + 0.7Wice + SL
4. DL + WL
5. DL + 0.75WL + 0.75LL + 0.75SL
6. 0.6DL + WL
7. 0.6DL + 0.7Ice + 0.7Wice
8. DL + WL (Tank Stability Against Overturning: AWWA Requirement)

1. Referenced Standard for Antenna Supporting Structures & Antennas:

- TIA-222-H & ASCE 7-16

Wind Loading on Antennas & Antenna Supports :

Basic Wind Speed per TIA: $V_{ult} := 107 \quad MPH$ (From TIA Annex B or ASCE 7-16. Includes factor for Risk Category)

Exposure C

Risk Category: II (Risk category for Mount)

Gust Factor $G := 1.0$ (Per TIA 16.6 Use 1.0 gust factor)

Wind Direction Probability Factor: $K_d := 0.95$ (Table 2-2 TIA-222-H)

Topographic Factor: $K_{zt} := 1.0$

Ground Elevation Factor: $K_e := 1.0$

Rooftop Speed up Factor: $K_s := 1.0$

Sheilding Factor: $K_a := 1.0$ (TIA section 16.6; Ka may be taken as 0.9 for appurtenances and mounting system)

Basic Wind Speed per TIA: $V := 60 \quad MPH$ (From TIA Annex 2.8.3)

Design Ice Thickness on Antennas & Antenna Supports:

$t_i := 1.5 \ \boldsymbol{in}$ (TIA Annex B Figure B-9)

Wind speed (with ice) $V_i := 40 \quad MPH$ (TIA Annex B Figure B-9)

Ice Importance Factor: $I_i := 1.0$ (TIA Table 2-3)

Service & Maintenance Basic Wind Speed per TIA (WLm): $V := 60$ MPH (From TIA Annex 2.8.3)

Note: Wind speed used in conjunction with maintenance Loads below is 30 MPH. Conservatively use 60 MPH.

Design Load Combinations For Antennas & Antenna supports Per TIA-222-H:

Basic Strength Limit States Load Combinations:

1. 1.2 DL + 1.0WL
2. 0.9DL+1.0WL
3. 1.2DL+1.0Ice+1.0Wice

Service Load Combinations:

1. 1.0 DL + 1.0 WLm (w/ 60 MPH Wind speed)

Additional Mounting System Strength combinations per TIA 16.4.2:

Lm = 500 lb maintenance load on mounting pipe
Lv = 250 lb maintenance load on horizontal members

1. 1.4 DL
2. 1.2DL + 1.5Lm + 1.0WLm
3. 1.2DL + 1.5Lv

<u>ANTENNA & EQUIPMENT LOADS FOR MOUNT ANALYSIS</u>:

NEW ANTENNA & EQUIPMENT LOADS:

Reference TIA-222-H

Wind Loading on Antennas & Antenna Supports :

Basic Wind Speed per TIA: $V_{ult} := 107$ *MPH* (From TIA Annex B or ASCE 7-16. Includes factor for Risk Category)

Exposure C

Risk Category: II (Risk category for Mount)

Gust Factor $G := 1.0$ (Per TIA 16.6 Use 1.0 gust factor)

Wind Direction Probability Factor: $K_d := 0.95$ (Table 2-2 TIA-222-H)

Topographic Factor: $K_{zt} := 1.0$

Ground Elevation Factor: $K_e := 1.0$

Rooftop Speed up Factor: $K_s := 1.0$

Sheilding Factor: $K_a := 0.9$ (TIA section 16.6; Ka may be taken as 0.9 for appurtenances and mounting system. Use. Ka 1.0 on appurtenances and systems for tank anlaysis.)

Design Ice Thickness on Antennas & Antenna Supports:

$t_i := 1.5$ ***in*** (TIA Annex B Figure B-9)

Wind speed (with ice) $V_i := 40$ *MPH* (TIA Annex B Figure B-9)

Ice Importance Factor: $I_i := 1.0$ (TIA Table 2-3)

Service Load Combinations:

1.0 DL + 1.0 WL (w/ 60 MPH Wind speed)

Basic Wind Speed per TIA: $V := 60$ *MPH* (From TIA Annex 2.8.3)

Proposed Amphenol TWIN658LU000G Antenna (Total 6)

Dimensions : $h := 96 \cdot in$ $w := 26 \cdot in$ $d := 8.5 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

Member Type		Aspect Ratio ≤ 2.5 C_a	Aspect Ratio = 7 C_a	Aspect Ratio ≥ 25 C_a
Flat		1.2	1.4	2.0
Square & Rectangular HSS		1.2 - 2.8(r_s) ≥ 0.85	1.4 - 4.0(r_s) ≥ 0.90	2.0 - 6.0(r_s) ≥ 1.25
Round	C < 39 [5.3] (Subcritical)	0.70	0.80	1.2
	39 ≤ C ≤ 78 [5.3 ≤ C ≤ 10.6] (Transitional)	4.14/(C)^0.485 [1.57/(C)^0.485]	3.66/(C)^0.415 [1.60/(C)^0.415]	46.8/(C)^1.0 [6.36/(C)^1.0]
	C > 78 [10.6] (Supercritical)	0.50	0.60	0.60

$$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$$

$$C := (K_{zt} \cdot K_z \cdot K_e)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 80.432\ ft$$

Aspect Ratio: $A_1 := \frac{h}{w} = 3.692$

Force Coefficient $C_a := 1.3$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 32.981\ psf$$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 10.37\ psf$ $q_{za} := 10\ psf$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 22.533\ ft^2 F_A := q_z \cdot G \cdot EPA \cdot K_a = 668.849\ lbf$

Ice load : $K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083$ $D_{ci} := \sqrt{(w^2) + (d^2)} = 2.28\ ft$ $t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot (K_{zt})^{.35} \cdot 1\right) = 1.624\ in$

$A_{iz} := 3.14 \cdot t_{iz} \cdot (D_{ci} + t_{iz}) = 1.026\ ft^2$ $W_i := \left(56 \cdot \frac{lb}{ft^3}\right) \cdot (A_{iz}) \cdot \frac{h}{12 \cdot \frac{in}{ft}} = 459.714\ lb$

$$WL_{iz} := (A_{iz} + EPA) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 290.47\ lbf$$

Load Summary:

Ice Load, $W_i = 459.714\ lb$

Self Weight = 98 lbs

Wind Load on face of Antenna = $F_A = 668.849\ lbf$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 210.311\ lbf$

Wind on Ice = $WL_{iz} = 290.47\ lbf$

Proposed RRU 4449 (Total 3 Interior Mount)

Dimensions : $h := 17.9 \cdot in$ $w := 13.2 \cdot in$ $d := 10.5 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$ $C := (K_{zt} \cdot K_z \cdot K_e)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 17.986\ ft$ Aspect Ratio: $A_1 := \frac{h}{w} = 1.356$

Force Coefficient $C_a := 1.2$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 32.981\ psf$$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 10.37\ psf$ $q_{za} := 10\ psf$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 1.969\ ft^2$ $F_A := q_{za} \cdot G \cdot EPA \cdot K_a = 17.721\ lbf$

Ice load : $K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083$ $D_{ci} := \sqrt{(w^2) + (d^2)} = 1.406\ ft$ $t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot (K_{zt})^{.35} \cdot 1\right) = 1.624\ in$

$A_{iz} := 3.14 \cdot t_{iz} \cdot (D_{ci} + t_{iz}) = 0.655\ ft^2$ $W_i := \left(56 \cdot \frac{lb}{ft^3}\right) \cdot (A_{iz}) \cdot \frac{h}{12 \cdot \frac{in}{ft}} = 54.696\ lb$

$$WL_{iz} := (A_{iz} + EPA) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 32.349\ lbf$$

Load Summary:

Ice Load, $W_i = 54.696\ lb$

Self Weight = 70 lbs

Wind Load on face of Antenna = $F_A = 17.721\ lbf$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 18.377\ lbf$

Wind on Ice = $WL_{iz} = 32.349\ lbf$

Proposed Ericsson 8843 RRU (Total 3 Interior mount)

Proposed Ericsson 8843 RRU (Total 3 Interior mount)

Dimensions : $h := 15 \cdot in$ $w := 13.2 \cdot in$ $d := 11.1 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

Member Type		Aspect Ratio ≤ 2.5 C_a	Aspect Ratio = 7 C_a	Aspect Ratio ≥ 25 C_a
Flat		1.2	1.4	2.0
Square & Rectangular HSS		1.2 - 2.8(r_s) ≥ 0.85	1.4 - 4.0(r_s) ≥ 0.90	2.0 - 6.0(r_s) ≥ 1.25
Round	C < 39 [5.3] (Subcritical)	0.70	0.80	1.2
	39 ≤ C ≤ 78 [5.3 ≤ C ≤ 10.6] (Transitional)	$4.14/(C)^{0.485}$ [$1.57/(C)^{0.485}$]	$3.66/(C)^{0.415}$ [$1.60/(C)^{0.415}$]	$46.8/(C)^{1.0}$ [$6.36/(C)^{1.0}$]
	C > 78 [10.6] (Supercritical)	0.50	0.60	0.60

$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$

$C := (K_{zt} \cdot K_z \cdot K_e)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 16.159\ ft$

Aspect Ratio: $A_1 := \frac{h}{w} = 1.136$

Force Coefficient $C_a := 1.2$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 32.981\ psf$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 10.37\ psf$ $q_{za} := 10\ psf$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 1.65\ ft^2$ $F_A := q_{za} \cdot G \cdot EPA \cdot K_a = 14.85\ lbf$

Ice load : $K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083$ $D_{ci} := \sqrt{(w^2) + (d^2)} = 1.437\ ft$ $t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot (K_{zt})^{.35} \cdot 1\right) = 1.624\ in$

$A_{iz} := 3.14 \cdot t_{iz} \cdot (D_{ci} + t_{iz}) = 0.668\ ft^2$ $W_i := \left(56 \cdot \frac{lb}{ft^3}\right) \cdot (A_{iz}) \cdot \frac{h}{12 \cdot \frac{in}{ft}} = 46.776\ lb$

$WL_{iz} := (A_{iz} + EPA) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 28.582\ lbf$

Load Summary:

Ice Load, $W_i = 46.776\ lb$

Self Weight = 75 lbs

Wind Load on face of Antenna = $F_A = 14.85\ lbf$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 15.4\ lbf$

Wind on Ice = $WL_{iz} = 28.582\ lbf$

Proposed RRU11 (Total 3 Interior Mount)

Dimensions : $h := 19.7 \cdot in$ $w := 17 \cdot in$ $d := 7.2 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$ $C := (K_{zt} \cdot K_z \cdot K_e)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 21.043\ ft$ Aspect Ratio: $A_1 := \frac{h}{w} = 1.159$

Force Coefficient $C_a := 1.2$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 32.981\ psf$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ psf = 10.37\ psf$ $q_{za} := 10\ psf$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 2.791\ ft^2$ $F_A := q_{za} \cdot G \cdot EPA \cdot K_a = 25.118\ lbf$

Ice load : $K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083$ $D_{ci} := \sqrt{(w^2) + (d^2)} = 1.538\ ft$ $t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot (K_{zt})^{.35} \cdot 1\right) = 1.624\ in$

$A_{iz} := 3.14 \cdot t_{iz} \cdot (D_{ci} + t_{iz}) = 0.711\ ft^2$ $W_i := \left(56 \cdot \frac{lb}{ft^3}\right) \cdot (A_{iz}) \cdot \frac{h}{12 \cdot \frac{in}{ft}} = 65.389\ lb$

$WL_{iz} := (A_{iz} + EPA) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 43.178\ lbf$

Load Summary:

Ice Load, $W_i = 65.389\ lb$

Self Weight = 50.7 lbs

Wind Load on face of Antenna = $F_A = 25.118\ lbf$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 26.048\ lbf$

Wind on Ice = $WL_{iz} = 43.178\ lbf$

Proposed RUSDC-6267-PF-48 (Total 3 Interior Mount)

Dimensions : $h := 20.6 \cdot in$ $w := 18.9 \cdot in$ $d := 5.8 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

Member Type		Aspect Ratio ≤ 2.5	Aspect Ratio = 7	Aspect Ratio ≥ 25
		C_a	C_a	C_a
Flat		1.2	1.4	2.0
Square & Rectangular HSS		$1.2 - 2.8(r_s) \geq 0.85$	$1.4 - 4.0(r_s) \geq 0.90$	$2.0 - 6.0(r_s) \geq 1.25$
Round	C < 39 [5.3] (Subcritical)	0.70	0.80	1.2
	$39 \leq C \leq 78$ [$5.3 \leq C \leq 10.6$] (Transitional)	$4.14/(C)^{0.485}$ [$1.57/(C)^{0.485}$]	$3.66/(C)^{0.415}$ [$1.60/(C)^{0.415}$]	$46.8/(C)^{1.0}$ [$6.36/(C)^{1.0}$]
	C > 78 [10.6] (Supercritical)	0.50	0.60	0.60

$$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$$

$$C := \left(K_{zt} \cdot K_z \cdot K_e\right)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 22.608\ \boldsymbol{ft}$$

Aspect Ratio: $A_1 := \frac{h}{w} = 1.09$

Force Coefficient $C_a := 1.2$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^{\ 2} \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 32.981\ \boldsymbol{psf}$$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 10.37\ \boldsymbol{psf}$ $q_{za} := 10\ \boldsymbol{psf}$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 3.245\ \boldsymbol{ft}^2$ $F_A := q_{za} \cdot G \cdot EPA \cdot K_a = 29.201\ \boldsymbol{lbf}$

Ice load :

$$K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083 \qquad D_{ci} := \sqrt{\left(w^2\right) + \left(d^2\right)} = 1.647\ \boldsymbol{ft} \qquad t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot \left(K_{zt}\right)^{.35} \cdot 1\right) = 1.624\ \boldsymbol{in}$$

$$A_{iz} := 3.14 \cdot t_{iz} \cdot \left(D_{ci} + t_{iz}\right) = 0.758\ \boldsymbol{ft}^2 \qquad W_i := \left(56 \cdot \frac{\boldsymbol{lb}}{\boldsymbol{ft}^3}\right) \cdot \left(A_{iz}\right) \cdot \frac{h}{12 \cdot \frac{\boldsymbol{in}}{\boldsymbol{ft}}} = 72.829\ \boldsymbol{lb}$$

$$WL_{iz} := \left(A_{iz} + EPA\right) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 49.343\ \boldsymbol{lbf}$$

Load Summary:

Ice Load, $W_i = 72.829\ \boldsymbol{lb}$

Self Weight **=** 20 lbs

Wind Load on face of Antenna = $F_A = 29.201\ \boldsymbol{lbf}$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 30.282\ \boldsymbol{lbf}$

Wind on Ice = $WL_{iz} = 49.343\ \boldsymbol{lbf}$

Proposed Ericsson RRU 2205

Dimensions : $h := 8 \cdot in$ $w := 8 \cdot in$ $d := 5 \cdot in$ $RAD := 73$ ft Member Type: Flat

Wind Load :

$$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184 \qquad C := \left(K_{zt} \cdot K_z \cdot K_e\right)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 9.149\ \boldsymbol{ft}$$

Aspect Ratio: $A_1 := \frac{h}{w} = 1$

Force Coefficient $C_a := 1.2$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^{\ 2} \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 32.981\ \boldsymbol{psf}$$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 10.37\ \boldsymbol{psf}$ $q_{za} := 10\ \boldsymbol{psf}$ (Interior Mount)

$EPA := h \cdot w \cdot C_a = 0.533\ \boldsymbol{ft}^2$ $F_A := q_z \cdot G \cdot EPA \cdot K_a = 15.831\ \boldsymbol{lbf}$

Ice load :

$$K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083 \qquad D_{ci} := \sqrt{\left(w^2\right) + \left(d^2\right)} = 0.786\ \boldsymbol{ft} \qquad t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot \left(K_{zt}\right)^{.35} \cdot 1\right) = 1.624\ \boldsymbol{in}$$

$$A_{iz} := 3.14 \cdot t_{iz} \cdot \left(D_{ci} + t_{iz}\right) = 0.392\ \boldsymbol{ft}^2 \qquad W_i := \left(56 \cdot \frac{\boldsymbol{lb}}{\boldsymbol{ft}^3}\right) \cdot \left(A_{iz}\right) \cdot \frac{h}{12 \cdot \frac{\boldsymbol{in}}{\boldsymbol{ft}}} = 14.619\ \boldsymbol{lb}$$

$$WL_{iz} := \left(A_{iz} + EPA\right) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 11.403\ \boldsymbol{lbf}$$

Load Summary:

Ice Load, $W_i = 14.619\ \boldsymbol{lb}$

Self Weight **=** 13 lbs

Wind Load on face of Antenna = $F_A = 15.831\ \boldsymbol{lbf}$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 4.978\ \boldsymbol{lbf}$

Wind on Ice = $WL_{iz} = 11.403\ \boldsymbol{lbf}$

Existing BXA-70063-8CF-EDIN

Dimensions **:** $h := 94.7 \cdot \boldsymbol{in}$ $w := 11.2 \cdot \boldsymbol{in}$ $d := 5.2 \cdot \boldsymbol{in}$ $RAD := 73$ *ft* Member Type: Flat

Wind Load **:**

$$K_z := 2.01 \cdot \left(\left(\frac{RAD}{900}\right)^{\frac{2}{9.5}}\right) = 1.184 \qquad C := \left(K_{zt} \cdot K_z \cdot K_e\right)^{0.5} \cdot V_{ult} \cdot \left(\sqrt{\left(\frac{h}{12}\right)^2 + \left(\frac{w}{12}\right)^2}\right) = 77.117\ \boldsymbol{ft} \qquad \text{Aspect Ratio: } A_1 := \frac{h}{w} = 8.455$$

Force Coefficient $C_a := 1.4$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot {V_{ult}}^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 32.981\ \boldsymbol{psf}$$

Maintenance Wind Loading: $q_{zm} := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 10.37\ \boldsymbol{psf}$ $q_{za} := 10\ \boldsymbol{psf}$ (Interior Mount)

$$EPA := h \cdot w \cdot C_a = 10.312\ \boldsymbol{ft}^2 \qquad F_A := q_z \cdot G \cdot EPA \cdot K_a = 306.081\ \boldsymbol{lbf}$$

Ice load **:**

$$K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083 \qquad D_{ci} := \sqrt{\left(w^2\right) + \left(d^2\right)} = 1.029\ \boldsymbol{ft} \qquad t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot \left(K_{zt}\right)^{.35} \cdot 1\right) = 1.624\ \boldsymbol{in}$$

$$A_{iz} := 3.14 \cdot t_{iz} \cdot \left(D_{ci} + t_{iz}\right) = 0.495\ \boldsymbol{ft}^2 \qquad W_i := \left(56 \cdot \frac{\boldsymbol{lb}}{\boldsymbol{ft}^3}\right) \cdot \left(A_{iz}\right) \cdot \frac{h}{12 \cdot \frac{\boldsymbol{in}}{\boldsymbol{ft}}} = 218.656\ \boldsymbol{lb}$$

$$WL_{iz} := \left(A_{iz} + EPA\right) \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) \cdot G = 133.236\ \boldsymbol{lbf}$$

Load Summary:

Ice Load, $W_i = 218.656\ \boldsymbol{lb}$

Self Weight **=** 24 lbs

Wind Load on face of Antenna = $F_A = 306.081\ \boldsymbol{lbf}$

Maintenance Wind Load: $F_{Am} := q_{zm} \cdot G \cdot EPA \cdot K_a = 96.243\ \boldsymbol{lbf}$

Wind on Ice = $WL_{iz} = 133.236\ \boldsymbol{lbf}$

Loading on Tank Catwalks, Ladders, Handrail, etc:

Reference AWWA D100-11

Wind Loading on Tank, per AWWA

Ultimate Wind Speed per IBC: $V_{ult} := 120$ MPH

Nominal wind speed Conversion: $V_{nom} := V_{ult} \cdot \sqrt{.6} = 92.952$ MPH

Exposure C

Risk Category: IV

Gust Factor $G := 1.0$ (Per AWWA 3.1.4)

Importance Factor $I_w := 1.15$ (Per AWWA 3.1.4; included in conversation)

Topographic Factor: $K_{zt} := 1.0$

Design Ice Thickness:

$t_i := 0.75$ $\boldsymbol{in}$ (Per ASCE 7)

Wind speed (with ice) $V_i := 40$ MPH

Ice Importance Factor: $I_i := 1.0$

Misc. Loading on Balcony's, ladders & Stairs Per AWWA D100-11 Sec. 3.1.6

- Vertical load of 1,000 lbs. to any 10-ft^2 area on the balcony floor, 1,000lbs to each platform, 500 lb to any 10-ft^2 area on the tank roof, and 350 lb on each vertical section of the ladder. Combine with Dead Load only.

Misc. Loading on handrail and guardrails Per AWWA D100-11 Sec. 3.1.7

- The assemblies shall be designed to resist a simultaneous vertical and horizontal load of 50 lb/ft applied to the top rail and to transfer this load through supports to the struture. Handrails and guardrails must be designed to withstand a concentrated load of 200 lb applied in any direction (non-concurent with 50 lb/ft load)

Tank handrail Design Environment Loads used for Overturning Stability Analysis:

$Height := 181$ ft $H := Height = 181$

Wind Load **:**

Sheilding Factor: $K_a := 0.8$

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.434$$

Flat Members: Force coeficient/Drag Factor: $C_f := 2.0$

Wind Direction Factor: $D_f := 1.0$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}^{\ 2} \cdot 1\ \boldsymbol{psf} = 31.718\ \boldsymbol{psf}$

$F_f := q_z \cdot K_a \cdot C_f \cdot D_f \cdot G = 50.749\ \boldsymbol{psf}$

Round Members: Force coeficient/Drag Factor: $C_f := 1.2$

Wind Direction Factor: $D_r := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}^{\;2} \cdot 1\ \boldsymbol{psf} = 31.718\ \boldsymbol{psf}$$

$$F_r := q_z \cdot K_a \cdot C_f \cdot D_r \cdot G = 30.449\ \boldsymbol{psf}$$

HSS Members: Force coeficient/Drag Factor: $C_f := 1.25$

Wind Direction Probability Factor: $K_d := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}^{\;2} \cdot 1\ \boldsymbol{psf} = 31.718\ \boldsymbol{psf}$$

$$F_r := q_z \cdot K_a \cdot C_f \cdot K_d \cdot G = 31.718\ \boldsymbol{psf}$$

$Height := 73$ $\quad ft \quad$ $H := Height = 73$

Wind Load :

Sheilding Factor: $K_a := 0.8$

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900}\right)^{\frac{2}{9.5}}\right) = 1.184$$

Flat Members: Force coeficient/Drag Factor: $C_f := 2.0$

Wind Direction Factor: $D_f := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}^{\;2} \cdot 1\ \boldsymbol{psf} = 26.199\ \boldsymbol{psf}$$

$$F_f := q_z \cdot K_a \cdot C_f \cdot D_f \cdot G = 41.918\ \boldsymbol{psf}$$

Round Members: Force coeficient/Drag Factor: $C_f := 1.2$

Wind Direction Factor: $D_r := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}^{\;2} \cdot 1\ \boldsymbol{psf} = 26.199\ \boldsymbol{psf}$$

$$F_r := q_z \cdot K_a \cdot C_f \cdot D_r \cdot G = 25.151\ \boldsymbol{psf}$$

Appurtenance Wind Loads used for Overturning Stability Analysis:

$Height := 181$ ft $\quad H := Height = 181$

Wind Load :

Wind Direction Probability Factor: $K_d := 0.95$

Sheilding Factor: $K_a := 0.8$

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.434$$

Force Coefficient: $C_a := 1.4$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}{}^2 \cdot 1\ \mathbf{psf} = 31.718\ \mathbf{psf}$

$F_f := q_z \cdot K_a \cdot C_f \cdot K_d \cdot G = 28.927\ \mathbf{psf}$

$Height := 105$ ft $\quad H := Height = 105$

Wind Load :

Wind Direction Probability Factor: $K_d := 0.95$

Sheilding Factor: $K_a := 0.8$

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.279$$

Force Coefficient: $C_a := 1.4$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}{}^2 \cdot 1\ \mathbf{psf} = 28.282\ \mathbf{psf}$

$F_f := q_z \cdot K_a \cdot C_f \cdot K_d \cdot G = 25.794\ \mathbf{psf}$

$Height := 73$ ft $\quad H := Height = 73$

Wind Load :

Wind Direction Probability Factor: $K_d := 0.95$

Sheilding Factor: $K_a := 0.8$

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.184$$

Force Coefficient: $C_a := 1.4$

$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{nom}{}^2 \cdot 1\ \mathbf{psf} = 26.199\ \mathbf{psf}$

$F_f := q_z \cdot K_a \cdot C_f \cdot K_d \cdot G = 23.893\ \mathbf{psf}$

Miscellaneous Antenna Support Loading:

Reference TIA-222-H

Wind Loading on Antennas & Antenna Supports :

Basic Wind Speed per TIA: $V_{ult} := 107$ *MPH* (From TIA Annex B or ASCE 7-16. Includes factor for Risk Category)

Exposure C

Topographic Factor: $K_{zt} := 1.0$

Ground Elevation Factor: $K_e := 1.0$

Rooftop Speed up Factor: $K_s := 1.0$

Design Ice Thickness on Antennas & Antenna Supports:

$t_i := 1.5$ ***in*** (TIA Annex B Figure B-9)

Wind speed (with ice) $V_i := 40$ *MPH* (TIA Annex B Figure B-9)

Ice Importance Factor: $I_i := 1.0$ (TIA Table 2-3)

Service Load Combinations:

1.0 DL + 1.0 WL (w/ 60 MPH Wind speed)

Basic Wind Speed per TIA: $V := 60$ *MPH* (From TIA Annex 2.8.3)

$H := 73$ *ft*

Wind Direction Probability Factor: $K_d := 0.85$ (Table 2-2 TIA-222-H)

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.184$$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V^2 \cdot K_s \cdot K_e \cdot K_d \cdot 1\ \boldsymbol{psf} = 9.279\ \boldsymbol{psf}$$

Design Wind loads for Design of Mounting Systems per TIA 16.6

$H := 73$ *ft*

Gust Factor $G := 1.0$

Sheilding Factor: $K_a := 0.9$

Risk Category: II (Risk category for Mount)

$$K_z := 2.01 \cdot \left(\left(\frac{H}{900} \right)^{\frac{2}{9.5}} \right) = 1.184$$

Flat Members: Force coeficient/Drag Factor: $C_f := 2.0$

Wind Direction Factor: $D_f := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^{\ 2} \cdot K_s \cdot K_e \cdot 1\ \boldsymbol{psf} = 34.717\ \boldsymbol{psf}$$

$$F_f := q_z \cdot K_a \cdot C_f \cdot D_f \cdot G = 62.49\ \boldsymbol{psf}$$

Round Members: Force coeficient/Drag Factor: $C_f := 1.2$

Wind Direction Factor: $D_r := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^{\ 2} \cdot K_s \cdot K_e \cdot 1\ \textbf{psf} = 34.717\ \textbf{psf}$$

$$F_r := q_z \cdot K_a \cdot C_f \cdot D_r \cdot G = 37.494\ \textbf{psf}$$

HSS Members: Force coeficient/Drag Factor: $C_f := 1.25$

Wind Direction Probability Factor: $K_d := 1.0$

$$q_z := .00256 \cdot K_z \cdot K_{zt} \cdot V_{ult}^{\ 2} \cdot K_s \cdot K_e \cdot 1\ \textbf{psf} = 34.717\ \textbf{psf}$$

$$F_r := q_z \cdot K_a \cdot C_f \cdot K_d \cdot G = 39.056\ \textbf{psf}$$

2-7/8" OD pipe

Dimensions : $h := 12 \cdot \textbf{in}$ $w := 2.875 \cdot \textbf{in}$ $d := 2.875 \cdot \textbf{in}$ $RAD := 73$ ft Member Type: HSS

$q_z := 37.5\ \textbf{psf}$

Ice load :

$$K_{zi} := \left(\frac{RAD}{33}\right)^{.1} = 1.083 \quad D_{ci} := \sqrt{\left(w^2\right) + \left(d^2\right)} = 0.339\ \textbf{ft} \quad t_{iz} := \left(t_i \cdot I_i \cdot K_{zi} \cdot \left(K_{zt}\right)^{.35} \cdot 1\right) = 1.624\ \textbf{in}$$

$$A_{iz} := 3.14 \cdot t_{iz} \cdot \left(D_{ci} + t_{iz}\right) = 0.201\ \textbf{ft}^2 \quad W_i := \left(56 \cdot \frac{\textbf{lb}}{\textbf{ft}^3}\right) \cdot \left(A_{iz}\right) \cdot \frac{h}{12 \cdot \frac{\textbf{in}}{\textbf{ft}}} = 11.283\ \textbf{lb}$$

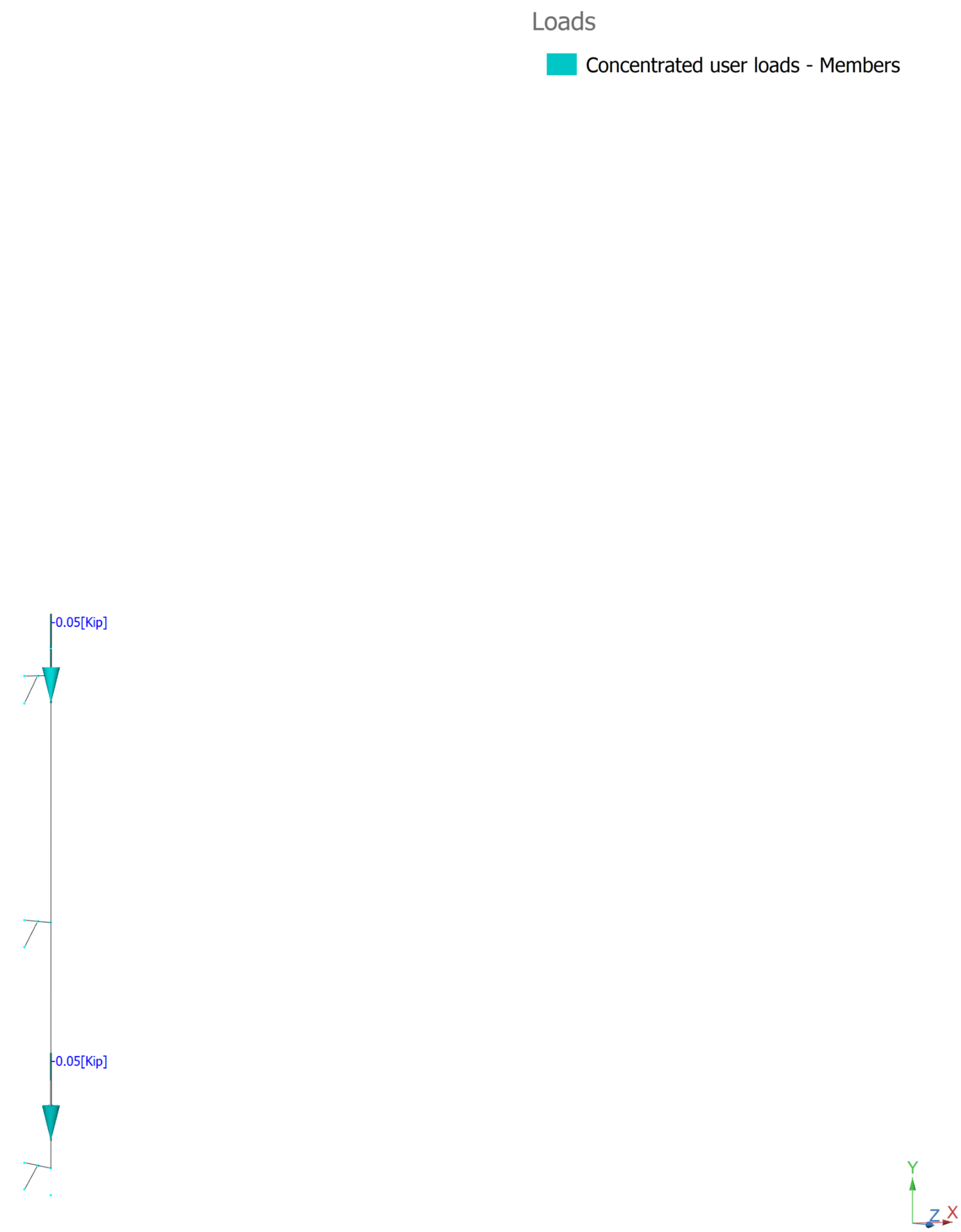
$$WL_{iz} := \frac{\left(A_{iz} + (h \cdot w)\right)}{h \cdot w} \cdot \left(q_z \cdot \frac{V_i}{V_{ult}}\right) = 25.808\ \textbf{psf}$$

Load Summary:

Ice Load, $W_i = 11.283\ \textbf{lb}$ per foot

Wind on Ice = $WL_{iz} = 25.808\ \textbf{psf}$

Current Date: 11/1/2019 9:33 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: DL2=Dead Load Antennas

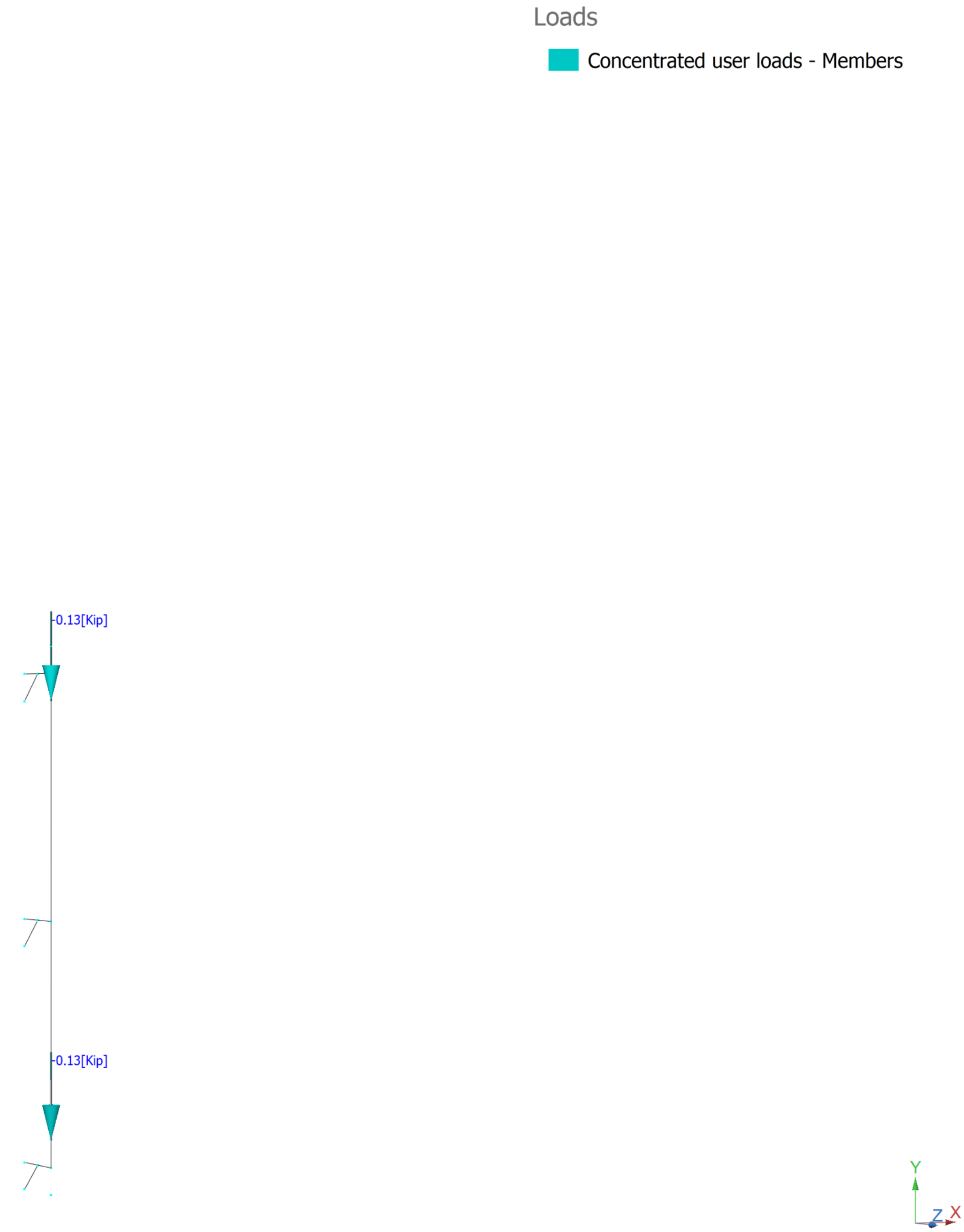


Current Date: 11/1/2019 9:33 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Ice1=Ice Load Mount

Loads

Distributed user loads - Members

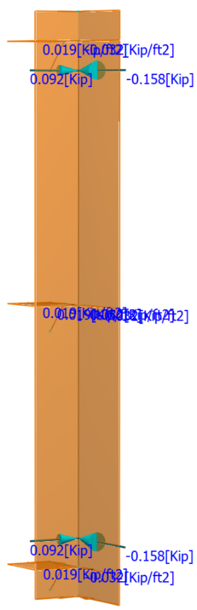
Current Date: 11/1/2019 9:33 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Ice2=Ice Load Antennas

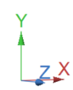


Current Date: 11/1/2019 9:34 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm30=Wind Load Mount 30

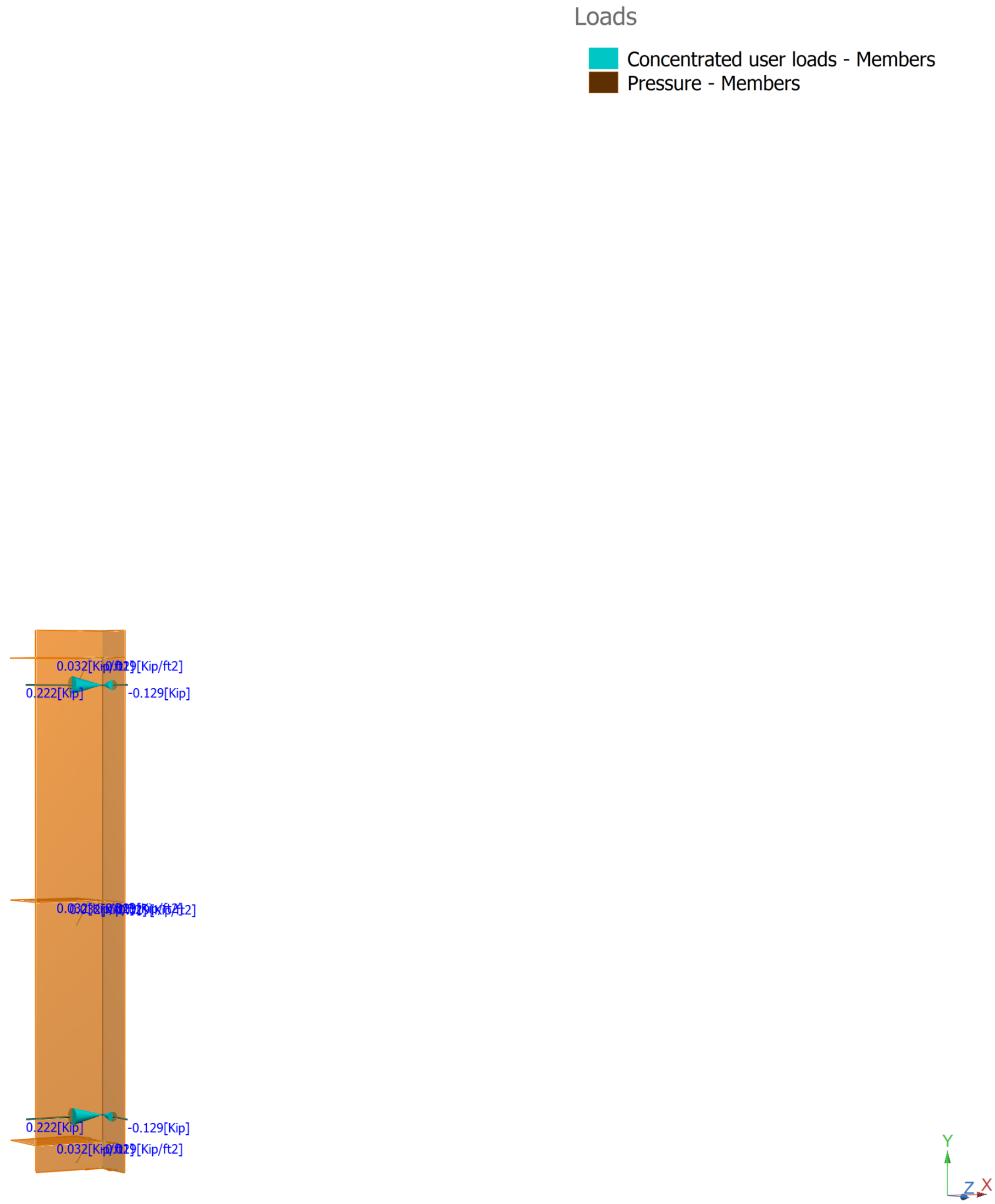
Loads

Concentrated user loads - Members
Pressure - Members

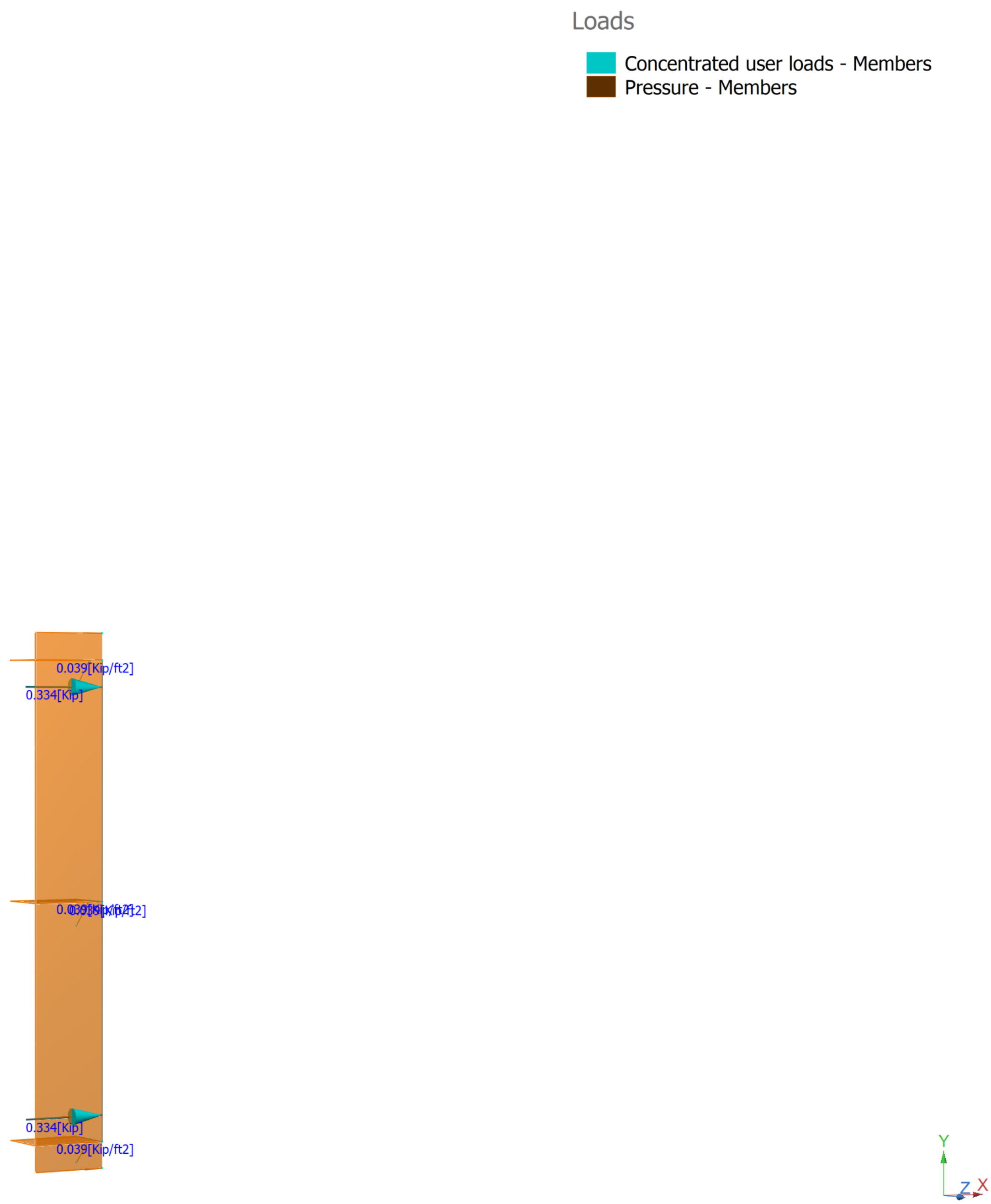




Current Date: 11/1/2019 9:34 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm60=Wind Load Mount 60



Current Date: 11/1/2019 9:34 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm90=Wind Load mount 90



Current Date: 11/1/2019 9:34 AM
Units system: English
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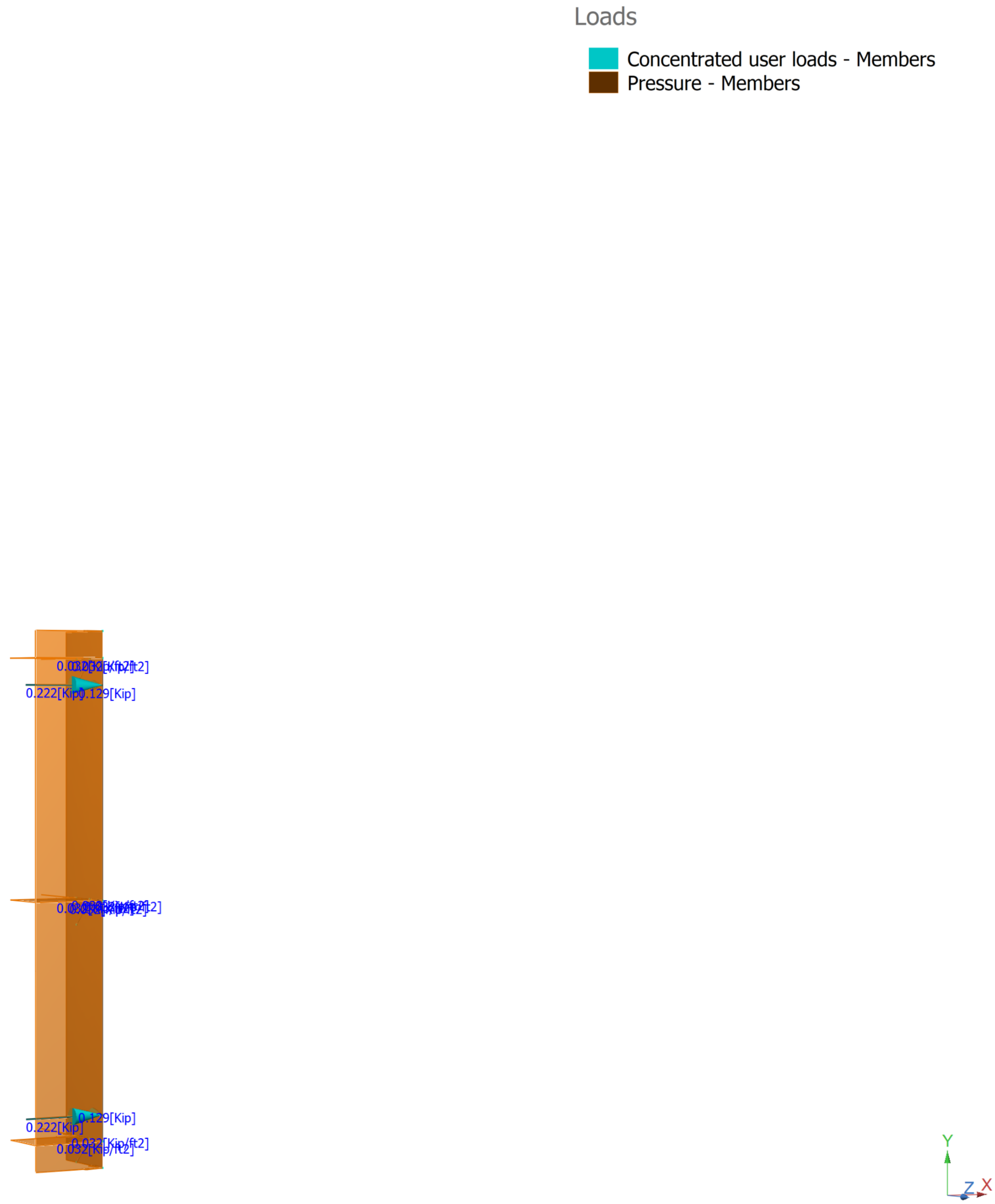
Load condition: Wm120=Wind load mount 120



Current Date: 11/1/2019 9:34 AM
Units system: English
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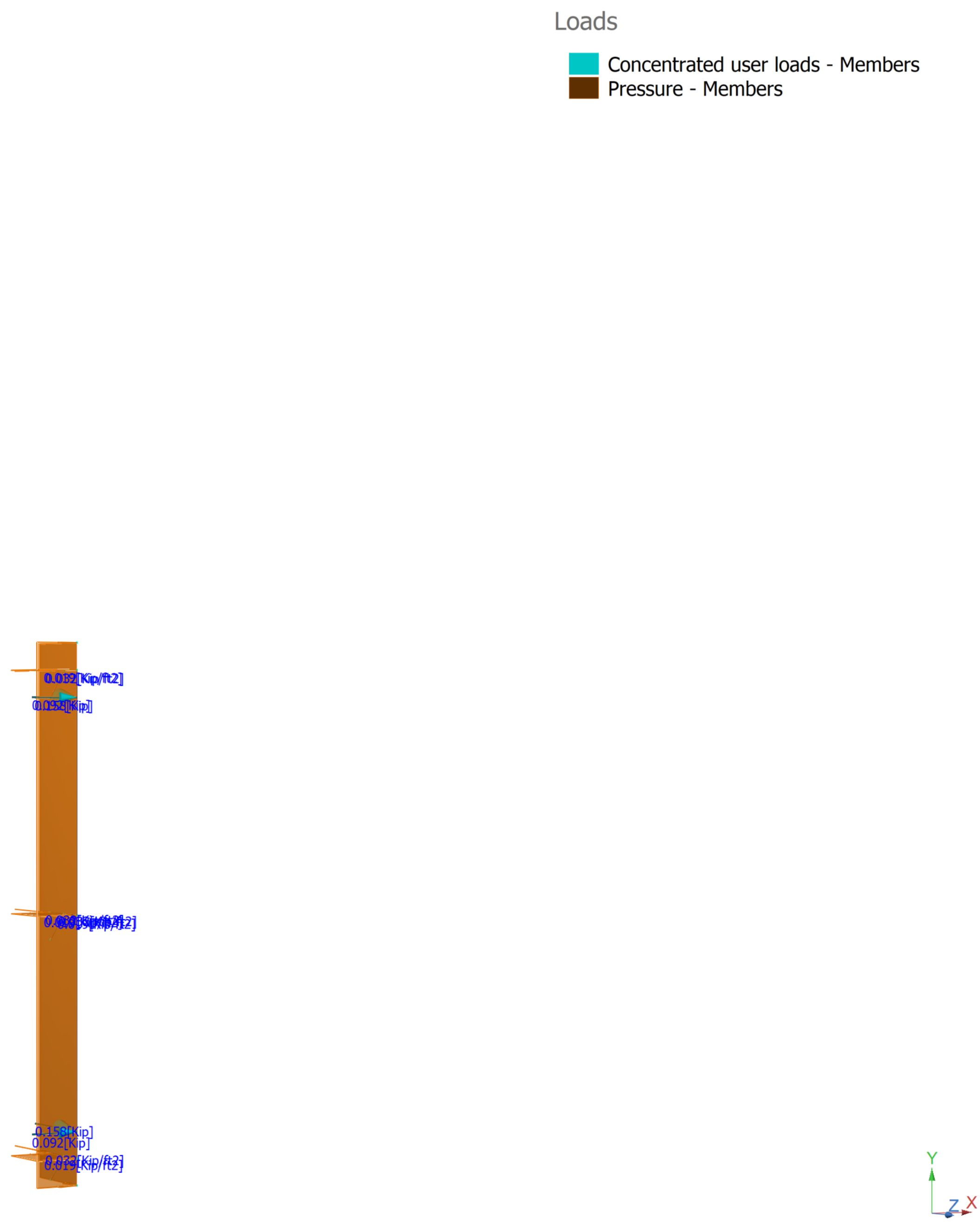
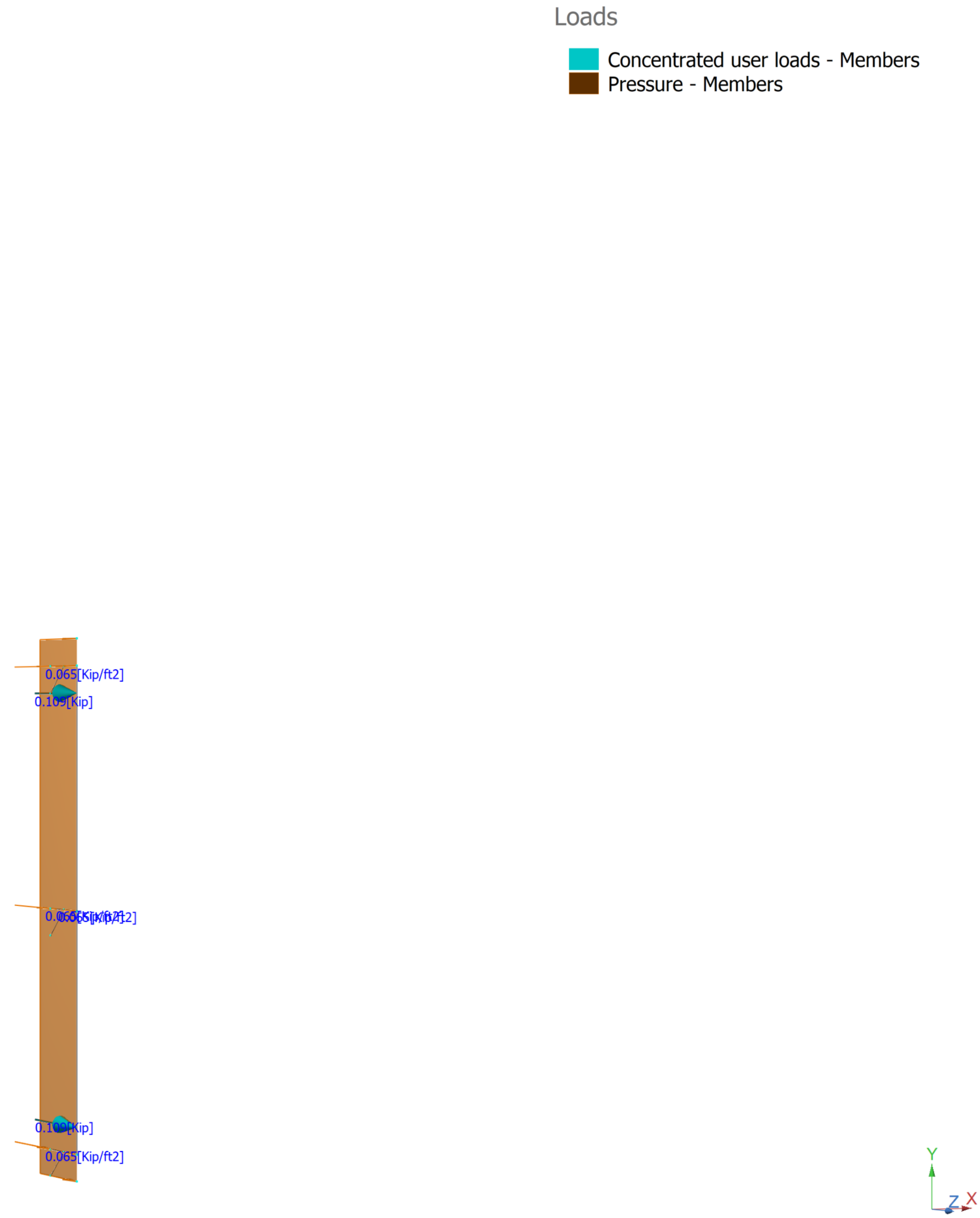
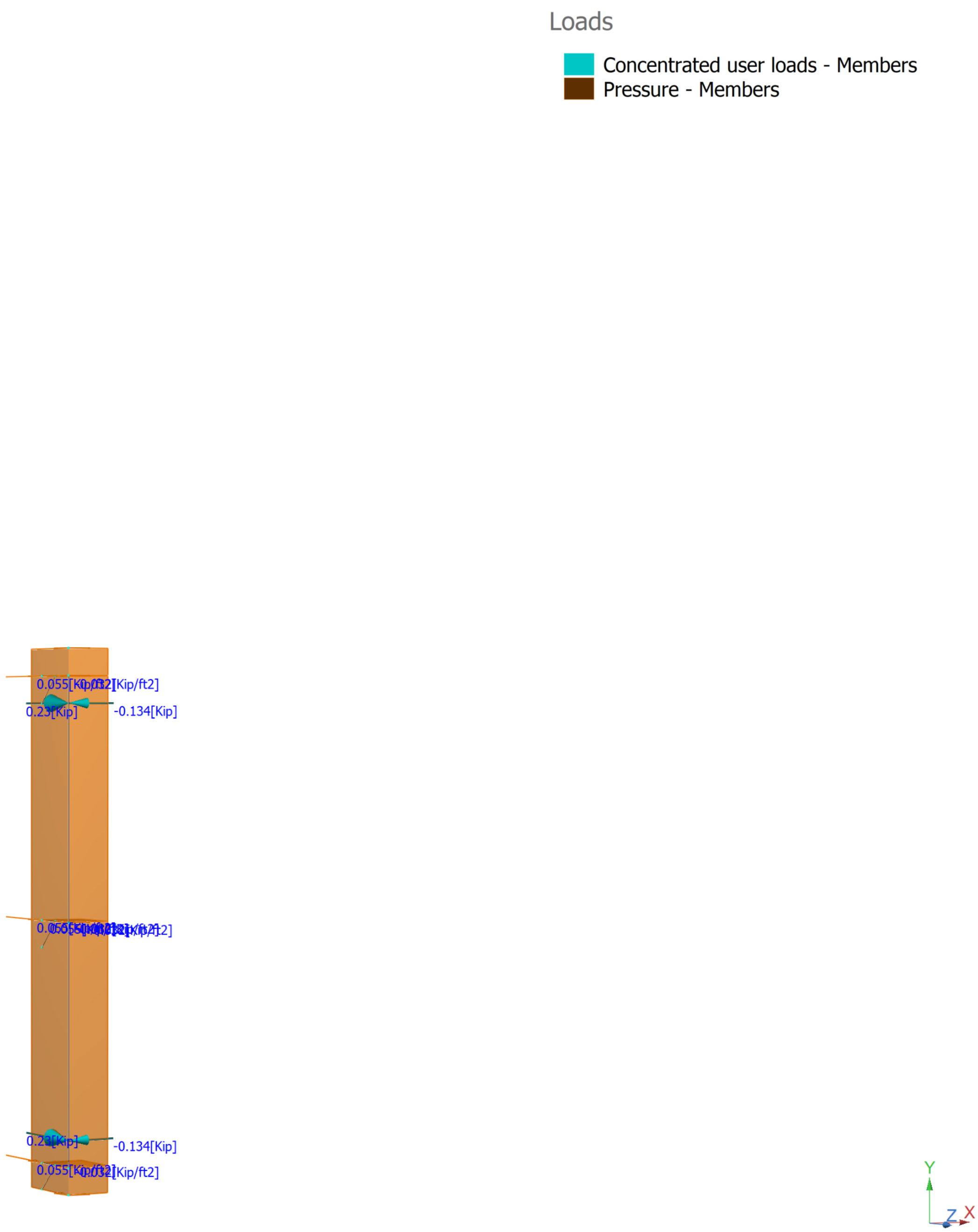
Load condition: Wm150=Wind load mount 150



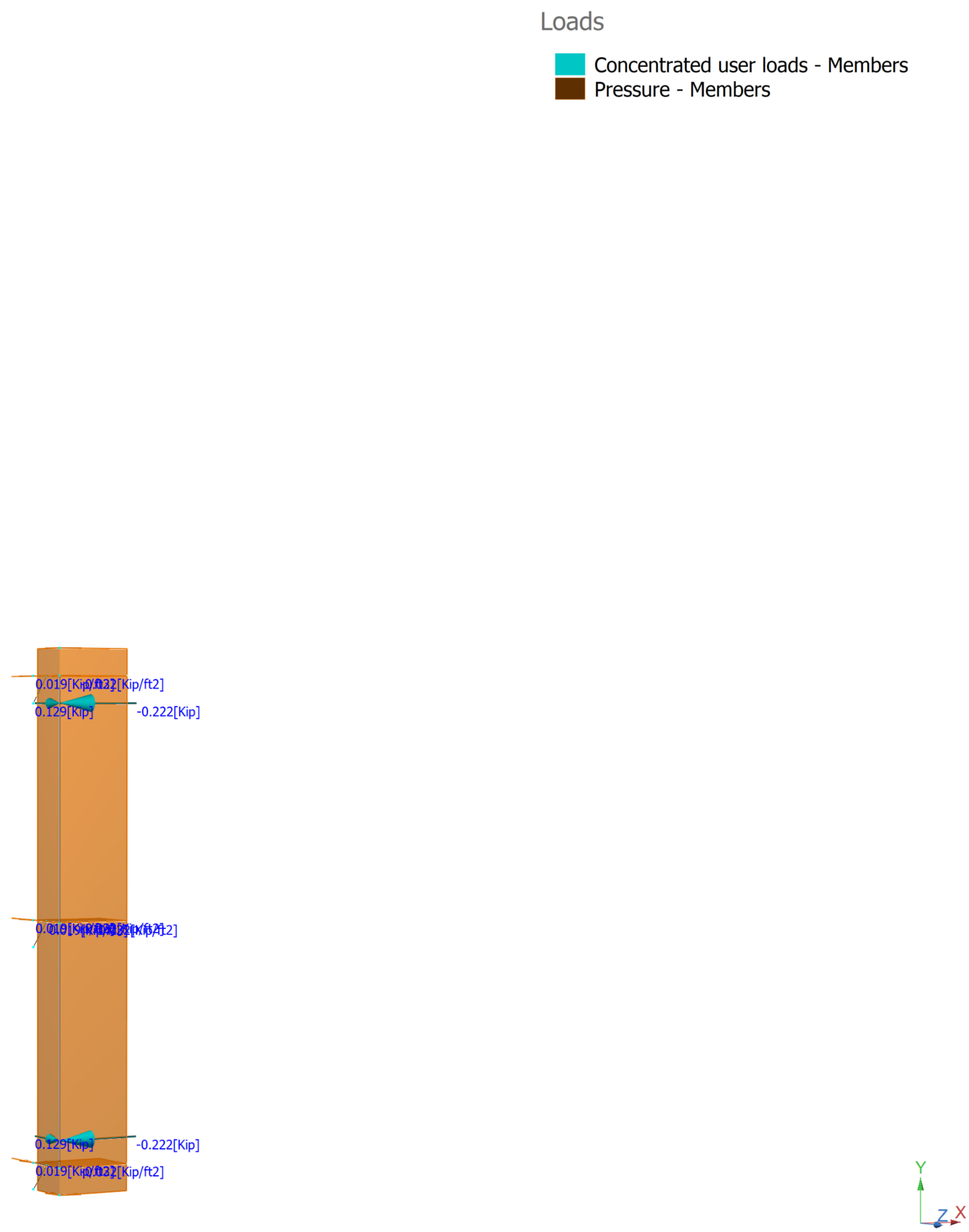
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm180=Wind load mount 180



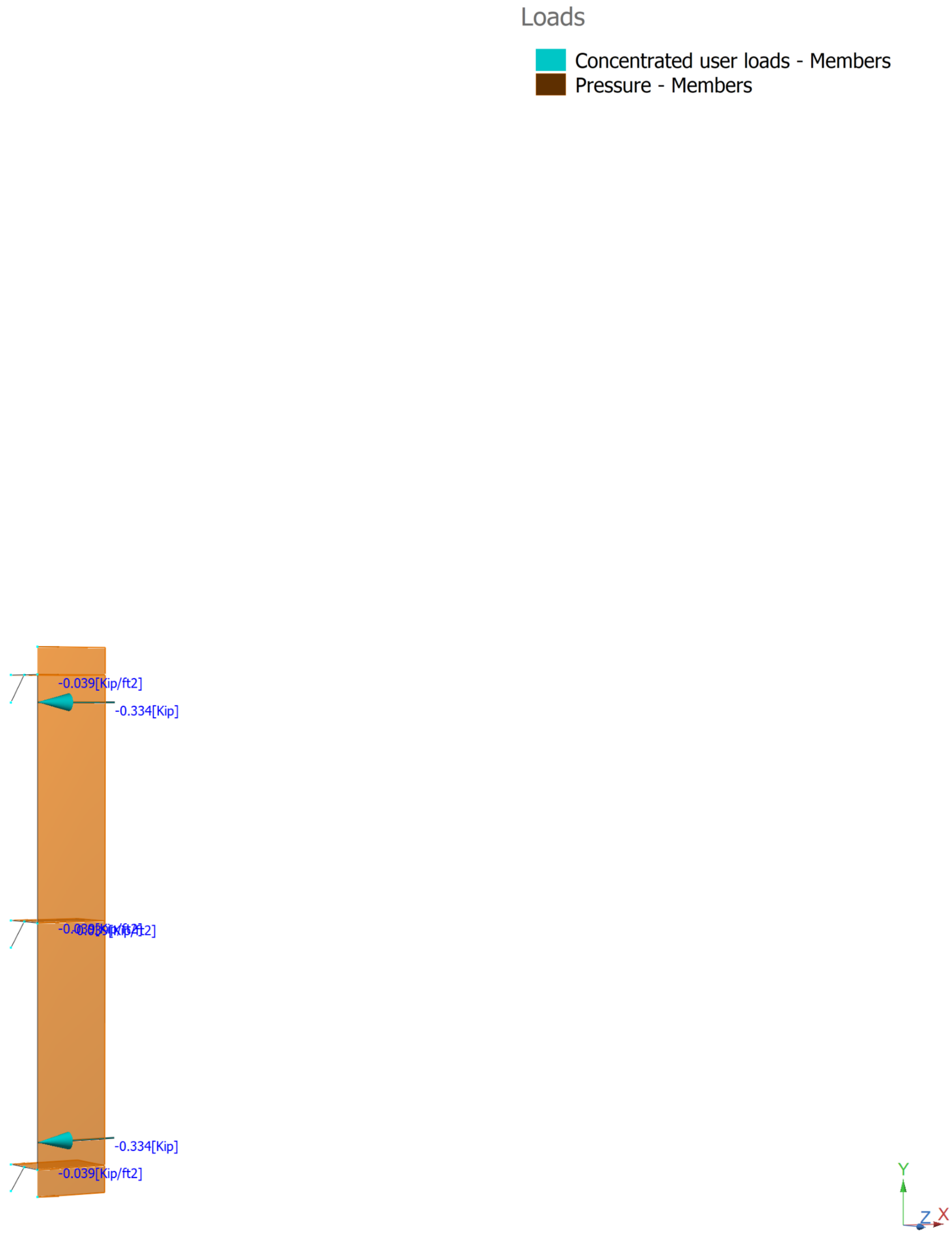
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm210=Wind load mount 210



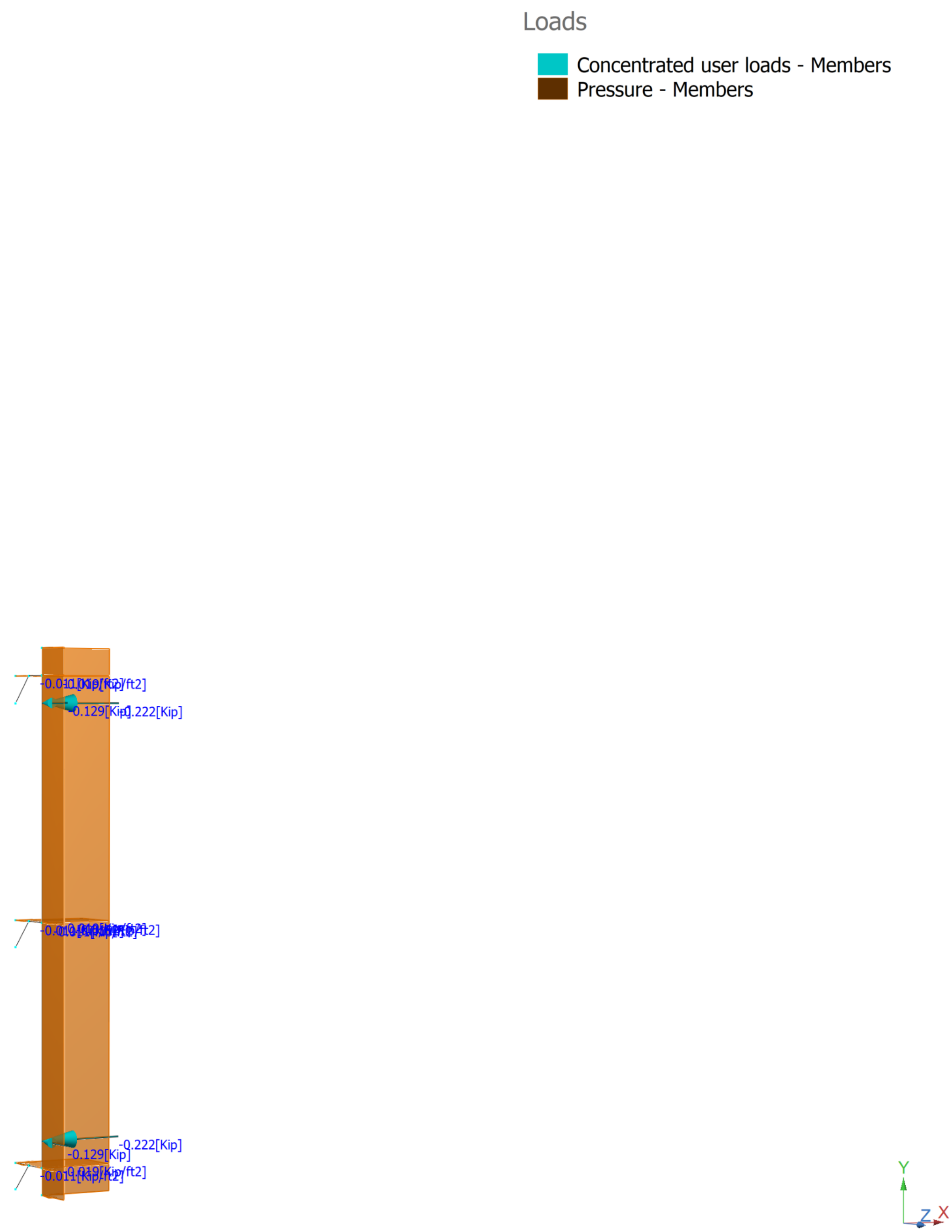
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm240=Wind load mount 240



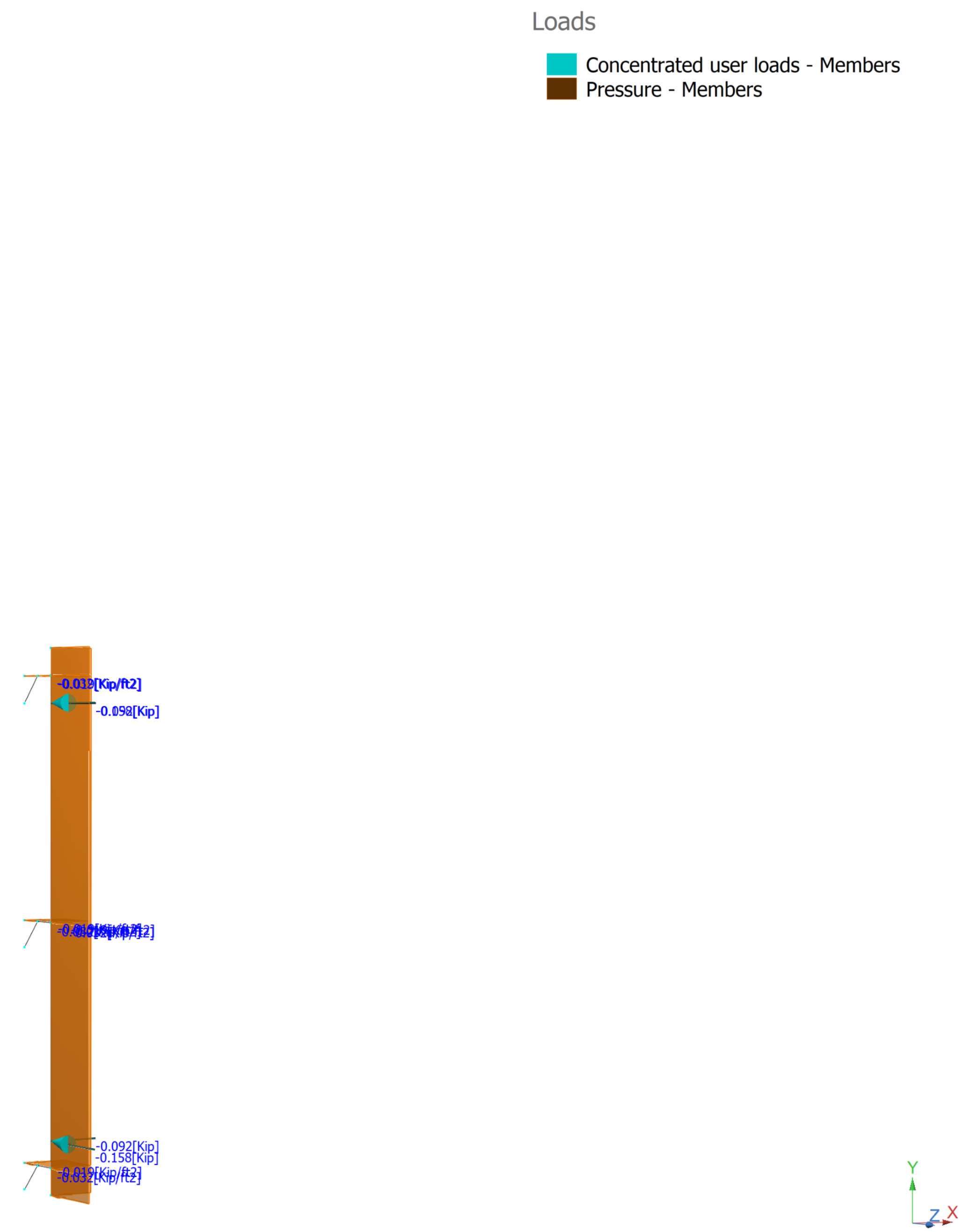
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm270=Wind loa mount 270



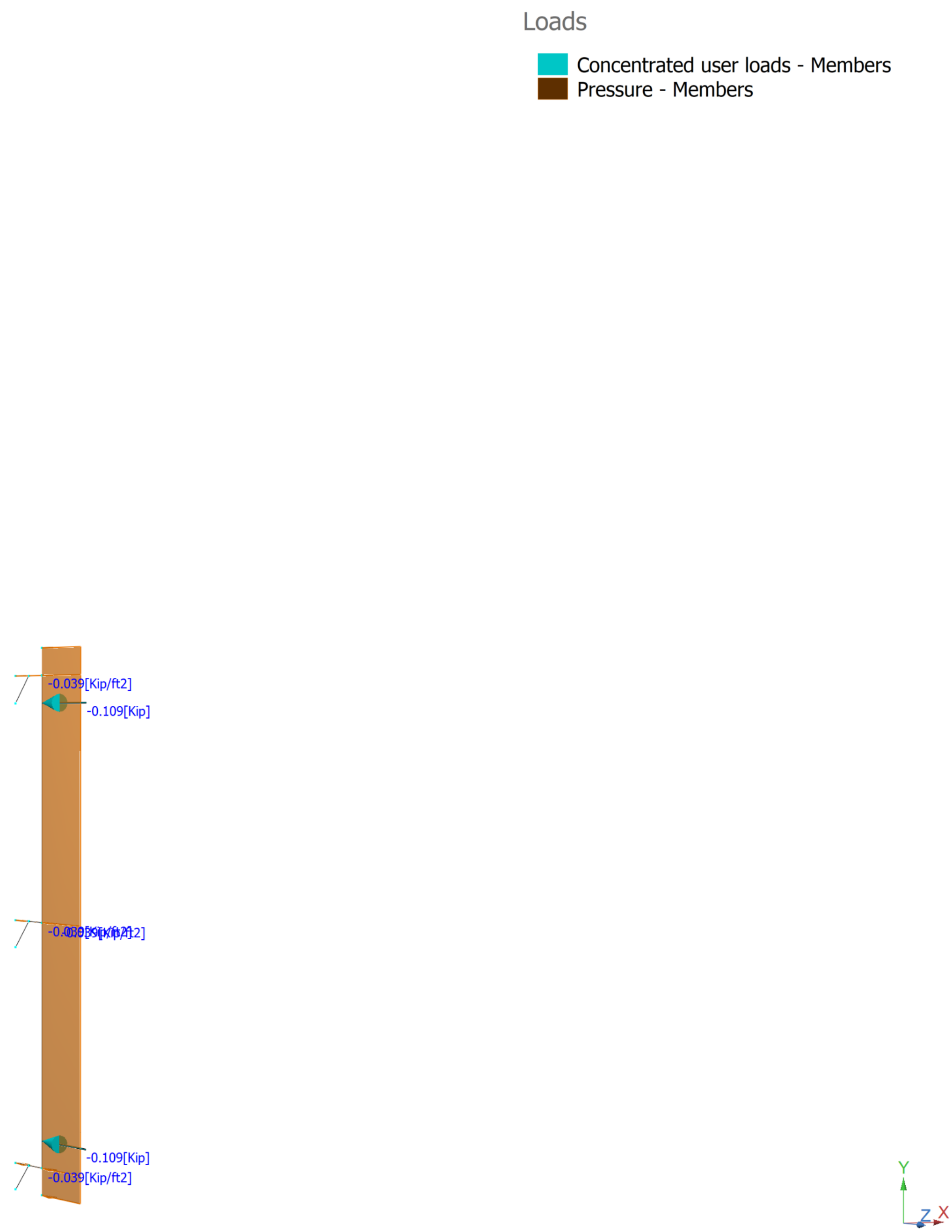
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm300=Wind load mount 300



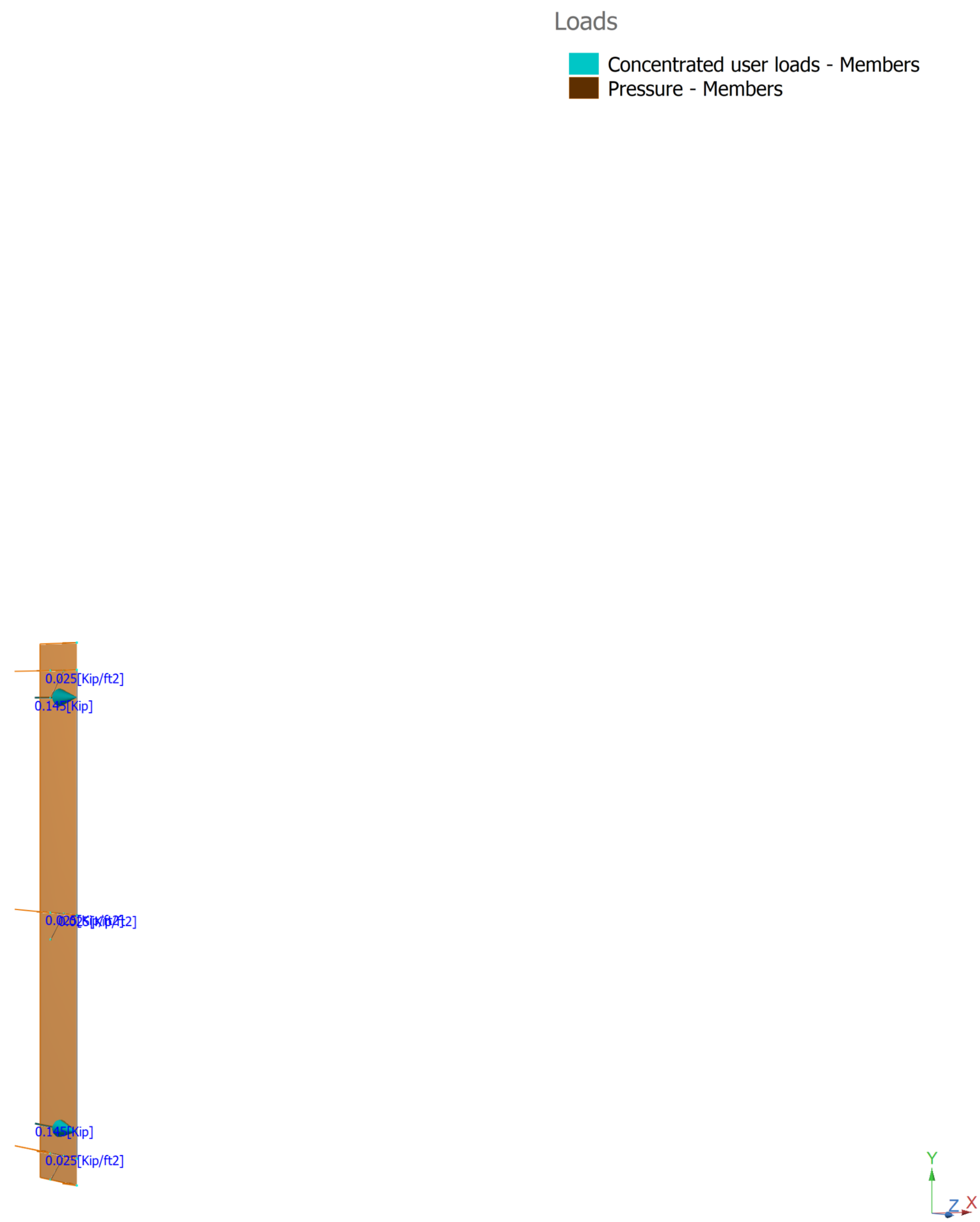
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm330=Wind load mount 330



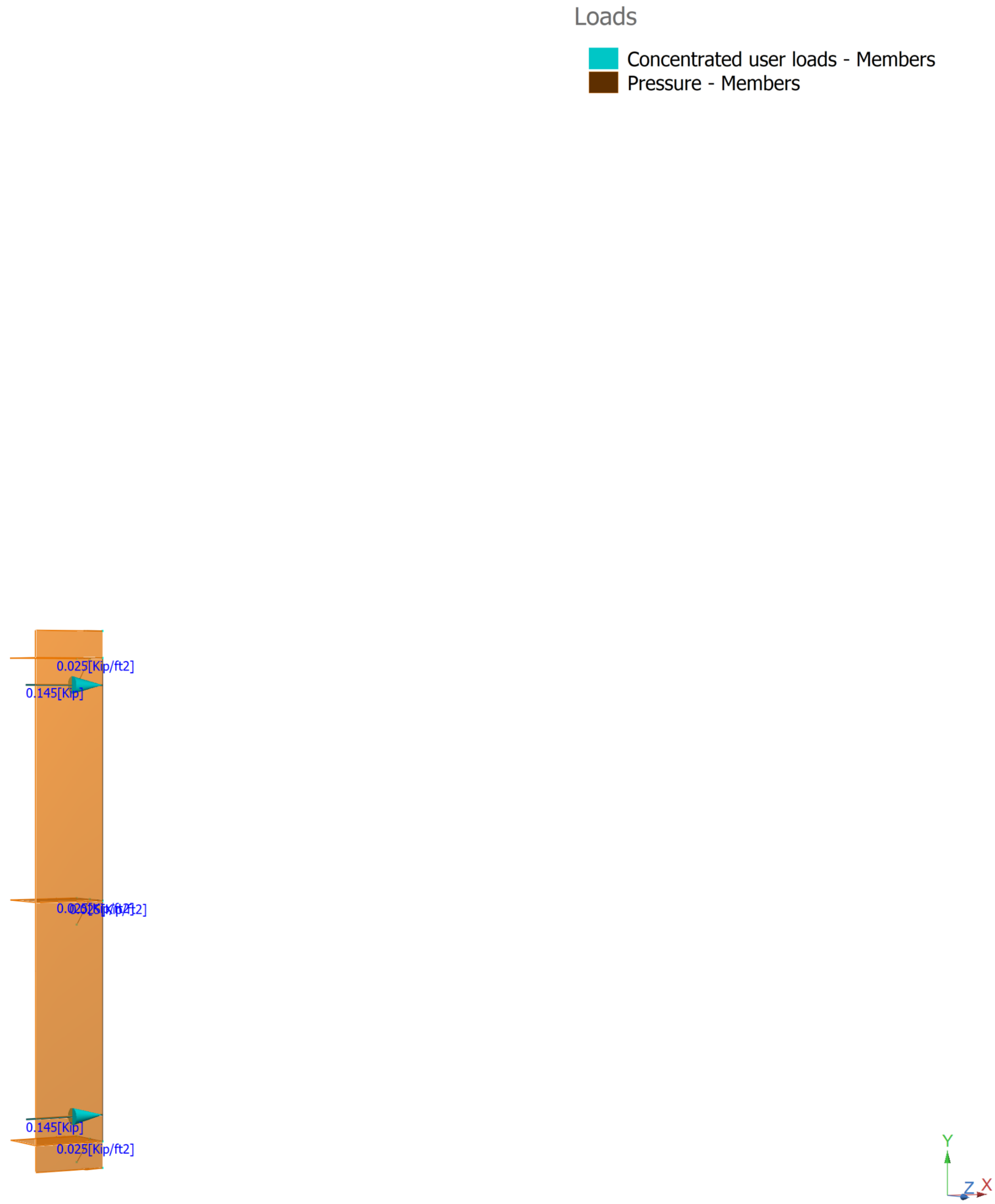
Current Date: 11/1/2019 9:35 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: Wm360=Wind load mount 360



Current Date: 11/1/2019 9:36 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: WLicz=Wind Load Ice Z

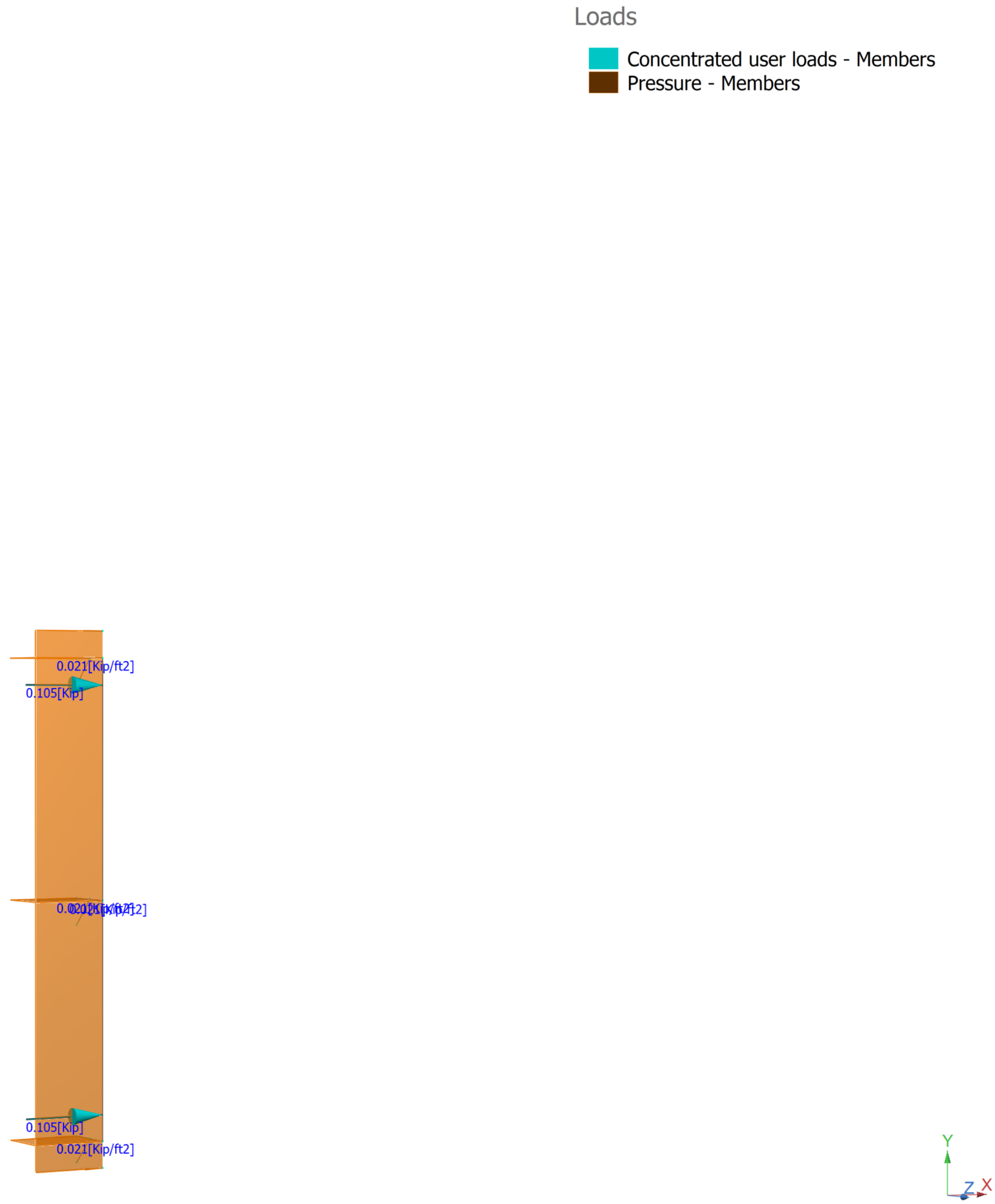


Current Date: 11/1/2019 9:36 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: WLicx=Wind Load Ice X

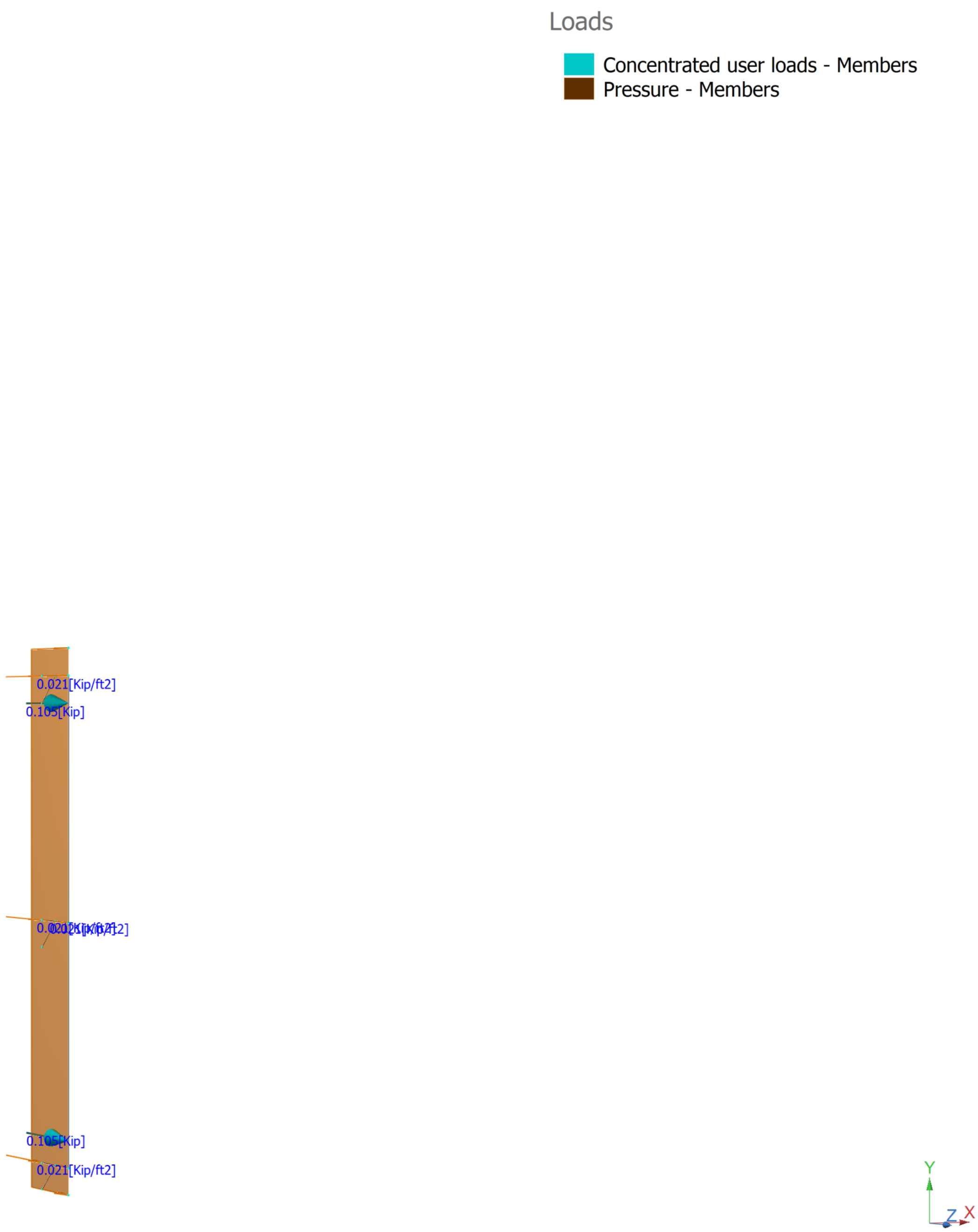


Current Date: 11/1/2019 9:36 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: LM1=Maintenance Load 1a

Current Date: 11/1/2019 9:36 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: WLxm=Wind Load X Maintenance 60MPH



Current Date: 11/1/2019 9:36 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\
Load condition: WLzm=Wind Load Z Maintenance 60MPH



Unable to read file "<C:\Program Files (x86)\Bentley\Engineering\RAM Elements.en\Images\LOGO.BM...

Current Date: 11/1/2019 9:37 AM
Units system: English
File name: C:\Users\sarah.brost\Desktop\Transfer to Vault\Edge\County grounds\19208004_County Grounds-Mount_30.etz\

Steel Code Check

Report: Summary - Group by description

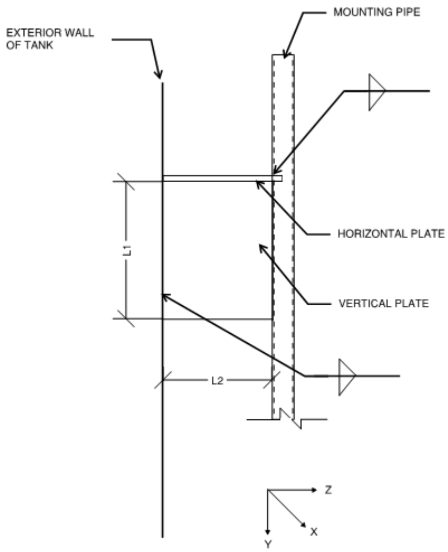
Load conditions to be included in design :

D1a=1.2DL1+1.2DL2+Wm30
D1b=1.2DL1+1.2DL2+Wm60
D1c=1.2DL1+1.2DL2+Wm90
D1d=1.2DL1+1.2DL2+Wm120
D1e=1.2DL1+1.2DL2+Wm150
D1f=1.2DL1+1.2DL2+Wm180
D1g=1.2DL1+1.2DL2+Wm210
D1h=1.2DL1+1.2DL2+Wm240
D1i=1.2DL1+1.2DL2+Wm270
D1j=1.2DL1+1.2DL2+Wm300
D1k=1.2DL1+1.2DL2+Wm330
D1l=1.2DL1+1.2DL2+Wm360
D2a=0.9DL1+0.9DL2+Wm30
D2b=0.9DL1+0.9DL2+Wm60
D2c=0.9DL1+0.9DL2+Wm90
D2d=0.9DL1+0.9DL2+Wm120
D2e=0.9DL1+0.9DL2+Wm150
D2f=0.9DL1+0.9DL2+Wm180
D2g=0.9DL1+0.9DL2+Wm210
D2h=0.9DL1+0.9DL2+Wm240
D2i=0.9DL1+0.9DL2+Wm270
D2j=0.9DL1+0.9DL2+Wm300
D2k=0.9DL1+0.9DL2+Wm330
D2l=0.9DL1+0.9DL2+Wm360
D3a=1.2DL1+1.2DL2+Ice1+Ice2+WLicx
D3b=1.2DL1+1.2DL2+Ice1+Ice2+WLicz
D4=1.4DL1+1.4DL2
D5a=1.2DL1+1.2DL2+1.5LM1+WLxm
D5b=1.2DL1+1.2DL2+1.5LM1+WLzm
D6=1.2DL1+1.2DL2+1.5Lv1
D5h=1.2DL1+1.2DL2+1.5LM2+WLxm
D5c=1.2DL1+1.2DL2+1.5LM2+WLzm
D5d=1.2DL1+1.2DL2+1.5LM3+WLxm
D5e=1.2DL1+1.2DL2+1.5LM3+WLzm
D5f=1.2DL1+1.2DL2+1.5Lv2
D5g=1.2DL1+1.2DL2+1.5Lv3

Description	Section	Member	Ctrl Eq.	Ratio	Status	Reference
Plate 1	***RECTBAR 3/8x6***	**7**	D5b at 100.00%	0.20	OK	Eq. H2-1
Plate 2		**9**	D5b at 25.00%	0.01	OK	Eq. H2-1
Support Pipe	***PIPE 2-1_2x0.203***	**6**	D1g at 10.94%	0.05	OK	Eq. H1-1b

MOUNT WELD CHECKS

Designed Per TIA-222-H



Distance between Horizontal Plates: $D := 4.5\ ft$

Distance from tank wall to center of antennas: $L := 24\ in$

$L1 := 6\ in$ $L2 := 12\ in$

$D_{pipe} := 2.875\ in$

Width of Horizontal PL $w_{pl} := 6\ in$

Thickness of Horizontal Plate $t_{plh} := .375\ in$

Thickness of Vertical Plate $t_{plv} := .375\ in$

Weld Size: $w := .1875\ in$

LOADS:

Note: All loads provided are 1/3 total Load since there are (3) mount plates

$P_{ydl} := .1\ kip$ $P_{yice} := 0.2\ kip$ $P_{xwl} := .334\ kip$ $T_{zwl} := .222\ kip$ $P_{xwlice} := .13\ kip$ $T_{zwlice} := .13\ kip$

$T_{dl} := P_{ydl} \cdot \frac{L}{D} = 0.044\ kip$ $T_{ice} := P_{yice} \cdot \frac{L}{D} = 0.089\ kip$

1. 1.2DL+ICE+WLIce

A. Vertical Plate(takes total vertical load of entire mount):

$\phi := .75$

OR Use full eccentricity on vert plate:

$M_{x1} := (1.2 \cdot P_{ydl} + P_{yice}) \cdot (L2) = 3.84\ kip \cdot in$

$M_{x2} := (1.2 \cdot P_{ydl} + P_{yice}) \cdot (L) = 7.68\ kip \cdot in$

$S_{weld} := \frac{L1^2}{3} = 12\ in^2$ $f_y := \frac{(1.2 \cdot P_{ydl} + P_{yice})}{(L1 \cdot 2) + (2 \cdot t_{plv})} = 0.025\ \frac{kip}{in}$ $f_{bx} := \frac{M_{x2}}{S_{weld}} = 0.64\ \frac{kip}{in}$

$f_{wtotal} := \sqrt{\left({f_y}^2 + (f_{bx})^2\right)} = 0.64\ \frac{kip}{in}$ $F_w := \phi \cdot 0.6 \cdot 70\ ksi \cdot .707 \cdot w = 4.176\ \frac{kip}{in}$

$$Result := \left\| \begin{array}{l} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{array} \right\| = \text{“Weld OK”}$$

B. Horizontal Plate (WLicex):

$M_y := (P_{xwlice}) \cdot (L) = 3.12\ kip \cdot in$ $S_{weld} := \frac{{w_{pl}}^2}{3} = 12\ in^2$

$f_{by} := \frac{M_y}{S_{weld}} = 0.26\ \frac{kip}{in}$ $f_x := \frac{(P_{xwlice})}{(w_{pl} \cdot 2)} = 0.011\ \frac{kip}{in}$ $f_z := \frac{(1.2 \cdot T_{dl} + T_{ice})}{(L1 \cdot 2)} = 0.012\ \frac{kip}{in}$

$f_{wtotal} := \sqrt{\left({f_x}^2 + \left({f_{by}}^2 + {f_z}^2\right)\right)} = 0.26\ \frac{kip}{in}$

$F_w := \phi \cdot 0.6 \cdot 70\ ksi \cdot .707 \cdot w = 4.176\ \frac{kip}{in}$

$$Result := \left\| \begin{array}{l} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{array} \right\| = \text{“Weld OK”}$$

C. Horizontal Plate (Wicez):

$$f_z := \frac{\left(1.2 \cdot T_{dl} + T_{ice} + T_{zwlice}\right)}{\left(w_{pl} \cdot 2\right)} = 0.023\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$f_{wtotal} := \sqrt{\left(f_z^{\ 2}\right)} = 0.023\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$F_w := \phi \cdot 0.6 \cdot 70\ \boldsymbol{ksi} \cdot .707 \cdot w = 4.176\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$Result := \begin{Vmatrix} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{Vmatrix} = \text{“Weld OK”}$$

2. 0.9DL+WL

A. Vertical Plate(takes total vertical load of entire mount):

$$M_x := \left(0.9 \cdot P_{ydl}\right) \cdot \left(L2\right) = 1.08\ \boldsymbol{kip \cdot in}$$

OR Use full eccentricity on vert plate:

$$M_{x2} := \left(0.9 \cdot P_{ydl}\right) \cdot \left(L\right) = 2.16\ \boldsymbol{kip \cdot in}$$

$$S_{weld} := \frac{L1^2}{3} = 12\ \boldsymbol{in}^2 \qquad f_y := \frac{\left(0.9 \cdot P_{ydl}\right)}{\left(L1 \cdot 2\right)} = 0.008\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$f_{bx} := \frac{M_{x2}}{S_{weld}} = 0.18\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad f_{wtotal} := \sqrt{\left(f_y^{\ 2} + \left(f_{bx}\right)^2\right)} = 0.18\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad F_w := \phi \cdot 0.6 \cdot 70\ \boldsymbol{ksi} \cdot .707 \cdot w = 4.176\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$Result := \begin{Vmatrix} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{Vmatrix} = \text{“Weld OK”}$$

B. Horizontal Plate (Wx):

$$M_y := \left(P_{xwl}\right) \cdot \left(L\right) = 8.016\ \boldsymbol{kip \cdot in} \qquad f_x := \frac{\left(P_{xwl}\right)}{\left(w_{pl} \cdot 2\right)} = 0.028\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad f_z := \frac{\left(0.9 \cdot T_{dl}\right)}{\left(w_{pl} \cdot 2\right)} = 0.003\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad f_{by} := \frac{M_y}{S_{weld}} = 0.668\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$S_{weld} := \frac{w_{pl}^{\ 2}}{3} = 12\ \boldsymbol{in}^2 \qquad f_{wtotal} := \sqrt{\left(f_x^{\ 2} + f_z^{\ 2} + f_{by}^{\ 2}\right)} = 0.669\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad F_w := \phi \cdot 0.6 \cdot 70\ \boldsymbol{ksi} \cdot .707 \cdot w = 4.176\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$Result := \begin{Vmatrix} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{Vmatrix} = \text{“Weld OK”}$$

C. Horizontal Plate (WLz):

$$f_z := \frac{\left(0.9\ T_{dl} + T_{zwl}\right)}{\left(w_{pl} \cdot 2\right)} = 0.022\ \frac{\boldsymbol{kip}}{\boldsymbol{in}} \qquad f_{wtotal} := \sqrt{\left(f_z^{\ 2}\right)} = 0.022\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

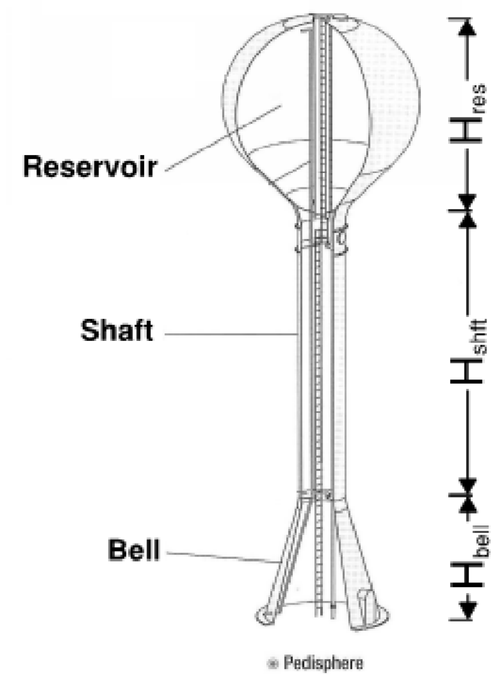
$$F_w := \phi \cdot 0.6 \cdot 70\ \boldsymbol{ksi} \cdot .707 \cdot w = 4.176\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$Result := \begin{Vmatrix} \text{if } f_{wtotal} \le F_w \\ \quad \| \text{“Weld OK”} \\ \text{if } f_{wtotal} > F_w \\ \quad \| \text{“Overstress”} \end{Vmatrix} = \text{“Weld OK”}$$

Provide 3/8" Mount plates with 3/16" fillet welds.

Overturning Calculation

Note: Overturning calculation is based on many unknowns including but not limited to existing antenna quantity, size, weight, and location. Since not all antenna wind surface area are in the direction of the wind load, a percentage is applied to the overall wind surface load to accomodate this.



Diameter:

$D_{res} := 74 \cdot ft$

$D_{shft} := 15 \cdot ft$

$D_{bell} := 36 \cdot ft$

Height:

$H_{res} := 52.5 \cdot ft$

$H_{shft} := 90.4 \cdot ft$

$H_{bell} := 35.5 \cdot ft$

$$A_{res} := \pi \cdot \left(\frac{D_{res}}{2}\right) \cdot \left(\frac{H_{res}}{2}\right) = 3051.27\ ft^2$$

Wall Thickness:

Thickness of reservoir (Average) $t_{res} := 0.69 \cdot in$

Thickness of shaft (Average) $t_{shft} := 1.4 \cdot in$

Thickness of bell (Average) $t_{bell} := 1.25 \cdot in$

Antenna Input Variables:

Existing Antennas @ Handrail (other carriers) :

Number of Existing Antennas @ Handrail: $N_{ante1} := 13$

Average Existing antenna surface area: $A_{ante1} := 5.1 \cdot ft^2$

Average Existing antenna Centroid: $y_{ante1} := 183 \cdot ft$

Average Antenna Weight: $WT_{ante1} := 40 \cdot lbf$

Number of Existing Equipment: $N_{equipe1} := 30$

Average Existing equip surface area: $A_{equipe1} := 1.73 \cdot ft^2$

Average Equip Weight: $WT_{equipe1} := 40 \cdot lbf$

Wind Load on antennas: $W_{ante1} := 28.9 \cdot psf$

Existing Antennas @ Shaft (Other Carriers):

Number of Existing Antennas: $N_{ante2} := 9$

Average Existing antenna surface area: $A_{ante2} := 2.33 \cdot ft^2$

Average Existing antenna Centroid: $y_{ante2} := 105 \cdot ft$

Average Antenna Weight: $WT_{ante2} := 40 \cdot lbf$

Number of Existing Equipment: $N_{equipe2} := 6$

Average Existing equip surface area: $A_{equipe2} := .5 \cdot ft^2$

Average Equip Weight: $WT_{equipe2} := 20 \cdot lbf$

Number of Sector Mounts: $N_{mounte2} := 3$

Approx. Self Weight per Sector Mount: $WT_{mounte2} := 300\ lbf$

Approx. wind surface area per mount: $A_{mounte2} := 15\ ft^2$

Wind Load on antennas: $W_{ante2} := 25.7 \cdot psf$

Wind Load on Mount: $W_{mounte2} := 25.1 \cdot psf$

Existing US Cellular Antennas on shaft to be removed:

Number of Existing Antennas: $N_{ante3} := 3$

Average Existing antenna surface area: $A_{ante3} := 8 \cdot ft^2$

Average Existing antenna Centroid: $y_{ante3} := 73 \cdot ft$

Average Antenna Weight: $WT_{ante3} := 40 \cdot lbf$

Number of Existing Equipment: $N_{equipe3} := 3$

Average Existing equip surface area: $A_{equipe3} := 2.32 \cdot ft^2$

Average Equip Weight: $WT_{equipe3} := 70 \cdot lbf$

Wind Load on antennas: $W_{ante3} := 23.8 \cdot psf$

Existing US Cellular Antennas on shaft to remain:

Number of Existing Antennas: $N_{ante4} := 3$

Average Existing antenna surface area: $A_{ante4} := 8 \cdot ft^2$

Average Existing antenna Centroid: $y_{ante4} := 73 \cdot ft$

Average Antenna Weight: $WT_{ante4} := 24 \cdot lbf$

Number of Existing Equipment: $N_{equipe4} := 1$

Average Existing equip surface area: $A_{equipe4} := 0 \cdot ft^2$ (RRU's remaining are placed on interior of tank and do not contribue to wind load for overturning analysis)

Average Equip Weight: $WT_{equipe4} := 70 \cdot lbf$

Number of Sector Mounts: $N_{mounte4} := 9$

Approx. Self Weight per Sector Mount: $WT_{mounte4} := 90\ lbf$

Approx. wind surface area per mount: $A_{mounte4} := 4\ ft^2$

Wind Load on antennas: $W_{ante4} := 23.8 \cdot psf$

Wind Load on Mount: $W_{mounte4} := 25.1 \cdot psf$

Proposed US Cellular Antennas @ Shaft:

Number of Proposed Antennas: $N_{antn1} := 9$

Average antenna surface area: $A_{antn1} := 11.7 \cdot ft^2$

Average antenna Centroid: $y_{antn1} := 73 \cdot ft$

Average Antenna Weight: $WT_{antn1} := 70 \cdot lbf$

Number of Proposed Verizon Equipment: $N_{equipn1} := 12$

Average Existing equip surface area: $A_{equipn1} := 0 \cdot ft^2$

(New Equipment noted are placed on interior of tank and do not contribue to wind load for overturning analysis)

Average Equip Weight: $WT_{equipn1} := 50 \cdot lbf$

Number of Sector Mounts: $N_{mountn1} := 6$

Approx. Self Weight per Sector Mount: $WT_{mountn1} := 90\ lbf$

Approx. wind surface area per mount: $A_{mountn1} := 4\ ft^2$

Wind Load on antennas: $W_{antn1} := 23.8 \cdot psf$

Wind Load on Mount: $W_{mountn1} := 25.1 \cdot psf$

Miscellaneous Input Variables:

Tower property outputs:

Wind Load: $W_1 := 18 \cdot psf$ $W_2 := 19.38 \cdot psf$ $W_3 := 21.6 \cdot psf$ Note: Reference AWWA D100-2011

$W_{res} := 17.55 \cdot psf$ $W_{shft} := 18.28 \cdot psf$ $W_{bell} := 18 \cdot psf$

Area:

$$A_{shft} := D_{shft} \cdot H_{shft} = 1356\ ft^2$$

$$A_{bell} := (D_{shft} \cdot H_{bell}) + (D_{bell} - D_{shft}) \cdot .5 \cdot H_{bell} = 905.25\ ft^2$$

Centroid:

$$y_{res} := H_{shft} + H_{bell} + .5 \cdot H_{res} = 152.15\ ft$$

$$y_{shft} := .5 \cdot H_{shft} + H_{bell} = 80.7\ ft$$

$$y_{bell} := \left(\frac{H_{bell}}{3}\right) \cdot \left(\frac{(2 \cdot D_{shft} + D_{bell})}{(D_{shft} + D_{bell})}\right) = 15.31\ ft$$

Original Overturning Moment:

$$M_{orig} := (W_{bell} \cdot A_{bell} \cdot y_{bell}) + (W_{shft} \cdot A_{shft} \cdot y_{shft}) + (W_{res} \cdot A_{res} \cdot y_{res}) = 10397.5\ kip \cdot ft$$

Existing Overturning Moment:

Handrail Wind Shear: $W_{handrail} := 30.45 \cdot psf$ $H_{rail} := 181\ ft$ $WT_{rail} := 2\ kip$ (Approximate) $A_{rail} := 61\ ft^2$

$$M_{rail} := W_{handrail} \cdot A_{rail} \cdot H_{rail} = 336.2\ kip \cdot ft$$

$M_{ante1} := (W_{ante1} \cdot N_{ante1} \cdot A_{ante1} \cdot y_{ante1}) + (W_{ante1} \cdot N_{equipe1} \cdot A_{equipe1} \cdot y_{ante1}) = 625.12\ kip \cdot ft$

$M_{ante2} := (W_{ante2} \cdot N_{ante2} \cdot A_{ante2} \cdot y_{ante2}) + (W_{ante2} \cdot N_{equipe2} \cdot A_{equipe2} \cdot y_{ante2}) + (N_{mounte2} \cdot W_{mounte2} \cdot y_{ante2} \cdot A_{mounte2}) = 183.28\ kip \cdot ft$

$M_{ante3} := (W_{ante3} \cdot N_{ante3} \cdot A_{ante3} \cdot y_{ante3}) + (W_{ante3} \cdot N_{equipe3} \cdot y_{ante3} \cdot A_{equipe3}) = 53.79\ kip \cdot ft$

$M_{ante4} := (W_{ante4} \cdot N_{ante4} \cdot A_{ante4} \cdot y_{ante4}) + (W_{ante4} \cdot N_{equipe4} \cdot A_{equipe4} \cdot y_{ante4}) + (N_{mounte4} \cdot W_{mounte4} \cdot y_{ante4} \cdot A_{mounte4}) = 107.66\ kip \cdot ft$

$M_{exist} := (M_{orig} + M_{ante1} + M_{ante2} + M_{ante3} + M_{ante4} + M_{rail}) = 11703.55\ kip \cdot ft$

Proposed Overturning Moment:

$M_{antn1} := (W_{antn1} \cdot N_{antn1} \cdot A_{antn1} \cdot y_{antn1}) + (W_{antn1} \cdot N_{equipn1} \cdot A_{equipn1} \cdot y_{antn1}) + (N_{mountn1} \cdot W_{mountn1} \cdot y_{antn1} \cdot A_{mountn1}) = 226.92\ kip \cdot ft$

$M_{new} := (M_{exist} + M_{antn1} - M_{ante3}) = 11876.69\ kip \cdot ft$

Percent Increase in Overturning Moment from Original Design:

$$\%M_{inc1} := \left(\frac{M_{new} - M_{orig}}{M_{orig}}\right) \cdot 100 = 14.23$$

Percent Increase in Overturning Moment from Previous Design:

$$\%M_{inc2} := \left(\frac{M_{new} - (M_{exist})}{M_{exist}}\right) \cdot 100 = 1.48$$

Water Tower Anchor Bolt Capacity Check

Anchor Bolt Input Data:

Anchor Bolt GR: A449, Gr. 36 ksi

$F_u := 58 \cdot ksi$

$F_A := 15\ ksi$ (maximum tensile unit stress per AWWA)

$F_{nt} := .75 \cdot F_u = 43.5\ ksi$

Tower Base Circumference: $WT_{circ} := \pi \cdot D_{bell} = 113.1\ ft$

Anchor Bolt Size: $Sz_{anc} := 1.5 \cdot in$ $A_{st} := 1.77\ in^2$ Number of Anchors: $N_{anc} := 18$

Anchor Bolt Spacing: $S_{anc} := \dfrac{WT_{circ}}{N_{anc}} = 6.28\ ft$

$\gamma_{steel} := 490 \cdot \dfrac{lbf}{ft^3}$ $deg_{anc} := \dfrac{360}{N_{anc}} = 20$ $y_{anc} := \dfrac{D_{bell}}{2} = 18\ ft$

Veight of Tank (empty):

Weight of Tank (empty):

$$P_{res} := \pi \cdot D_{res} \cdot H_{res} \cdot t_{res} \cdot \gamma_{steel} = 343.88\ \boldsymbol{kip}$$

$$P_{shft} := H_{shft} \cdot D_{shft} \cdot t_{shft} \cdot \pi \cdot \gamma_{steel} = 243.53\ \boldsymbol{kip}$$

$$P_{bell} := \left(\left(\pi \cdot D_{bell}\right) - \left(\pi \cdot D_{shft}\right)\right) \cdot \gamma_{steel} \cdot H_{bell} \cdot t_{bell} = 119.54\ \boldsymbol{kip}$$

$$P_{ante1} := \left(N_{ante1} \cdot WT_{ante1}\right) + \left(N_{equipe1} \cdot WT_{equipe1}\right) = 1.72\ \boldsymbol{kip}$$

$$P_{ante2} := \left(N_{ante2} \cdot WT_{ante2}\right) + \left(N_{equipe2} \cdot WT_{equipe2}\right) + \left(N_{mounte2} \cdot WT_{mounte2}\right) = 1.38\ \boldsymbol{kip}$$

$$P_{ante4} := \left(N_{ante4} \cdot WT_{ante4}\right) + \left(N_{equipe4} \cdot WT_{equipe4}\right) + \left(N_{mounte4} \cdot WT_{mounte4}\right) = 0.95\ \boldsymbol{kip}$$

$$P_{antn} := \left(N_{antn1} \cdot WT_{antn1}\right) + \left(WT_{equipn1} \cdot N_{equipn1}\right) + \left(N_{mountn1} \cdot WT_{mountn1}\right) = 1.77\ \boldsymbol{kip}$$

$$P_{rail} := WT_{rail} = 2\ \boldsymbol{kip}$$

$P_{add} := 20 \cdot \boldsymbol{kip}$ (This is an additional assumed weight of interior steel, ladders, etc.)

$$P_{total} := P_{res} + P_{shft} + P_{bell} + P_{ante1} + P_{ante2} + P_{ante4} + P_{antn} + WT_{rail} + P_{add} = 734.77\ \boldsymbol{kip}$$

Max Tension Force of One Anchor:

$$F_{bolt} := \left(\frac{P_{total}}{N_{anc}}\right) - \left(4 \cdot \frac{M_{new}}{N_{anc} \cdot D_{bell}}\right) = -32.49\ \boldsymbol{kip}$$ (-value denotes uplift on anchor)

<u>Anchor Bolt Capacity:</u>

Note: Anchor bolt shear is resisted by anchors in compression only

$F_{bolt\_Capacity} := F_A \cdot A_{st} \cdot 1.33 = 35.31\ \boldsymbol{kip}$ (A 33% increase allowed per AWWA for anchors resisting wind loads)

$$F_{bolt\_Capacity2} := \frac{\left(0.75 \cdot F_u \cdot A_{st}\right)}{2} = 38.5\ \boldsymbol{kip}$$

Anchor Bolt Capacity Demand: $\%Anchor\_Demand := \left(\frac{F_{bolt}}{(-1) \cdot F_{bolt\_Capacity}}\right) \cdot 100 = 92.02$

<u>SUMMARY:</u>

$\%M_{inc1} = 14.23$

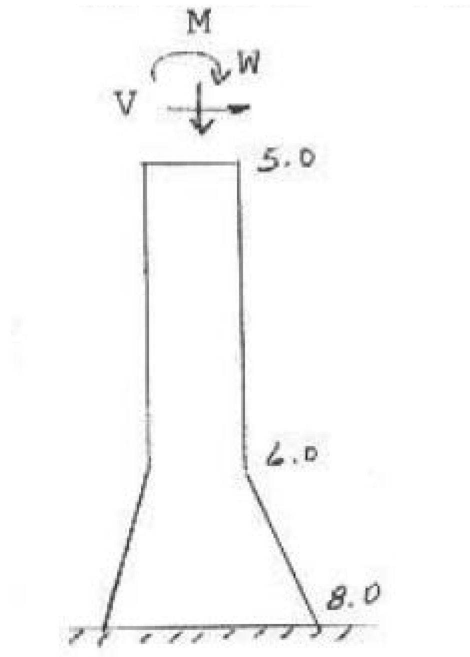
$\%M_{inc2} = 1.48$

$\%Anchor\_Demand = 92.02$

New antenna layout will increase the overturning moment on the tank approximately 1.48% from the previous antenna installation and approximately 14% from the original tank design. The anchor bolts are stressed at approximately 92% of their tensile steel capacity, when the tank is empty. The water tank anchorage is capable of safely resisting the resultant forces from overturning moment.

Tank Stress Design Check

-Per AWWA, use a 33% increase in allowable stress for wind load
- Basic Load combinations through AWWA-D100-11



Metal weight of reservoir: $W_{res} := 344\ kip$

Weight of water at Pt. 5 $W_w := 8340\ kip$

Height of Reservoir: $H_{res} := 52.5\ ft$

Height of shaft $H_{shft} := 90.4\ ft$

Height of Bell $H_{bell} := 35.5\ ft$

Wind shear on reservoir $V_{res} := 53.5\ kip$

Handrail & Handrail Antennas:

Weight of existing handrail+Antennas $W_{rail} := 3.72\ kip$

Height of railing above tank $H_{rail} := 3.5\ ft$

Wind shear on railing: $V_{rail} := 1.86\ kip$

Height of antennas above tank $H_{ant1} := 4.5\ ft$

Wind Shear of handrail Antennas: $V_{a1} := 3.4\ kip$

Pod framing /Monopole & Antennas on POD

Height of CL POD above tank: $H_{pod1} := 0\ ft$

Wind Shear of POD: $V_{pod1} := 0\ kip$

Weight of POD: $W_{pod1} := 0\ kip$

Height of CL POD platform above tank: $H_{frame1} := 0\ ft$

Wind Shear of platform frame: $V_{frame1} := 0\ kip$

Weight of platform frame $W_{frame1} := 0\ kip$

Antenna Weight at Platform: $W_{a1} := 0\ kip$

Load Combination: DL+WL

Check Point 5 (base of reservoir):

Shaft Diameter at pt. 5 $D_{in5} := 15\ ft$ Shaft thickness at pt. 5 $t_{shft5} := 1.247\ in$

$$D_{out5} := D_{in5} + \left(2 \cdot t_{shft5}\right) = 15.208\ ft$$

$$r_5 := \frac{\sqrt{\left(D_{out5}{}^2 + D_{in5}{}^2\right)}}{4} = 64.082\ in \qquad R_{shft5} := \frac{\frac{\left(D_{out5} + D_{in5}\right)}{2}}{2} = 7.552\ ft$$

$$ratio_{slender5} := \frac{(2 \cdot H_{shft})}{r_5} = 33.857$$

$$Ratio_1 := \frac{t_{shft5}}{R_{shft5}} = 0.014$$

$F_{L5} := 15\ \boldsymbol{ksi}$ Reference Table 12 for Class 1
Reference Table 13 for Class 2

$$C'c_5 := \sqrt{\frac{(\pi^2 \cdot 29000\ \boldsymbol{ksi})}{F_{L5}}} = 138.135$$

$$K_{\varphi 5} := \begin{array}{l} \text{if } ratio_{slender5} \le 25 \\ \quad 1 \\ \text{if } ratio_{slender5} \ge C'c_5 \\ \quad 0.5 \cdot \left(\left(\frac{C'c_5}{ratio_{slender5}} \right)^2 \right) \\ \text{if } 25 < ratio_{slender5} \le C'c_5 \\ \quad 1 - \left(0.5 \cdot \left(\frac{ratio_{slender5}}{C'c_5} \right)^2 \right) \end{array} = 0.97$$

$$F_{a5} := K_{\varphi 5} \cdot F_{L5} = 14.549\ \boldsymbol{ksi}$$

Antenna Wind Moment at Pt. 5 $M_{a5} := (V_{a1} \cdot (H_{res} + H_{ant1})) = 193.8\ \boldsymbol{kip \cdot ft}$

Handrail Moment at Pt. 5 $M_{rail5} := (V_{rail} \cdot (H_{res} + H_{rail})) = 104.16\ \boldsymbol{kip \cdot ft}$

POD Wind Moment at Pt. 5 $M_{pod5} := (V_{pod1} \cdot (H_{res} + H_{pod1})) + (V_{frame1} \cdot (H_{res} + H_{frame1})) = 0\ \boldsymbol{kip \cdot ft}$

Reservoir Wind Moment at Pt. 5 $M_{res5} := \left(V_{res} \cdot \frac{H_{res}}{2} \right) = 1404.375\ \boldsymbol{kip \cdot ft}$

1. Original Tank Loads Only

$$Axial_1 := \frac{(W_{res} + W_w)}{(2 \cdot \pi \cdot R_{shft5})} = 15.251\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$V_1 := \frac{(M_{res5})}{\left(\pi \cdot \left(R_{shft5}{}^2\right)\right)} = 0.653\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

Dead Load: $Stress_1 := \frac{Axial_1}{t_{shft5}} = 12.23\ \boldsymbol{ksi}$

$$Result_1 := \begin{array}{l} \text{if } Stress_1 \le F_{a5} \\ \quad \text{“Stress OK”} \\ \text{if } Stress_1 > F_{a5} \\ \quad \text{“Overstress”} \end{array} = \text{“Stress OK”}$$

Dead Load + Wind Load: $Stress_2 := \frac{Axial_1 + V_1}{t_{shft5}} = 12.754\ \boldsymbol{ksi}$ $Result_2 := \begin{Vmatrix} \text{if } Stress_2 \le F_{a5} \cdot 1.33 \\ \quad \Vert \text{"Stress OK"} \\ \text{if } Stress_2 > F_{a5} \cdot 1.33 \\ \quad \Vert \text{"Overstress"} \end{Vmatrix} = \text{"Stress OK"}$

2. Original Tank Load and Antenna Loads

$$Axial_2 := \frac{\left(W_{res} + W_w + W_{rail} + W_{a1} + W_{pod1} + W_{frame1}\right)}{\left(2 \cdot \pi \cdot R_{shft5}\right)} = 15.258\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$V_2 := \frac{\left(M_{rail5} + M_{res5} + M_{a5} + M_{rail5} + M_{pod5}\right)}{\left(\pi \cdot \left(R_{shft5}{}^2\right)\right)} = 0.84\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

Dead Load: $Stress_3 := \frac{Axial_2}{t_{shft5}} = 12.235\ \boldsymbol{ksi}$ $Result_3 := \begin{Vmatrix} \text{if } Stress_3 \le F_{a5} \\ \quad \Vert \text{"Stress OK"} \\ \text{if } Stress_3 > F_{a5} \\ \quad \Vert \text{"Overstress"} \end{Vmatrix} = \text{"Stress OK"}$

Dead Load + Wind Load: $Stress_4 := \frac{Axial_2 + V_2}{t_{shft5}} = 12.909\ \boldsymbol{ksi}$ $Result_4 := \begin{Vmatrix} \text{if } Stress_4 \le F_{a5} \cdot 1.33 \\ \quad \Vert \text{"Stress OK"} \\ \text{if } Stress_4 > F_{a5} \cdot 1.33 \\ \quad \Vert \text{"Overstress"} \end{Vmatrix} = \text{"Stress OK"}$

Check Point 6 (base of Shaft):

Shaft Diameter at pt. 6 $D_{in6} := 15\ \boldsymbol{ft}$ Shaft thickness at pt. 6 $t_{shft6} := 1.626\ \boldsymbol{in}$

$$D_{out6} := D_{in6} + \left(2 \cdot t_{shft6}\right) = 15.271\ \boldsymbol{ft}$$

$$R_{shft6} := \frac{\frac{\left(D_{out6} + D_{in6}\right)}{2}}{2} = 7.568\ \boldsymbol{ft} \qquad r_6 := \frac{\sqrt{\left(D_{out6}{}^2 + D_{in6}{}^2\right)}}{4} = 64.217\ \boldsymbol{in}$$

$$ratio_{slender6} := \frac{\left(2 \cdot H_{shft}\right)}{r_6} = 33.785$$

$$Ratio_2 := \frac{t_{shft6}}{R_{shft6}} = 0.018$$

$F_{L6} := 15\ \boldsymbol{ksi}$ Reference Table 12 for Class 1
Reference Table 13 for Class 2

$$C'c_6 := \sqrt{\frac{\left(\pi^2 \cdot 29000\ \boldsymbol{ksi}\right)}{F_{L6}}} = 138.135$$

$$K_{\varphi6} := \left\| \begin{array}{l} \text{if } ratio_{slender6} \le 25 \\ \quad \| \; 1 \\ \text{if } ratio_{slender6} \ge C'c_6 \\ \quad \left\| \; 0.5 \cdot \left(\left(\dfrac{C'c_6}{ratio_{slender6}} \right)^2 \right) \right. \\ \text{if } 25 < ratio_{slender6} \le C'c_6 \\ \quad \left\| \; 1 - \left(0.5 \cdot \left(\dfrac{ratio_{slender6}}{C'c_6} \right)^2 \right) \right. \end{array} \right. = 0.97$$

$F_{a6} := 15 \; \boldsymbol{ksi}$

Metal weight of shaft: $W_{shft} := 243.5 \; \boldsymbol{kip}$

Wind shear on shaft: $V_{shft} := 24.78 \; \boldsymbol{kip}$

Existing Anenna information @ RAD = 105' (Other Carriers)

Exsting Shaft Antenna RAD $H_{ant3} := 105 \; \boldsymbol{ft}$

Existing Shaft Antenna & Mount Wind Shear $V_{a3} := 1.73 \; \boldsymbol{kip}$

Existing Antenna & Mount Weight at shaft $W_{a3} := 1.3 \; \boldsymbol{kip}$

Proposed US Cellular Anenna information @ RAD = 73' (Includes existing mounts and antennas remaining from previous install)

Proposed Antenna & Mount Weight on Shaft: $W_{a4} := 2.72 \; \boldsymbol{kip}$

Proposed Antenna wind Shear: $V_{a4} := 4.58 \; \boldsymbol{kip}$

Proposed Shaft Antenna RAD $RAD := 73 \; \boldsymbol{ft}$

Antenna Wind Moment at Pt. 6

$$M_{ante6} := \left(V_{a1} \cdot \left(H_{res} + H_{ant1} + H_{shft}\right)\right) + V_{a3} \cdot \left(H_{ant3} - H_{bell}\right) = 621.395 \; \boldsymbol{kip \cdot ft}$$

$$M_{antn6} := V_{a4} \cdot \left(RAD - H_{bell}\right) = 171.75 \; \boldsymbol{kip \cdot ft}$$

Railing Wind Moment at Pt. 6 $M_{rail6} := \left(V_{rail} \cdot \left(H_{res} + H_{rail} + H_{shft}\right)\right) = 272.304 \; \boldsymbol{kip \cdot ft}$

POD Wind Moment at Pt. 6

$$M_{pod1\_6} := \left(V_{pod1} \cdot \left(H_{res} + H_{pod1} + H_{shft}\right)\right) + \left(V_{frame1} \cdot \left(H_{res} + H_{frame1} + H_{shft}\right)\right) = 0 \; \boldsymbol{kip \cdot ft}$$

$$M_{pod6} := M_{pod1\_6} = 0 \; \boldsymbol{kip \cdot ft}$$

Reservoir Wind Moment at Pt. 6 $M_{res6} := \left(V_{res} \cdot \left(\frac{H_{res}}{2} + H_{shft}\right)\right) = 6240.775\ \boldsymbol{kip \cdot ft}$

Shaft Wind Moment at Pt. 6 $M_{shft6} := \left(V_{shft} \cdot \left(\frac{H_{shft}}{2}\right)\right) = 1120.056\ \boldsymbol{kip \cdot ft}$

1. Original Tank Loads Only

$$Axial_3 := \frac{\left(W_{res} + W_w + W_{shft}\right)}{\left(2 \cdot \pi \cdot R_{shft6}\right)} = 15.646\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$V_3 := \frac{\left(M_{res6} + M_{shft6}\right)}{\left(\pi \cdot \left(R_{shft6}{}^2\right)\right)} = 3.409\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

Dead Load: $Stress_5 := \frac{Axial_3}{t_{shft6}} = 9.622\ \boldsymbol{ksi}$ $\quad Result_5 := \begin{array}{l} \text{if } Stress_5 \le F_{a6} \\ \quad \text{“Stress OK”} \\ \text{if } Stress_5 > F_{a6} \\ \quad \text{“Overstress”} \end{array} = \text{“Stress OK”}$

Dead Load + Wind Load: $Stress_6 := \frac{Axial_3 + V_3}{t_{shft6}} = 11.719\ \boldsymbol{ksi}$ $\quad Result_6 := \begin{array}{l} \text{if } Stress_6 \le F_{a6} \cdot 1.33 \\ \quad \text{“Stress OK”} \\ \text{if } Stress_6 > F_{a6} \cdot 1.33 \\ \quad \text{“Overstress”} \end{array} = \text{“Stress OK”}$

2. Original Tank Load and Antenna Loads

$$Axial_4 := \frac{\left(W_{res} + W_w + W_{rail} + W_{shft} + W_{pod1} + W_{frame1} + W_{a1} + W_{a3} + W_{a4}\right)}{\left(2 \cdot \pi \cdot R_{shft6}\right)} = 15.66\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

$$V_4 := \frac{\left(M_{rail6} + M_{res6} + M_{ante6} + M_{shft6} + M_{antn6} + M_{pod6}\right)}{\left(\pi \cdot \left(R_{shft6}{}^2\right)\right)} = 3.903\ \frac{\boldsymbol{kip}}{\boldsymbol{in}}$$

Dead Load: $Stress_7 := \frac{Axial_4}{t_{shft6}} = 9.631\ \boldsymbol{ksi}$ $\quad Result_7 := \begin{array}{l} \text{if } Stress_7 \le F_{a6} \\ \quad \text{“Stress OK”} \\ \text{if } Stress_7 > F_{a6} \\ \quad \text{“Overstress”} \end{array} = \text{“Stress OK”}$

Dead Load + Wind Load: $Stress_8 := \frac{Axial_4 + V_4}{t_{shft6}} = 12.031\ \boldsymbol{ksi}$ $\quad Result_8 := \begin{array}{l} \text{if } Stress_8 \le F_{a6} \cdot 1.33 \\ \quad \text{“Stress OK”} \\ \text{if } Stress_8 > F_{a6} \cdot 1.33 \\ \quad \text{“Overstress”} \end{array} = \text{“Stress OK”}$

Summary: Tank Shaft Stresses Sufficient for proposed new loading.

Penetration Calculation

Referenced Code: AWWA-D100-11

NOTE: Only cut-outs 4" or less are allowed without reinforcement

Input Variables:

Steel Weight/Dead Load tank above penetration: $W_1 := 614\ kip$ Water weight in tank, $W_2 := 8340\ kip$

Stem Diameter $d_{stem} := 15\ ft$

Stem metal thickness $t_1 := 1.56 \cdot in$ $d_i := d_{stem} - (2 \cdot t_1) = 14.74\ ft$ $H_{shft} := 90.4\ ft$

Diameter of penetration: $d_{hole} := 4 \cdot in$

Number of penetrations in a single vertical plane $n_1 := 1$

Vertical distance between holes $h_1 := 0 \cdot in$

Number of penetrations along stem: $n_2 := 6$

Wind surface area of reservoir: $A_{res} := 3051\ ft^2$

Wind Load: $W_{res} := 17.55\ psf$ $W_{shft} := 18.28\ psf$

Distance from top of reservoir to hole: $H := 105.5\ ft$

Tank circumference at hole: $Circ := 3.14 \cdot d_{stem} = 47.1\ ft$

Area of steel at stem: $A_{st} := Circ \cdot t_1 = 881.712\ in^2$

Net area at holes: $A_{net} := (Circ - (n_2 \cdot d_{hole})) \cdot t_1 = 844.272\ in^2$

Load Combination: DL+LL

$$Ratio_1 := \frac{t_1}{\left(\frac{d_{stem}}{2}\right)} = 0.017 \qquad r := \frac{\sqrt{\left(d_{stem}^{\ 2} + d_i^{\ 2}\right)}}{4} = 63.09\ in$$

$$slenderness := \frac{(2 \cdot H_{shft})}{r} = 34.389$$

Axial stress on tank wall:

$$f_{aorig} := \frac{(W_1 + W_2)}{A_{st}} = 10.155\ ksi$$

$$f_a := \frac{(W_1 + W_2)}{A_{net}} = 10.606\ ksi$$

$F_a := 15\ ksi$ Reference Table 12 for Class 1
Reference Table 13 for Class 2

$$Result_1 := \begin{array}{|l} \text{if } f_a \le F_a \\ \quad \| \text{"Stress OK"} \\ \text{if } f_a > F_a \\ \quad \| \text{"Overstress – Reinforce Penetration"} \end{array} = \text{"Stress OK"}$$

Load Combination: DL+.75LL +.75WL

Axial stress on tank wall: $f_a := \dfrac{(W_1 + .75 \cdot W_2)}{A_{net}} = 8.136\ ksi$

$F_a = 15\ ksi$

Overturning Moment at hole location: $M_{OT} := 0.75 \cdot W_{res} \cdot A_{res} \cdot H = 4236.752\ (kip \cdot ft)$

$d_{out} := d_{stem} = 180\ in$

$d_{in} := d_{stem} - (2 \cdot t_1) = 176.88\ in$

$$S_{riser} := \left(\frac{3.14}{32}\right) \cdot \left(\frac{\left({d_{out}}^4 - {d_{in}}^4\right)}{d_{out}}\right) = \left(3.866 \cdot 10^4\right)\ in^3$$

$$f_b := \frac{M_{OT}}{S_{riser}} = 1.315\ ksi$$

$F_b := 18\ ksi$

Axial + Bending stress : $Combo := \dfrac{f_b}{F_b} + \dfrac{f_a}{F_a} = 0.615$

$$Result_2 := \begin{array}{|l} \text{if } Combo \le 1 \\ \quad \| \text{"Stress OK"} \\ \text{if } Combo > 1 \\ \quad \| \text{"Overstress"} \end{array} = \text{"Stress OK"}$$

Check Pipe Neck for Reinforcement:

Neck thickness of pipe: $t_p := 0.318 \cdot in$

Outside Diameter of Pipe: $d_p := 4 \cdot in$ $Id_p := d_p - (2 \cdot t_p) = 3.364\ in$

Length of Pipe (centered on opening): $l_p := 5 \cdot in$

Effective widith of pipe used for reinforcement: $w_e := 4 \cdot t_p \cdot 2 = 2.544\ in$

Effective Area of neck reinforcement $A_{neck} := w_e \cdot t_p \cdot 2 = 1.618\ in^2$

Area of shell cut-out $A_{shell} := t_1 \cdot Id_p = 5.248\ in^2$

Required thickness of pipe for adequate reinforcement area: $t_{preq} := \sqrt{\dfrac{(Id_p \cdot t_1)}{8 \cdot 2}} = 0.573\ in$

$$Result_1 := \begin{Vmatrix} \text{if } t_{preq} \le t_p \\ \quad \Vert \text{“thickness sufficient”} \\ \text{if } t_{preq} > t_p \\ \quad \Vert \text{“revise pipe thickness”} \end{Vmatrix} = \text{“revise pipe thickness”}$$

$$Result_2 := \begin{Vmatrix} \text{if } A_{shell} \le A_{neck} \\ \quad \Vert \text{“neck self reinforcing”} \\ \text{if } A_{shell} > A_{neck} \\ \quad \Vert \text{“additional reinforcement required”} \end{Vmatrix} = \text{“additional reinforcement required”}$$

<u>Design Reinforcing Plate for Buckling:</u>

Section Properties of Reinforcing plate:

Reinforcement plate: $w_1 := 4 \cdot in$

$t_2 := .5 \cdot in$

$L_1 := 18 \cdot in$

$F_y := 36\ ksi$ $L_2 := 4 \cdot in$ (use L2 as unbraced length in compression analysis below)

weld size $w := 0.5 \cdot in$ NOTE: Weld size should be size of reinf. plate or bell thickness, whichever is smaller

$A_p := w_1 \cdot t_2 = 2\ in^2$ (compressive area of plate to carry force that would be carried by new penetrations)

$r_p := \dfrac{t_2}{\left(12^{(.5)}\right)} = 0.144\ in$ $K := .65$ $\dfrac{K \cdot L_1}{r_p} = 81.06$ $F_e := \left(3.14^2 \cdot \dfrac{29500\ ksi}{\left(K \cdot \dfrac{L_1}{r_p}\right)^2}\right) = 44.266\ ksi$

If KL/r is less than 133.7: $F_{cr1} := \left(0.658^{\left(36 \frac{ksi}{F_e}\right)}\right) \cdot 36\ ksi = 25.614\ ksi$

If KL/r is greater than 133.7 : $F_{cr2} := 0.877 \cdot F_e = 38.821\ ksi$

$$F_{cr} := \begin{Vmatrix} \text{if } \left(K \cdot \dfrac{L_1}{r_p}\right) \le 133.7 \\ \quad \Vert F_{cr1} \\ \text{if } \left(K \cdot \dfrac{L_1}{r_p}\right) > 133.7 \\ \quad \Vert F_{cr2} \end{Vmatrix} = 25.614\ ksi$$

Compressive Strength of Reinforcing plate:

$$P_n := n_2 \cdot F_{cr} \cdot \frac{A_p}{1.67} = 184.05\ \boldsymbol{kip}$$

Force transferred through hole $P := d_{hole} \cdot t_1 \cdot F_a = 93.6\ \boldsymbol{kip}$

$$Result_3 := \begin{Vmatrix} \text{if } P \le P_n \\ \quad \Vert \text{"Stress OK"} \\ \text{if } P > P_n \\ \quad \Vert \text{"Overstress"} \end{Vmatrix} = \text{"Stress OK"}$$

Weld:

Weld strength $F_w := .707 \cdot 21\ \boldsymbol{ksi} \cdot w = 7.424\ \dfrac{\boldsymbol{kip}}{\boldsymbol{in}}$

Required height of plate above CL of penetration $h_2 := \left(\dfrac{d_{hole}}{2}\right) + \dfrac{\left(\dfrac{P}{n_2}\right)}{F_w} = 4.101\ \boldsymbol{in}$

Required height of plate after penetration: $h_3 := \dfrac{\left(\dfrac{\left(\dfrac{P}{n_2}\right)}{F_w}\right)}{2} = 1.051\ \boldsymbol{in}$

Total required length of plate $L_4 := h_2 + h_2 = 8.203\ \boldsymbol{in}$

Total required length of plate based on weld $L_3 := h_2 + \left(\left(n_1 - 1\right) \cdot h_1\right) + h_2 = 8.203\ \boldsymbol{in}$

$$Result_2 := \begin{Vmatrix} \text{if } L_3 \le L_1 \\ \quad \Vert \text{"Stress OK"} \\ \text{if } L_3 > L_1 \\ \quad \Vert \text{"Overstress"} \end{Vmatrix} = \text{"Stress OK"}$$

Provide 4" Sch. 80 x 0'-5" long pipe sleeve (thickness 0.337 inches). Secure with 1/2" all around fillet weld. Add additional 0'-4" x 1/2" x 18" reinforcing bars on each side of the opening. Weld to tank shaft with 1/2" fillet welds.

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STRUCTURAL DESIGN CRITERIA

TIA-222-H

1. GOVERNING CODES: WELDED CARBON STEEL TANKS FOR WATER STORAGE, AWWA D100-11
   INTERNATIONAL BUILDING CODE 2015
2. SNOW LOAD:

   MINIMUM DESIGN SNOW LOAD: PD = 25 PSF
3. WIND DESIGN DATA:

   BASIC WIND SPEED (3-SECOND GUST): V = 90 MPH
   WIND IMPORTANCE FACTOR: IW = 1.15
   WIND EXPOSURE: C

GENERAL

1. THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING DIMENSIONS, ELEVATIONS, AND CONDITIONS PRIOR TO COMMENCING ANY WORK. THE CONTRACTOR WILL BE SOLELY RESPONSIBLE FOR THE PROPER FIT AND CLEARANCE IN THE FIELD. CONTACT EDGE CONSULTING ENGINEERS, INC. IF ANY DISCREPANCIES EXIST.

   DO NOT SCALE DRAWINGS.
2. THIS DRAWING IS NOT VALID IF LOADS OTHER THAN THOSE CONSIDERED IN THE STRUCTURAL ANALYSIS ARE ADDED TO OR REMOVED FROM THE STRUCTURE UNLESS APPROVED IN WRITING BY EDGE CONSULTING ENGINEERS, INC.
3. THE PROPOSED LOADS SHALL NOT BE ADDED TO THE STRUCTURE UNTIL ALL MODIFICATIONS ARE MADE AND APPROVED BY THE WELDING INSPECTOR.
4. THE DRAWINGS REPRESENT THE FINISHED STRUCTURE UNLESS NOTED OTHERWISE. THE DRAWINGS DO NOT INDICATE THE MEANS OR METHODS OF CONSTRUCTION. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ALL CONSTRUCTION PROCEDURES AND PRACTICES.
5. THE DRAWINGS DO NOT INCLUDE THE NECESSARY COMPONENTS OR EQUIPMENT FOR THE STABILITY OF THE STRUCTURE DURING CONSTRUCTION UNLESS NOTED OTHERWISE. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR STRUCTURAL STABILITY DURING CONSTRUCTION. THIS INCLUDES, BUT IS NOT LIMITED TO, ERECTION PROCEDURES AND SEQUENCE, SHORING, BRACING, RIGGING, GUYS, SCAFFOLDING, FORMWORK, AND OTHER WORK AIDS TO SAFELY PERFORM THE WORK SHOWN ON THE DRAWINGS.
6. BEFORE PROCEEDING WITH ANY WORK ADJACENT TO OR WITHIN THE EXISTING STRUCTURE, THE CONTRACTOR SHALL BECOME FAMILIAR WITH EXISTING CONDITIONS. DURING THE PROCESS OF CONSTRUCTION, THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR MAINTAINING THE INTEGRITY OF THE EXISTING STRUCTURE WHERE THE EXISTING STRUCTURE IS MODIFIED TO ACCOMMODATE NEW CONSTRUCTION AND FOR PROTECTING FROM DAMAGE THOSE PORTIONS OF THE EXISTING STRUCTURE WHICH ARE TO REMAIN.
7. THE CONTRACTOR SHALL NOT CUT, CORE, DRILL, OR OTHERWISE ALTER THE EXISTING STRUCTURAL ELEMENTS OTHER THAN THE MODIFICATIONS SHOWN ON THE DRAWINGS WITHOUT PRIOR WRITTEN APPROVAL OF EDGE CONSULTING ENGINEERS, INC.
8. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR THE ON-SITE SAFETY ASSOCIATED WITH THE WORK TO BE PERFORMED. ALL SAFETY REQUIREMENTS AS DICTATED BY OSHA AND THE LOCAL JURISDICTION'S SHALL BE FOLLOWED.
9. IT SHOULD BE UNDERSTOOD THAT THE CONTRACTOR IS THE GUARANTOR OF ALL WORK AND RESPONSIBLE TO CONSTRUCT THE TOWER SITE ACCORDING TO APPLICABLE PLANS, SPECIFICATIONS AND STANDARDS.
10. SECTIONS, DETAILS, AND NOTES SHOWN ON THE DRAWINGS ARE INTENDED TO BE TYPICAL AND SHALL APPLY TO SIMILAR CONDITIONS ELSEWHERE, UNLESS OTHERWISE SHOWN.
11. ALL MATERIALS, WORKMANSHIP, AND DETAILS SHALL CONFORM TO THE LATEST EDITION OF THE BUILDING CODE.
12. ALL PROPOSED INSTALLATIONS SHALL NOT DENY OR INTERFERE WITH AND ACCESS TO ANY OPERATIONAL OR SAFETY EQUIPMENT/APPURTENANCES.

PROTECTIVE GROUNDING

1. TOWER GROUNDING SHALL BE IN ACCORDANCE WITH CHAPTER 10 OF THE TIA-222 REV. G CODE WITH THE FOLLOWING EXCEPTIONS:
   - UNO, NO TESTING TO VERIFY FINAL RESISTANCE SHALL BE COMPLETED UNLESS IT IS SPECIFICALLY REQUESTED BY THE CLIENT.
   - ALTERNATE GROUNDING METHODS FOR SPECIFIC SITE CONDITIONS DESIGNED IN ACCORDANCE WITH MOTOROLA R56 "STANDARDS AND GUIDELINES FOR COMMUNICATION SITES" MAY BE USED WITH ENGINEER APPROVAL.

WATER TANK DESIGN LOADS (PER AWWA-D100-11):
A. WIND LOAD:
   ULTIMATE WIND SPEED (3 SEC. GUST) = 120 MPH (PER 2015 IBC WIND SPEED MAPS)
   NOMINAL WIND SPEED CONVERSION = 93 MPH
   RISK CATEGORY: III
   WIND IMPORTANCE FACTOR: I_W = 1.15
   WIND EXPOSURE: C

ANTENNA SUPPORTING STRUCTURES & ANTENNA DESIGN LOADS (PER TIA-222-H)
A. WIND LOAD:
   ULTIMATE WIND SPEED (3 SEC. GUST) = 107 MPH
   RISK CATEGORY II
   WIND IMPORTANCE FACTOR: I_W = 1.0
   WIND EXPOSURE: C
B. ICE LOAD:
   UNIFORM ICE THICKNESS: T = 1.5 INCHES
   ICE IMPORTANCE FACTOR: I_i = 1.0
   DESIGN ICE THICKNESS: T_D = 1.86 INCHES
   CONCURRENT WIND SPEED (3 SEC. GUST) = 40 MPH

STRUCTURAL STEEL

1. STRUCTURAL STEEL DESIGN AND FABRICATION SHALL BE IN ACCORDANCE WITH THE CURRENT AISC STEEL CONSTRUCTION MANUAL.
2. MATERIAL PROPERTIES ARE TO BE AS INDICATED BELOW UNLESS NOTED OTHERWISE.

W-SHAPES	Fy = 50 KSI (A992 OR A572 Gr 50)
C-SHAPES & ANGLES	Fy = 36 KSI (A36)
PLATES & BARS	Fy = 36 KSI (A36)
SQUARE TUBES	Fy = 50 KSI (A500 Gr C)
ROUND TUBES	Fy = 35 KSI (A53 TYPE S, Gr B)
RODS	Fy = 36 KSI (A36)
ANCHOR RODS	Fy = 36 KSI (F1554-Gr 36)
U-BOLTS	Fu = 58 KSI MIN.

3. MINIMUM BOLT EDGE DISTANCES ARE TO BE THE LARGER OF THE EXISTING CONDITION OR THE TABLE PROVIDED BELOW UNLESS APPROVED BY THE ENGINEER.

BOLT DIAMETER (IN)	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	> 1 1/4
MIN. EDGE DISTANCE	3/4	7/8	1	1 1/8	1 1/4	1 1/2	1 5/8	1.25 x d

4. ALL CONNECTION BOLTING IS TO BE WITH A-325X BOLTS UNLESS NOTED OTHERWISE. BOLTS NEED ONLY BE TIGHTENED TO THE SNUG-TIGHT CONDITION. SNUG-TIGHT IS DEFINED AS THE TIGHTNESS OBTAINED BY A FEW IMPACTS OF AN IMPACT WRENCH OR THE FULL EFFORT OF A PERSON USING AN ORDINARY SPUD WRENCH. ALL U-BOLT CLAMP CONNECTIONS ARE TO BE INSTALLED IN A PRETENSIONED CONDITION USING THE TURN OF THE NUT OR ALTERNATIVE PROCEEDURE REFERENCED BY AISC.
5. ALL STEEL FRAMING MEMBERS, CONNECTION PLATES, FASTENERS AND ANCHOR BOLTS EXPOSED TO EARTH OR WEATHER TO HAVE HOT-DIP GALVANIZED FINISH UNLESS OTHERWISE SPECIFIED. APPLY COATING BY THE HOT-DIP PROCESS FOR GALVANIZING ACCORDING TO ASTM A123 OR ASTM A153.
6. ALL DINGS, SCRAPES, MARS AND WELDS IN THE GALVANIZED AREA SHALL BE COATED WITH A ZINC-RICH PAINT, APPLIED IN STRICT ACCORDANCE WITH MANUFACTURER'S SPECIFICATIONS AND RECOMMENDATIONS.
7. AFTER ZINC-RICH PAINT IS DRY, OVERCOAT WITH AN APPROPRIATE PAINT WITH THE SAME COLOR AS THE EXISTING.
8. SUBMIT SHOP DRAWINGS DETAILING FABRICATION OF STRUCTURAL STEEL COMPONENTS TO ENGINEER OF RECORD.
9. STEEL BEAMS WITH RESIDUAL CAMBER RESULTING FROM MILL FABRICATION OR ROLLING SHALL BE SHOP FABRICATED AND ERECTED SUCH THAT THIS RESIDUAL CAMBER COUNTERACTS GRAVITY LOAD DEFLECTION.
10. U.N.O., POST INSTALLED ANCHORS ARE TO BE HILTI HIT HY 200 ADHESIVE ANCHORS FOR SOLID BASE MATERIAL AS MANUFACTURED BY HILTI FASTENING SYSTEMS OF TULSA, OKLAHOMA OR APPROVED EQUAL. THE STEEL ANCHORS ARE TO BE HILTI HAS-R THREADED ROD OR CONTINUOUSLY THREADED STAINLESS STEEL ROD THAT COMPLY WITH ASTM F593 CW2 AND THAT HAVE THREAD CHARACTERISTICS COMPARABLE WITH ANSI B1.1 UNC COARSE THREAD SERIES. INSTALL ANCHORS WITH EMBEDMENT DEPTHS INDICATED.
11. U.N.O., NON-SHRINK GROUT SHALL BE A NON-METALLIC PREMIXED FORMULATION EQUIVALENT TO MASTERFLOW 713 PLUS BY DEGUSSA BUILDING SYSTEMS WITH A MINIMUM CONCRETE COMPRESSIVE STRENGTH OF 6000 PSI. BEAM AND LINTEL PLATES SHALL BE FULLY GROUTED WITH A MINIMUM 1/2" NON-SHRINK GROUT. COLUMN BASE PLATES SHALL BE FULLY GROUTED WITH A MINIMUM OF 1 1/2" NON-SHRINK GROUT.
12. METAL BAR GRATING SHALL BE FURNISHED AND INSTALLED ACCORDING TO ANSI/NAAMM MBG 531-00 METAL BAR GRATING MANUAL. METAL BAR GRATING SHALL BE WELDED STEEL GRATING FABRICATED FROM CARBON STEEL WITH MINIMUM BENDING STRESS OF FY=18,000 PSI AND E=29,000,000 PSI. THE MANUFACTURER SHALL SUBMIT (4) SETS OF PANEL FABRICATION DRAWINGS WITH ERECTION PLANS IDENTIFYING EACH PANEL WITH A MARK NUMBER AND PANEL DIMENSIONS. SHOP DRAWINGS SHALL BE SUBMITTED AND APPROVED PRIOR TO FABRICATION AND SHIPMENT OF GRATING. ALL GRATING PANELS SHALL BE CUT TO SIZE AND BANDED. GRATING SHALL BE FINISHED ACCORDING TO THE BID OPTION SELECTED. EACH GRATING PANEL SHALL BE TAGGED WITH THE ORDER NUMBER AND MARK NUMBER CORRESPONDING TO THE ERECTION PLAN. FIELD CUTTING OF GRATING IS NOT PERMITTED WITHOUT PRIOR WRITTEN APPROVAL OF THE ENGINEER. GRATING MAY BE FASTENED TO STRUCTURE BY WELDS OR CLIPS ACCORDING NAAMM STANDARDS.

EXISTING STRUCTURE REINFORCEMENT

1. MODIFICATIONS TO EXISTING STRUCTURES SHALL BE BASED UPON A RIGOROUS STRUCTURAL ANALYSIS.
2. ALL STRUCTURAL MEMBERS/CONNECTIONS HAVE BEEN DESIGNED IN ACCORDANCE WITH THE DESIGN CRITERIA.
3. PRIOR TO IMPLEMENTATION OF THE CHANGED CONDITIONS AND/OR MODIFICATIONS, ITEMS ON THE DESIGN DOCUMENT REQUIRING VERIFICATION SHALL BE RESOLVED.

WATER TOWER SPECIFICATIONS

WELDING NOTES:

1. ALL WELDING TO THE TANK STRUCTURE SHALL COMPLY WITH THE CURRENT ANSI/AWWA D100 STANDARD FOR WELDED STEEL TANKS FOR WATER STORAGE AND FEDERAL, STATE AND LOCAL CODES IN ADDITION TO AWS D1.1 STRUCTURAL WELDING CODE - STEEL.
2. NO WELDING SHALL BE DONE WHEN THE AMBIENT TEMPERATURE IS BELOW 32 DEGREES FAHRENHEIT UNLESS THE REQUIREMENTS OF AWWA D100, SEC 10.2.1 ARE MET.
3. WELDING TO THE TANK OR ACCESS TUBE OPPOSITE THE WATER LEVEL IS NOT PERMITTED. THE WATER LEVEL SHALL BE DRAWN DOWN TO A LEVEL TWO FEET BELOW THE POINT OF WELDING.
4. WELDING MAY CAUSE BLISTERING OF THE INTERIOR PAINT OPPOSITE THE WELD. ALL DAMAGED PAINT SURFACES INSIDE AND OUT SHALL BE REPAIRED. EXTERIOR PAINT DAMAGE SHALL BE REPAIRED AFTER COMPLETION OF THE ANTENNA INSTALLATION. CONTRACTOR IS TO COORDINATE WITH TOWER OWNER ON EXISTING PAINT SYSTEM.
5. PROTECT TANK SURFACES WITH WELDING BLANKETS ADJACENT TO WORK AREAS WHERE CUTTING, GRINDING AND WELDING ARE REQ'D.
6. GALVANIZED COMPONENTS SHALL NOT BE WELDED DIRECTLY TO THE TANK SURFACE. OTHER GALVANIZED SURFACES SHALL BE GROUND FREE OF GALVANIZING BEFORE WELDING.
7. UNACCEPTABLE WELDS SHALL BE REPAIRED AS REQUIRED TO MEET AWWA D100 REQUIREMENTS.
8. ALL ELECTRODES SHALL BE LOW HYDROGEN E70XX ELECTRODES, PER AWS D1.1 SPECIFICATIONS UNLESS NOTED OTHERWISE.
9. PRE-HEATING SHALL MEET THE MINIMUM TEMPERATURE REQUIREMENTS FOR STEEL GRADE AND THICKNESS IN CONFORMANCE WITH AWS D1.1.
10. WELD SMOOTH AND AVOID UNDERCUTS AND BURRS. GRIND ALL WELDS SMOOTH SO THAT NO SHARP PROTRUSIONS REMAIN. SMOOTH IS DEFINED AS: "NO CUTS OR ABRASIONS OCCUR WHEN RUBBING YOUR HAND OVER WELD.

PENETRATION NOTES:

1. ALL PIPE PENETRATIONS MUST CLEAR EXISTING TANK WELD SEAMS BY AT LEAST 6" (VERTICAL & HORIZONTAL).
2. TANK WATER LEVEL MUST BE LOWERED TO 50% OF MAXIMUM CAPACITY AND STIFFENERS ADDED BEFORE OPENINGS ARE CUT. WATER LEVEL REDUCTION TO BE SCHEDULED AT MUNICIPALITY'S CONVENIENCE TO MATCH WATER DEMAND. PROVIDE 2 DAYS MINIMUM NOTICE TO MUNICIPALITY.
3. CUT AND WELD PIPE SLEEVE IN PLACE COMPLETELY BEFORE REPEATING FOR ADDITIONAL SLEEVES.

PAINTING SPECIFICATIONS:

1. VERIFY PAINTING SPECIFICATIONS AND REQUIREMENTS WITH TANK OWNER.
2. CONTRACTOR IS RESPONSIBLE FOR CLEANING AND TEMP COATING ALL EXTERIOR WELDED OR DAMAGED COATING SURFACES.
   A. CLEAN ALL WELDS OR DAMAGED COATING SURFACES TO SSPC-SP11 "POWER TOOL CLEANING TO BARE METAL" AND FEATHER BACK THE EDGES.
   B. APPLY ONE SPOT PRIME COAT WITH REQUIRED PRIMER AT 4-6 MILS DFT PER COAT. IF TEMPERATURES ARE EXPECTED TO BE BELOW 50 DEGREES SUBSTITUTE WITH COLD GALVANIZED SPRAY.
3. CONTRACTOR SHALL ALSO PRIME AND PAINT ALL EXTERIOR RAILINGS AND PENETRATIONS TO EXTERIOR SURFACE PAINTING SPEC. TOWER OWNER TO BE CONTACTED TO DETERMINE IF ANTENNA MOUNTS AND MAST PIPS ARE REQUIRED TO BE PAINTED.
4. EXTERIOR SURFACE PAINTING REQUIREMENTS:
   A. EXTERIOR SURFACES TO BE PAINTED SHALL BE CLEANED TO SSPC-SP11 "POWER TOOL CLEANING TO BARE METAL" AND FEATHER BACK THE EDGES.
   B. THE EXTERIOR SURFACE PAIN SYSTEM SHALL BE TWO PRIME COAT OF REQUIRED PRIMER AT 4-6 MILS DFT PER COAT AND ONE FINISH COAT OF PAINT TO 3 MILS DFT.
   C. THE THREE-COAT SYSTEM SHALL BE APPLIED AT 3.0 - 6.0 MILS PER COAT, TO AN OVERALL THICKNESS OF 11.0 - 15.0 MILS.
   D. ALL PAINTED SURFACES ARE TO BE PREPARED PER MANUFACTURES RECOMMENDATIONS.
   E. EXTERIOR FINISH COLOR: TNEMEC 37BL TEARDROP (VERIFY W/ OWNER).
5. INTERIOR WET PAINTING REQUIREMENTS:
   A. INTERIOR WET SURFACES TO BE PAINTED SHALL BE CLEANED TO SSPC-SP11 "POWER TOOL CLEANING TO BARE METAL" AND FEATHER BACK THE EDGES.
   B. THE INTERIOR WET SURFACE PAINT SYSTEM SHALL BE PER REQUIRED FINISH AT 16 - 20 MILS DFT.
6. COORDINATE PAINTING SCHEDULE WITH TOWER OWNER. IF APPLICABLE, PAINT ALL THE NEW STEEL IN A SHOP SETTING, PRIOR TO DELIVERY TO THE SITE.
7. FOLLOW ALL PAINT MANUFACTURERS' RECOMMENDATIONS WHEN USING THEIR PRODUCTS. CONTACT PAINT MANUFACTURER TO OBTAIN SUITABLE SURFACE PREPARATION SYSTEM FOR PROPSED SURFACE.

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STRUCTURAL SPECIFICATIONS
COUNTY GROUNDS (784454)
WAUWAUTOSA, WISCONSIN

SUBMITTAL:

INT.	DATE:	DESCRIPTION:
ADS	10/15/2019	REV. A

CHECKED BY	KCB
PLOT DATE	10/15/2019
PROJECT NUMBER	21284
SET TYPE	DRAFT
SHEET NUMBER	S-001

MODIFICATION INSPECTION CHECKLIST

REPORT ITEM	DESCRIPTION	REQUIRED
PRE-CONSTRUCTION		
SHOP DRAWINGS	FABRICATION DRAWINGS SHALL BE SUBMITTED TO THE ENGINEER OF RECORD FOR REVIEW. THE CONTRACTOR SHALL PROVIDE THE APPROVED SHOP DRAWINGS TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
FABRICATION	A LETTER FROM THE FABRICATOR STATING THAT THE WORK WAS PERFORMED IN ACCORDANCE WITH INDUSTRY STANDARDS AND THE CONTRACTOR DOCUMENTS SHALL BE PROVIDED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
FABRICATOR CERTIFIED WELD INSPECTION	A CERTIFIED WELD INSPECTION SHALL BE COMPLETED ON ALL SHOP WELDS AND A REPORT SHALL BE PROVIDED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
WELDER QUALIFICATION TEST RECORD	AN AWS WELDER QUALIFICATION TEST RECORD SHALL BE SUBMITTED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
WELDING PROCEDURE SPECIFICATION (WPS)	A WPS (WITH SUPPORTING PQR's (PROCEDURE QUALIFICATION RECORD) IF REQUIRED) SHALL BE SUBMITTED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
MATERIAL TEST REPORT (MTR)	MILL CERTIFICATION OF ALL MODIFICATION STEEL SHALL BE SUBMITTED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
PACKING SLIPS	MATERIAL SHIPPING LIST SHALL BE PROVIDED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☒
DURING CONSTRUCTION		
FOUNDATION INSPECTION	A VISUAL OBSERVATION OF THE EXCAVATION AND REBAR INSTALLATION SHALL BE PERFORMED BY THE MODIFICATION INSPECTOR PRIOR TO CONCRETE PLACEMENT.	☐
CONCRETE	THE CONCRETE MIX DESIGN SHALL BE PROVIDED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT. CONCRETE SLUMP AND COMPRESSIVE STRENGTH TESTS SHALL BE PERFORMED BY THE MODIFICATION INSPECTOR IN ACCORDANCE WITH ACI SPECIFICATIONS.	☐
POST INSTALLED ANCHOR RODS	A VISUAL OBSERVATION OF THE POST INSTALLED ANCHOR ROD INSTALLATION SHALL BE PERFORMED BY THE MODIFICATION INSPECTOR TO ENSURE COMPLIANCE WITH THE MANUFACTURER'S INSTALLATION REQUIREMENTS.	☐
CERTIFIED WELD INSPECTION	A VISUAL WELD INSPECTION SHALL BE PERFORMED BY AN AWS CWI (CERTIFIED WELDING INSPECTOR) ON ALL WELDS IN ACCORDANCE WITH AWS D1.1 CLAUSE 6.	☒
NDE (NONDESTRUCTIVE EXAMINATION) - CJP WELDS	FULL PENETRATION WELDS IN THE VICINITY OF THE BASE OF THE TOWER ARE REQUIRED TO BE 100% NDE INSPECTED BY UT (ULTRASONIC TESTING) IN ACCORDANCE WITH AWS D1.1.	☐
NDE (NONDESTRUCTIVE EXAMINATION) - PJP WELDS	PARTIAL PENETRATION AND FILLET WELDS IN THE VICINITY OF THE BASE OF THE TOWER ARE REQUIRED TO BE 50% NDE INSPECTED BY MT (MAGNETIC PARTICLE TESTING) IN ACCORDANCE WITH AWS D1.1.	☐
ON SITE COLD GALVANIZATION	THE GENERAL CONTRACTOR SHALL PROVIDE DOCUMENTATION TO THE MODIFICATION INSPECTOR VERIFYING THAT ANY ON-SITE COLD GALVANIZING WAS APPLIED IN ACCORDANCE WITH SPECIFICATIONS.	☒
HIGH STRENGTH BOLT INSPECTION	A VISUAL OBSERVATION OF ALL HIGH STRENGTH BOLT INSTALLATION SHALL BE PERFORMED BY THE MODIFICATION INSPECTOR TO VERIFY MANUFACTURER'S TORQUE REQUIREMENTS. IF SPECIFIC TORQUE REQUIREMENTS BEYOND TURN-OF-NUT ARE SPECIFIED BY THE MANUFACTURER, THE MODIFICATION INSPECTOR SHALL SPOT CHECK TORQUE SPECIFICATIONS WITH A TORQUE WRENCH.	☐
GUY WIRE TENSIONS	THE GENERAL CONTRACTOR SHALL PROVIDE A GUY WIRE TENSION REPORT TO THE MODIFICATION INSPECTOR INDICATING THE TEMPERATURE AND TENSION IN EVERY GUY CABLE FOR INCLUSION IN THE REPORT. TENSIONS SHALL ALSO BE VERIFIED BY THE MODIFICATION INSPECTOR.	☐
TOWER PLUMB AND TWIST	TOWER PLUMB AND TWIST SHALL BE VERIFIED PER TIA SPECIFICATIONS BY MODIFICATION INSPECTOR.	☐
POST CONSTRUCTION		
GENERAL CONTRACTOR AS-BUILT DOCUMENTS	THE GENERAL CONTRACTOR SHALL SUBMIT A COPY OF THE CONTRACT DOCUMENTS EITHER STATING "INSTALLED AS DESIGNED" OR NOTING ANY CHANGES THAT WERE REQUIRED AND APPROVED BY THE ENGINEER OF RECORD DUE TO FIELD CONDITIONS.	☒
POST INSTALLED ANCHOR RODS	POST INSTALLED ANCHOR RODS SHALL BE TESTED IN ACCORDANCE WITH THE DESIGN SPECIFICATIONS AND A REPORT SHALL BE PROVIDED TO THE MODIFICATION INSPECTOR FOR INCLUSION IN THE REPORT.	☐
TOWER MODIFICATION	A FINAL VISUAL INSPECTION OF THE MODIFICATION SHALL BE COMPLETED BY THE MODIFICATION INSPECTOR TO ENSURE COMPLIANCE WITH THE DESIGN SPECIFICATIONS.	☒

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MODIFICATION INSPECTION CHECKLIST
COUNTY GROUNDS (784454)
WAUWAUTOSA, WISCONSIN

SUBMITTAL:

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ADS	10/15/2019	REV. A

CHECKED BY	KCB
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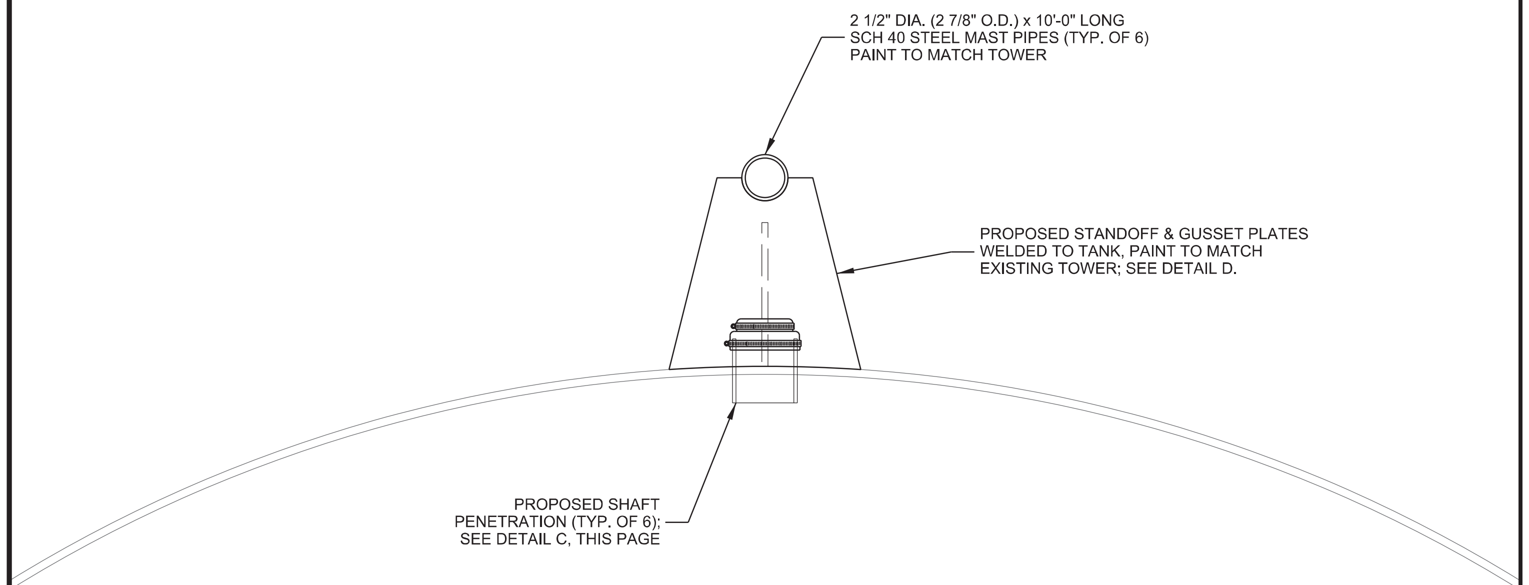
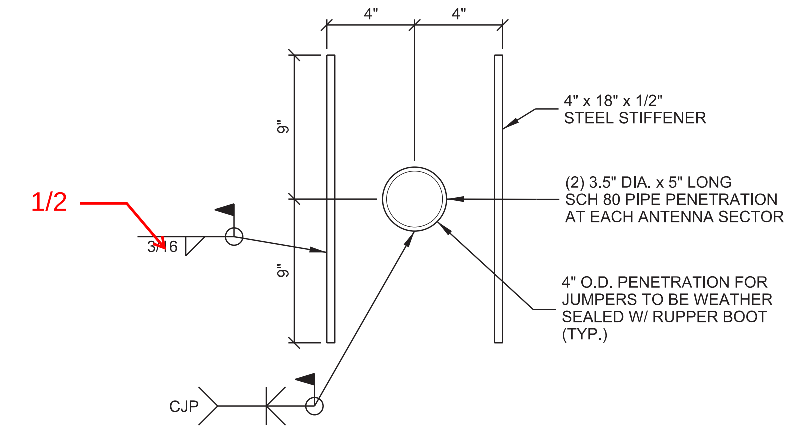
SHEET NUMBER	S-002



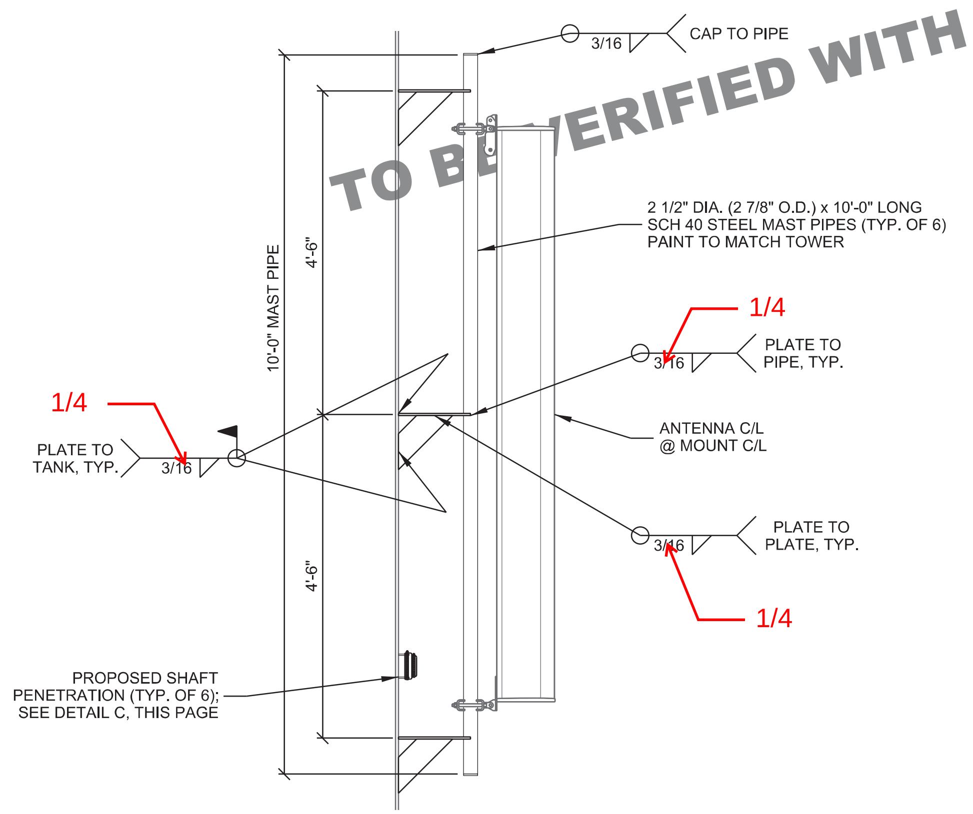
A ANTENNA MOUNT PLAN



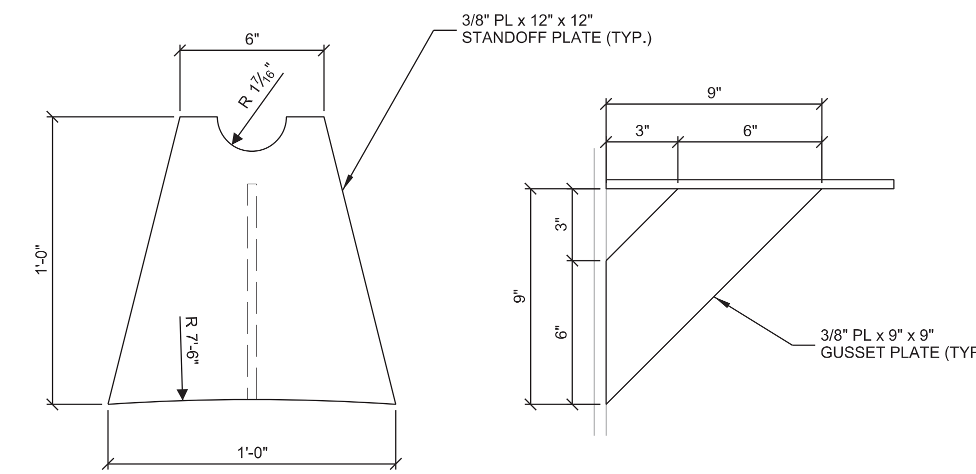
NOTES
1. ALL PIPE PENETRATIONS MUST BE MIN. OF 6" AWAY FROM EXISITING TANK SEAMS. (VERT. & HORZ.)
2. WELD STIFFENERS FIRST, THEN CUT & WELD PENETRATION.
3. ALL PENETRATIONS MUST BE SEAL WELDED INSIDE AND OUTSIDE STEM/ SHAFT.

C SHAFT PENETRATION DETAIL

TO BE VERIFIED WITH FINAL STRUCTURAL ANALYSIS



B ANTENNA MOUNT SECTION



STANDOFF PLATE

GUSSET PLATE

D STANDOFF & GUSSET PLATES

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U.S. Cellular
U.S. CELLULAR
8410 W. BRYN MAWR AVE.
SUITE 700
CHICAGO, IL 60631

MOUNT MODIFICATION DETAILS
COUNTY GROUNDS (784454)
WAUWAUTOSA, WISCONSIN

SUBMITTAL:

INT.	DATE:	DESCRIPTION:
ADS	10/15/2019	REV. A

CHECKED BY	KCB
PLOT DATE	10/15/2019
PROJECT NUMBER	21284
SET TYPE	DRAFT
SHEET NUMBER	S-501

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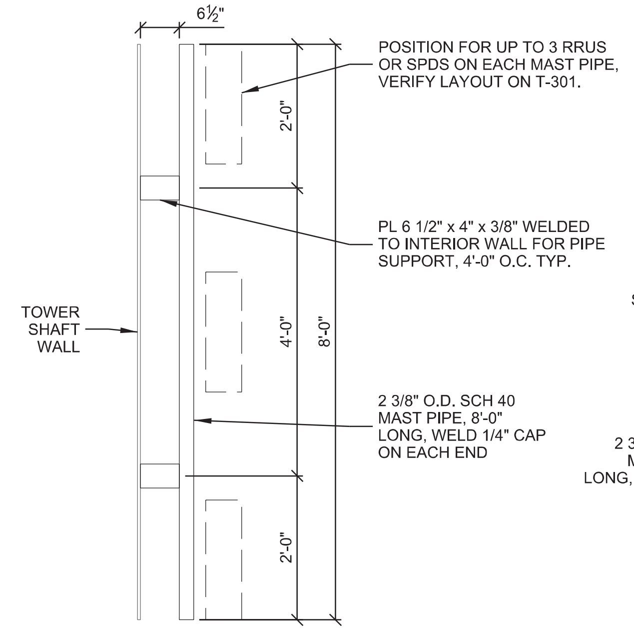
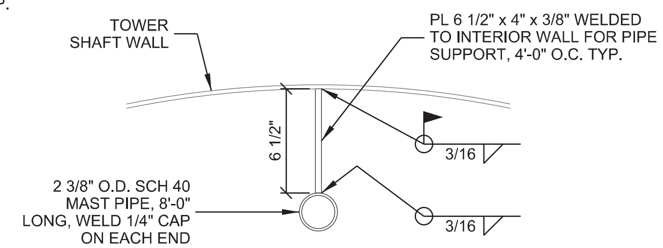


PROFILE VIEW

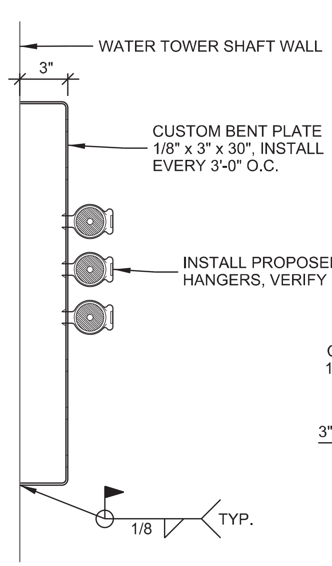


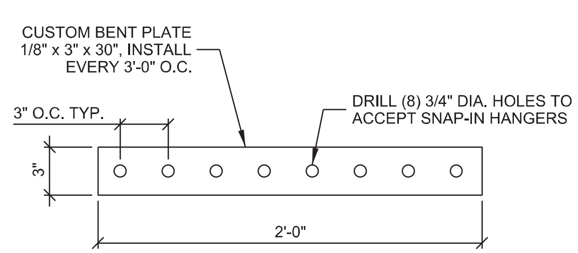
PLAN VIEW

NOTES:

1. FIELD VERIFY HORIZONTAL & VERTICAL CLEARANCE INSIDE TOWER. DO NOT OBSTRUCT ACCESS OR MAINTENANCE OF TOWER.
2. PIPE TO BE SHOP PRIMED, AND PAINTED TO MATCH EXISTING TOWER COATING. REPAIR ALL DAMAGE TO EXISTING TOWER COATING.
3. ALL WELDS SHALL BE SEAL WELDED TO PREVENT RUST.
4. ANY CLAMPED CONNECTION TO PAINTED STEEL SHALL HAVE A NEOPRENE GASKET TO PROTECT COATING.

A MOUNTING PIPE DETAIL





SIDE VIEW **PROFILE VIEW**

B BENT PLATE DETAIL

TO BE VERIFIED WITH FINAL STRUCTURAL ANALYSIS

THIS SPACE INTENTIONALLY LEFT BLANK

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