Date: **October 11, 2024**

WA COA# 3446
326 Tryon Road
Raleigh, NC 27603
(919) 661-6351

Subject: Structural Analysis Report

Carrier Designation:	***T-Mobile* Co-Locate**	
	Site Number:	SE02525A
	Site Name:	N/A
Crown Castle Designation:	**BU Number:**	880416
	Site Name:	Seattle Qwest - SEA155
	JDE Job Number:	2126185
	Work Order Number:	2333549
	Order Number:	681368 Rev. 1
Engineering Firm Designation:	**TEP Project Number:**	151934.1008537
Site Data:	**8477 SE 68th Street, Mercer Island, King County, WA 98040** **Latitude *47° 32' 30.00"*, Longitude *-122° 13' 25.00"*** **150 Foot - Concealment Tower**	

TEP is pleased to submit this **"Structural Analysis Report"** to determine the structural integrity of the above-mentioned tower.

The purpose of the analysis is to determine acceptability of the tower stress level. Based on our analysis we have determined the tower stress level for the structure and foundation, under the following load case, to be:

LC4.7: Modified Structure w/ Proposed Equipment Configuration **Sufficient Capacity**

This analysis utilizes an ultimate 3-second gust wind speed of 98 mph as required by the 2021 Washington State Building Code. Applicable Standard references and design criteria are listed in Section 2 - Analysis Criteria.

Structural analysis prepared by: MS / SMS

Respectfully submitted by:

Ronnie E. Glover, P.E., S.E.

10/11/2024

Electronic Copy

TABLE OF CONTENTS

1) INTRODUCTION

This is a 130-ft concealment tower designed by Rohn and mapped by CMC Communications in January of 2015 and FDH, Inc. in October 2014. The base tower is 100-ft, and the concealment spine extends from 100-ft to 130-ft. The tower has been modified per reinforcement drawings prepared by GPD Group in September of 2018. A proposed 50-ft spine replacement with 60-in ventilated canisters from 100-ft to 110-ft, and 60-in unvented canisters from 110-ft to 150-ft prepared by TEP in September of 2023, has been considered in this analysis, increasing the overall height to 150-ft.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	II
Wind Speed:	98 mph
Exposure Category:	B
Topographic Factor:	1.182
Ice Thickness:	1.0 in
Wind Speed with Ice:	30 mph
Seismic Ss:	1.461
Seismic S1:	0.505
Service Wind Speed:	60 mph

Table 1 - Proposed Equipment Configuration

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)
125.0	128.0	3	Nokia	AEHC w/ Mount Pipe	2	1-5/8
	125.0	1	Generic	60" Dia. x 10' Long Concealment Canister		
	123.0	3	Nokia	AHFII B25/66 4T4R_TMO		
		3	Nokia	AHLOB B71/65 4T4R_TMO		
117.0	115.0	3	Commscope	FFVV-65C-R3-V1_TMO w/ Mount Pipe	12	7/8
115.0	115.0	1	Generic	60" Dia. x 10' Long Concealment Canister	-	-

Table 2 - Other Considered Equipment

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)
146.0	146.0	3	JMA Wireless	MX08FRO665-21 w/ Mount Pipe	12	1-5/8
145.0	145.0	1	Generic	60" Dia. x 10' Long Concealment Canister	-	-
135.0	135.0	1	Generic	60" Dia. x 10' Long Concealment Canister	-	-
130.0	130.0	1	GPS	GPS_A	1	1/2

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)
105.0	107.0	3	Commscope	NHHS4-65A-R3B w/ Mount Pipe	6 1	7/8 1-5/8
		3	JMA Wireless	TBC-67C-A-P-2SF		
		3	Andrew	ATSBT-TOP-FM		
		1	Raycap	RRFDC-3315-PF-48		
	105.0	1	Generic	60" Dia. x 10' Long Ventilated Concealment Canister		
	104.0	3	Ericsson	4449		
	102.0	3	Ericsson	8843		
	101.0	3	Ericsson	RADIO 8863		

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Reference	Source
Geotechnical Report	1584043	CCISites
Tower Foundation Drawings	2030381	CCISites
Tower Manufacturer Drawings	2030383	CCISites
Tower Mapping Report	2030383	CCISites
Tower Reinforcement Drawings	7839688	CCISites
Post-Modification Inspection	8856717	CCISites
Tower Reinforcement Drawings	11095830	CCISites
Tower Reinforcement Drawings	11235995	CCISites

3.1) Analysis Method

tnxTower (version 8.2.4.3), a commercially available analysis software package, was used to create a three-dimensional model of the tower and calculate member stresses for various loading cases. Selected output from the analysis is included in Appendix A. When applicable, Crown Castle has calculated and provided the effective area for panel antennas using approved methods following the intent of the TIA-222 Standard.

RISA-3D, a commercially available analysis software package, was used to model and analyze the foundation. Selected output from the analysis is included in Appendix C.

SolidWorks, a commercially available analysis software package, was used to create a finite element model of the canister spine flange connection at the 100-ft level. Selected output from the analysis is included in Appendix C - Additional Calculations.

3.2) Assumptions

1) The tower and structures were maintained in accordance with the TIA-222 Standard.
2) The configuration of antennas, transmission cables, mounts and other appurtenances are as specified in Tables 1 and 2, and the referenced drawings.
3) Base and flange plate design methodology of the manufacturer has been reviewed and found to be an acceptable means of designing to resist the full capacity of the bolts and shaft.

This analysis may be affected if any assumptions are not valid or have been made in error. TEP should be notified to determine the effect on the structural integrity of the tower.

4) ANALYSIS RESULTS

Table 4 - Section Capacity (Summary)

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (k)	ϕP_{allow} (k)	% Capacity	Pass / Fail
L1	150 - 130	Pole	P6.625x0.432	1	-2.23	277.99	38.8	Pass
L2	130 - 110	Pole	P8.625x0.5	2	-6.64	422.13	74.4	Pass
L3	110 - 100	Pole	P8.625x0.5	3	-9.51	506.55	96.7	Pass
L4	100 - 60	Pole	P36x0.375	4	-18.37	1564.60	22.9	Pass
L5	60 - 20	Pole	P36x0.375	5	-26.39	1564.60	41.3	Pass
L6	20 - 0	Pole	P36x0.375	6	-30.43	1564.60	51.4	Pass
							Summary	
						Pole (L3)	96.7	Pass
						RATING =	**96.7**	**Pass**

Table 5 - Tower Component Stresses vs. Capacity - LC4.7

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1,2	Flange Connection	130.0	16.1	Pass
1,2	Flange Connection	110.0	59.7	Pass
1	Flange Connection (Stiffener Welds)	100.0	Sufficient	Pass
1,2	Flange Bolts	100.0	48.9	Pass
1,2,3	Flange Connection	60.0	15.9	Pass
1,2,3	Flange Connection	20.0	29.3	Pass
1,2	Anchor Rods	-	35.2	Pass
1,2,3	Base Plate	-	35.2	Pass
1,2	Base Foundation Structural	-	21.6	Pass
1,2	Base Foundation Soil Interaction	-	33.8	Pass

Structure Rating (max from all components) =	**96.7%**

Notes:
1) See additional documentation in "Appendix C - Additional Calculations" for calculations supporting the % capacity listed.
2) Rating per TIA-222-H Section 15.5
3) Base/Flange plates are assumed to have the same capacity as their respective splice bolts or shaft.

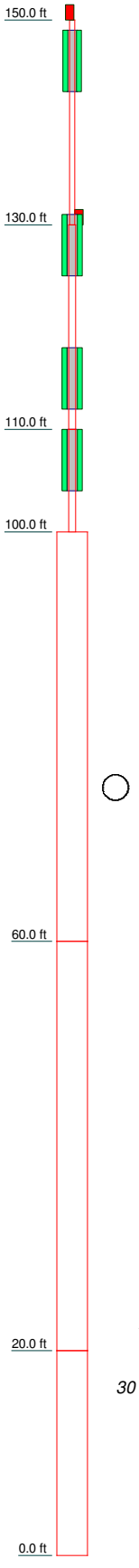
4.1) Recommendations

1) The tower and its foundation have sufficient capacity to carry the proposed load configuration. No further modifications are required once the proposed modifications are installed.

APPENDIX A

TNXTOWER OUTPUT

Section	Size	Length (ft)	Grade	Weight (K)
1	P6.625x0.432	20.00	A53-B-35	0.6
2	P8.625x0.5	20.00		0.9
3	P8.625x0.5	10.00		0.4
4	P36x0.375	40.00	A53-B-42	5.7
5	P36x0.375	40.00		5.7
6	P36x0.375	20.00		2.9
				16.2



ALL REACTIONS ARE FACTORED

AXIAL 40 K

SHEAR 2 K *MOMENT 152 kip-ft*

TORQUE 0 kip-ft

30 mph WIND - 1.0000 in ICE

AXIAL 30 K

SHEAR 7 K *MOMENT 695 kip-ft*

TORQUE 0 kip-ft

REACTIONS - 98 mph WIND

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A53-B-35	35 ksi	60 ksi	A53-B-42	42 ksi	63 ksi

TOWER DESIGN NOTES

1. Tower is located in King County, Washington.
2. Tower designed for Exposure B to the TIA-222-H Standard.
3. Tower designed for a 98 mph basic wind in accordance with the TIA-222-H Standard.
4. Tower is also designed for a 30 mph basic wind with 1.00 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon a 60 mph wind.
6. Tower Risk Category II.
7. Topographic Category 5 with Crest Height of 360.00 ft
8. TOWER RATING: 96.7%

TEP
326 Tryon Road
Raleigh. NC 27603
Phone: (919) 661-6351
FAX: (919) 661-6350

Job: **Seattle Qwest - SEA155 (BU 880416)**			
Project: **TEP No. 151934.1008537**			
Client: Crown Castle	Drawn by: MS	App'd:	
Code: TIA-222-H	Date: 10/10/24	Scale: NTS	
Path:		Dwg No. E-1	

Tower Input Data

The tower is a monopole.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

Tower is located in King County, Washington.
Tower base elevation above sea level: 350.00 ft.
Basic wind speed of 98 mph.
Risk Category II.
Exposure Category B.
Crest Height: 360.00 ft.
Rigorous Topographic Factor Procedure for wind speed-up calculations is used.
Topographic Feature: Continuous Escarpment.
Slope Distance L: 2360.00 ft.
Distance from Crest x: 2945.00 ft.
Horizontal Distance Downwind: Yes.
Nominal ice thickness of 1.0000 in.
Ice thickness is considered to increase with height.
Ice density of 56 pcf.
A wind speed of 30 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 60 mph.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.
Tower analysis based on target reliabilities in accordance with Annex S.
Load Modification Factors used: $K_{es}(F_w) = 0.95$, $K_{es}(t_i) = 0.85$.
Maximum demand-capacity ratio is: 1.05.
Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Options

	Consider Moments - Legs		Assume Legs Pinned		Calculate Redundant Bracing Forces
	Consider Moments - Horizontals	√	Assume Rigid Index Plate		Ignore Redundant Members in FEA
	Consider Moments - Diagonals	√	Use Clear Spans For Wind Area		SR Leg Bolts Resist Compression
	Use Moment Magnification		Use Clear Spans For KL/r		All Leg Panels Have Same Allowable
√	Use Code Stress Ratios		Retension Guys To Initial Tension		Offset Girt At Foundation
√	Use Code Safety Factors - Guys	√	Bypass Mast Stability Checks	√	Consider Feed Line Torque
	Escalate Ice	√	Use Azimuth Dish Coefficients		Include Angle Block Shear Check
	Always Use Max Kz	√	Project Wind Area of Appurtenances		Use TIA-222-H Bracing Resist. Exemption
	Use Special Wind Profile	√	Alternative Appurt. EPA Calculation		Use TIA-222-H Tension Splice Exemption
	Include Bolts In Member Capacity		Autocalc Torque Arm Areas		Poles
	Leg Bolts Are At Top Of Section		Add IBC .6D+W Combination	√	Include Shear-Torsion Interaction
	Secondary Horizontal Braces Leg	√	Sort Capacity Reports By Component		Always Use Sub-Critical Flow
	Use Diamond Inner Bracing (4 Sided)		Triangulate Diamond Inner Bracing		Use Top Mounted Sockets
	SR Members Have Cut Ends		Treat Feed Line Bundles As Cylinder	√	Pole Without Linear Attachments
	SR Members Are Concentric		Ignore KL/ry For 60 Deg. Angle Legs		Pole With Shroud Or No Appurtenances
	Distribute Leg Loads As Uniform		Use ASCE 10 X-Brace Ly Rules		Outside and Inside Corner Radii Are Known

Pole Section Geometry

Section	Elevation ft	Section Length ft	Pole Size	Pole Grade	Socket Length ft
L1	150.00-130.00	20.00	P6.625x0.432	A53-B-35 (35 ksi)	
L2	130.00-110.00	20.00	P8.625x0.5	A53-B-35 (35 ksi)	
L3	110.00-100.00	10.00	P8.625x0.5	A53-B-42 (42 ksi)	
L4	100.00-60.00	40.00	P36x0.375	A53-B-42 (42 ksi)	
L5	60.00-20.00	40.00	P36x0.375	A53-B-42 (42 ksi)	
L6	20.00-0.00	20.00	P36x0.375	A53-B-42 (42 ksi)	

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
L1 150.00-130.00				1	0	1			
L2 130.00-110.00				1	0	1			
L3 110.00-100.00				1	0	1			
L4 100.00-60.00				1	1	1			
L5 60.00-20.00				1	1	1			
L6 20.00-0.00				1	1	1			

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number	Number Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight plf
105 *											

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
3/4" Lighting Cable	C	No	No	Inside Pole	150.00 - 0.00	1	No Ice	0.00	0.35
							1/2" Ice	0.00	0.35
							1" Ice	0.00	0.35
146 AVA7-50(1-5/8")	B	No	No	Inside Pole	146.00 - 0.00	12	No Ice	0.00	0.72
							1/2" Ice	0.00	0.72
							1" Ice	0.00	0.72

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
130									
LDF4-50A(1/2)	C	No	No	Inside Pole	130.00 - 0.00	1	No Ice	0.00	0.15
							1/2" Ice	0.00	0.15
							1" Ice	0.00	0.15
1" Rigid Conduit	C	No	No	Inside Pole	130.00 - 0.00	1	No Ice	0.00	1.13
							1/2" Ice	0.00	1.13
							1" Ice	0.00	1.13
125									
HB158-21U6S24-xx M_TMO(1-5/8)	C	No	No	Inside Pole	125.00 - 0.00	2	No Ice	0.00	2.50
							1/2" Ice	0.00	2.50
							1" Ice	0.00	2.50
117									
LDF5-50A(7/8")	B	No	No	Inside Pole	117.00 - 0.00	12	No Ice	0.00	0.33
							1/2" Ice	0.00	0.33
							1" Ice	0.00	0.33
AVA5-50 (7/8")	B	No	No	Inside Pole	105.00 - 0.00	6	No Ice	0.00	0.30
							1/2" Ice	0.00	0.30
							1" Ice	0.00	0.30
HB158-21U6S12-X XXM-01(1-5/8)	B	No	No	Inside Pole	105.00 - 0.00	1	No Ice	0.00	1.90
							1/2" Ice	0.00	1.90
							1" Ice	0.00	1.90
*									

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	150.00-130.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.14
		C	0.000	0.000	0.000	0.000	0.01
L2	130.00-110.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.20
		C	0.000	0.000	0.000	0.000	0.11
L3	110.00-100.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.14
		C	0.000	0.000	0.000	0.000	0.07
L4	100.00-60.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.65
		C	0.000	0.000	0.000	0.000	0.27
L5	60.00-20.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.65
		C	0.000	0.000	0.000	0.000	0.27
L6	20.00-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.33
		C	0.000	0.000	0.000	0.000	0.13

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
L1	150.00-130.00	A	1.026	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.14
		C		0.000	0.000	0.000	0.000	0.01
L2	130.00-110.00	A	1.012	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.20
		C		0.000	0.000	0.000	0.000	0.11
L3	110.00-100.00	A	1.000	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.14
		C		0.000	0.000	0.000	0.000	0.07
L4	100.00-60.00	A	0.976	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.65
		C		0.000	0.000	0.000	0.000	0.27
L5	60.00-20.00	A	0.916	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.65
		C		0.000	0.000	0.000	0.000	0.27
L6	20.00-0.00	A	0.799	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.33
		C		0.000	0.000	0.000	0.000	0.13

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
L1	150.00-130.00	0.0000	0.0000	0.0000	0.0000
L2	130.00-110.00	0.0000	0.0000	0.0000	0.0000
L3	110.00-100.00	0.0000	0.0000	0.0000	0.0000
L4	100.00-60.00	0.0000	0.0000	0.0000	0.0000
L5	60.00-20.00	0.0000	0.0000	0.0000	0.0000
L6	20.00-0.00	0.0000	0.0000	0.0000	0.0000

Note: For pole sections, center of pressure calculations do not consider feed line shielding.

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
(2) 9"x5"x3.5" Sidelight	C	From Leg	0.00	0.0000	150.00	No Ice	0.38	0.26	0.00
			0.00			1/2" Ice	0.46	0.34	0.01
			0.00			1" Ice	0.55	0.42	0.01
146									
MX08FRO665-21 w/ Mount Pipe	A	From Leg	0.50	0.0000	146.00	No Ice	0.00	0.00	0.11
			0.00			1/2" Ice	0.00	0.00	0.11
			0.00			1" Ice	0.00	0.00	0.11
MX08FRO665-21 w/ Mount Pipe	B	From Leg	0.50	0.0000	146.00	No Ice	0.00	0.00	0.11
			0.00			1/2" Ice	0.00	0.00	0.11

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft Vert ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
			0.00			1" Ice	0.00	0.00	0.11
MX08FRO665-21 w/ Mount Pipe	C	From Leg	0.50 0.00 0.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.11 0.11 0.11
130									
GPS_A	B	From Face	0.50 0.00 0.00	0.0000	130.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.00 0.00 0.00
125									
AEHC w/ Mount Pipe	A	From Leg	0.50 0.00 3.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.11 0.11 0.11
AEHC w/ Mount Pipe	B	From Leg	0.50 0.00 3.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.11 0.11 0.11
AEHC w/ Mount Pipe	C	From Leg	0.50 0.00 3.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.11 0.11 0.11
AHFII B25/66 4T4R_TMO	A	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.07 0.07 0.07
AHFII B25/66 4T4R_TMO	B	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.07 0.07 0.07
AHFII B25/66 4T4R_TMO	C	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.07 0.07 0.07
AHLOB B71/65 4T4R_TMO	A	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.09 0.09 0.09
AHLOB B71/65 4T4R_TMO	B	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.09 0.09 0.09
AHLOB B71/65 4T4R_TMO	C	From Leg	0.50 0.00 -2.00	0.0000	125.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.09 0.09 0.09
*									
117									
FFVV-65C-R3-V1_TMO w/ Mount Pipe	A	From Leg	0.50 0.00 -2.00	0.0000	117.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.16 0.16 0.16
FFVV-65C-R3-V1_TMO w/ Mount Pipe	B	From Leg	0.50 0.00 -2.00	0.0000	117.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.16 0.16 0.16
FFVV-65C-R3-V1_TMO w/ Mount Pipe	C	From Leg	0.50 0.00 -2.00	0.0000	117.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.16 0.16 0.16
105									
NHHS4-65A-R3B w/ Mount Pipe	A	From Leg	0.50 0.00 2.00	0.0000	105.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.10 0.16 0.23
NHHS4-65A-R3B w/ Mount Pipe	B	From Leg	0.50 0.00 2.00	0.0000	105.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.10 0.16 0.23
NHHS4-65A-R3B w/ Mount Pipe	C	From Leg	0.50 0.00 2.00	0.0000	105.00	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.00 0.00 0.00	0.10 0.16 0.23

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft Vert ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
TBC-67C-A-P-2SF	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.01
			0.00			1/2" Ice	0.00	0.00	0.01
			2.00			1" Ice	0.00	0.00	0.02
TBC-67C-A-P-2SF	B	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.01
			0.00			1/2" Ice	0.00	0.00	0.01
			2.00			1" Ice	0.00	0.00	0.02
TBC-67C-A-P-2SF	C	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.01
			0.00			1/2" Ice	0.00	0.00	0.01
			2.00			1" Ice	0.00	0.00	0.02
RADIO 8863	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.05
			0.00			1/2" Ice	0.00	0.00	0.07
			-4.00			1" Ice	0.00	0.00	0.09
RADIO 8863	B	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.05
			0.00			1/2" Ice	0.00	0.00	0.07
			-4.00			1" Ice	0.00	0.00	0.09
RADIO 8863	C	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.05
			0.00			1/2" Ice	0.00	0.00	0.07
			-4.00			1" Ice	0.00	0.00	0.09
ATSBT-TOP-FM	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.00
			0.00			1/2" Ice	0.00	0.00	0.00
			2.00			1" Ice	0.00	0.00	0.01
ATSBT-TOP-FM	B	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.00
			0.00			1/2" Ice	0.00	0.00	0.00
			2.00			1" Ice	0.00	0.00	0.01
ATSBT-TOP-FM	C	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.00
			0.00			1/2" Ice	0.00	0.00	0.00
			2.00			1" Ice	0.00	0.00	0.01
RRFDC-3315-PF-48	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.02
			0.00			1/2" Ice	0.00	0.00	0.05
			2.00			1" Ice	0.00	0.00	0.08
4449	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-1.00			1" Ice	0.00	0.00	0.11
4449	B	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-1.00			1" Ice	0.00	0.00	0.11
4449	C	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-1.00			1" Ice	0.00	0.00	0.11
8843	A	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-3.00			1" Ice	0.00	0.00	0.11
8843	B	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-3.00			1" Ice	0.00	0.00	0.11
8843	C	From Leg	0.50	0.0000	105.00	No Ice	0.00	0.00	0.07
			0.00			1/2" Ice	0.00	0.00	0.09
			-3.00			1" Ice	0.00	0.00	0.11
*									
60" Dia. x 10' Long Concealment Canister	C	None		0.0000	145.00	No Ice	0.00	0.00	0.00
						1/2" Ice	0.00	0.00	0.00
						1" Ice	0.00	0.00	0.00
60" Dia. x 10' Long Concealment Canister	C	None		0.0000	135.00	No Ice	0.00	0.00	0.00
						1/2" Ice	0.00	0.00	0.00
						1" Ice	0.00	0.00	0.00
60" Dia. x 10' Long Concealment Canister	C	None		0.0000	125.00	No Ice	0.00	0.00	0.00
						1/2" Ice	0.00	0.00	0.00

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
						1" Ice	0.00	0.00	0.00
60" Dia. x 10' Long Concealment Canister	C	None		0.0000	115.00	No Ice	0.00	0.00	0.00
						1/2" Ice	0.00	0.00	0.00
						1" Ice	0.00	0.00	0.00
60" Dia. x 10' Long Ventilated Concealment Canister	C	None		0.0000	105.00	No Ice	0.00	0.00	0.00
						1/2" Ice	0.00	0.00	0.00
						1" Ice	0.00	0.00	0.00
*									
Canister Load0	C	None		0.0000	150.00	No Ice	0.00	0.00	0.22
						1/2" Ice	0.00	0.00	0.22
						1" Ice	0.00	0.00	0.22
*									
Canister Load1	C	None		0.0000	150.00	No Ice	11.25	11.25	0.16
						1/2" Ice	27.96	27.96	0.34
						1" Ice	28.42	28.42	0.53
Canister Load2	C	None		0.0000	140.00	No Ice	22.50	22.50	0.53
						1/2" Ice	55.92	55.92	0.90
						1" Ice	56.83	56.83	1.28
Canister Load3	C	None		0.0000	130.00	No Ice	22.50	22.50	0.53
						1/2" Ice	55.92	55.92	0.90
						1" Ice	56.83	56.83	1.28
Canister Load4	C	None		0.0000	120.00	No Ice	22.50	22.50	0.72
						1/2" Ice	55.92	55.92	1.09
						1" Ice	56.83	56.83	1.46
Canister Load5	C	None		0.0000	110.00	No Ice	35.00	35.00	0.75
						1/2" Ice	55.92	55.92	1.12
						1" Ice	56.83	56.83	1.49
Canister Load6	C	None		0.0000	100.00	No Ice	23.75	23.75	0.77
						1/2" Ice	27.96	27.96	0.96
						1" Ice	28.42	28.42	1.15
**********									

Load Combinations

Comb. No.	Description
1	Dead Only
2	1.2 Dead+1.0 Wind 0 deg - No Ice
3	0.9 Dead+1.0 Wind 0 deg - No Ice
4	1.2 Dead+1.0 Wind 30 deg - No Ice
5	0.9 Dead+1.0 Wind 30 deg - No Ice
6	1.2 Dead+1.0 Wind 60 deg - No Ice
7	0.9 Dead+1.0 Wind 60 deg - No Ice
8	1.2 Dead+1.0 Wind 90 deg - No Ice
9	0.9 Dead+1.0 Wind 90 deg - No Ice
10	1.2 Dead+1.0 Wind 120 deg - No Ice
11	0.9 Dead+1.0 Wind 120 deg - No Ice
12	1.2 Dead+1.0 Wind 150 deg - No Ice
13	0.9 Dead+1.0 Wind 150 deg - No Ice
14	1.2 Dead+1.0 Wind 180 deg - No Ice
15	0.9 Dead+1.0 Wind 180 deg - No Ice

Comb. No.	Description
16	1.2 Dead+1.0 Wind 210 deg - No Ice
17	0.9 Dead+1.0 Wind 210 deg - No Ice
18	1.2 Dead+1.0 Wind 240 deg - No Ice
19	0.9 Dead+1.0 Wind 240 deg - No Ice
20	1.2 Dead+1.0 Wind 270 deg - No Ice
21	0.9 Dead+1.0 Wind 270 deg - No Ice
22	1.2 Dead+1.0 Wind 300 deg - No Ice
23	0.9 Dead+1.0 Wind 300 deg - No Ice
24	1.2 Dead+1.0 Wind 330 deg - No Ice
25	0.9 Dead+1.0 Wind 330 deg - No Ice
26	1.2 Dead+1.0 Ice+1.0 Temp
27	1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp
28	1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp
29	1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp
30	1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp
31	1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp
32	1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp
33	1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp
34	1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp
35	1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp
36	1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp
37	1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp
38	1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp
39	Dead+Wind 0 deg - Service
40	Dead+Wind 30 deg - Service
41	Dead+Wind 60 deg - Service
42	Dead+Wind 90 deg - Service
43	Dead+Wind 120 deg - Service
44	Dead+Wind 150 deg - Service
45	Dead+Wind 180 deg - Service
46	Dead+Wind 210 deg - Service
47	Dead+Wind 240 deg - Service
48	Dead+Wind 270 deg - Service
49	Dead+Wind 300 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	150 - 130	26.563	41	2.3930	0.0005
L2	130 - 110	16.917	41	2.0754	0.0002
L3	110 - 100	9.445	41	1.3426	0.0001
L4	100 - 60	7.394	41	0.5577	0.0000
L5	60 - 20	3.132	41	0.4400	0.0000
L6	20 - 0	0.404	41	0.1861	0.0000

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
150.00	(2) 9"x5"x3.5" Sidelight	41	26.563	2.3930	0.0005	10675
146.00	MX08FRO665-21 w/ Mount Pipe	41	24.576	2.3332	0.0004	10675

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
145.00	60" Dia. x 10' Long Concealment Canister	41	24.081	2.3182	0.0004	10675
140.00	Canister Load2	41	21.627	2.2416	0.0003	5337
135.00	60" Dia. x 10' Long Concealment Canister	41	19.230	2.1613	0.0002	3558
130.00	GPS_A	41	16.917	2.0754	0.0002	2537
125.00	AEHC w/ Mount Pipe	41	14.722	1.9774	0.0001	1711
120.00	Canister Load4	41	12.703	1.8423	0.0001	1259
117.00	FFVV-65C-R3-V1_TMO w/ Mount Pipe	41	11.603	1.7312	0.0001	1086
115.00	60" Dia. x 10' Long Concealment Canister	41	10.923	1.6406	0.0001	995
110.00	Canister Load5	41	9.445	1.3426	0.0001	900
105.00	NHHS4-65A-R3B w/ Mount Pipe	41	8.300	0.9460	0.0000	1252
100.00	Canister Load6	41	7.394	0.5577	0.0000	2258

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	150 - 130	76.856	20	6.9700	0.0016
L2	130 - 110	48.861	6	6.0389	0.0006
L3	110 - 100	27.185	6	3.8953	0.0002
L4	100 - 60	21.255	6	1.6051	0.0000
L5	60 - 20	8.996	6	1.2648	0.0000
L6	20 - 0	1.160	6	0.5342	0.0000

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
150.00	(2) 9"x5"x3.5" Sidelight	20	76.856	6.9700	0.0017	3744
146.00	MX08FRO665-21 w/ Mount Pipe	20	71.088	6.7951	0.0014	3744
145.00	60" Dia. x 10' Long Concealment Canister	6	69.651	6.7510	0.0014	3744
140.00	Canister Load2	6	62.530	6.5265	0.0011	1870
135.00	60" Dia. x 10' Long Concealment Canister	6	55.574	6.2909	0.0009	1246
130.00	GPS_A	6	48.861	6.0389	0.0007	887
125.00	AEHC w/ Mount Pipe	6	42.493	5.7513	0.0005	596
120.00	Canister Load4	6	36.634	5.3556	0.0004	437
117.00	FFVV-65C-R3-V1_TMO w/ Mount Pipe	6	33.441	5.0305	0.0004	376
115.00	60" Dia. x 10' Long Concealment Canister	6	31.471	4.7656	0.0003	344
110.00	Canister Load5	6	27.185	3.8953	0.0002	311
105.00	NHHS4-65A-R3B w/ Mount Pipe	6	23.871	2.7379	0.0001	431
100.00	Canister Load6	6	21.255	1.6051	0.0000	777

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
L1	150 - 130 (1)	P6.625x0.432	20.00	0.00	0.0	8.4049	-2.23	264.76	0.008
L2	130 - 110 (2)	P8.625x0.5	20.00	0.00	0.0	12.7627	-6.64	402.03	0.017
L3	110 - 100 (3)	P8.625x0.5	10.00	0.00	0.0	12.7627	-9.51	482.43	0.020
L4	100 - 60 (4)	P36x0.375	40.00	0.00	0.0	41.9697	-18.37	1490.10	0.012
L5	60 - 20 (5)	P36x0.375	40.00	0.00	0.0	41.9697	-26.39	1490.10	0.018
L6	20 - 0 (6)	P36x0.375	20.00	0.00	0.0	41.9697	-30.43	1490.10	0.020

Pole Bending Design Data

Section No.	Elevation ft	Size	M_{ux} kip-ft	ϕM_{nx} kip-ft	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	M_{uy} kip-ft	ϕM_{ny} kip-ft	Ratio $\frac{M_{uy}}{\phi M_{ny}}$
L1	150 - 130 (1)	P6.625x0.432	17.36	43.56	0.398	0.00	43.56	0.000
L2	130 - 110 (2)	P8.625x0.5	66.28	86.75	0.764	0.00	86.75	0.000
L3	110 - 100 (3)	P8.625x0.5	103.56	104.11	0.995	0.00	104.11	0.000
L4	100 - 60 (4)	P36x0.375	304.77	1338.81	0.228	0.00	1338.81	0.000
L5	60 - 20 (5)	P36x0.375	556.73	1338.81	0.416	0.00	1338.81	0.000
L6	20 - 0 (6)	P36x0.375	694.67	1338.81	0.519	0.00	1338.81	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V_u K	ϕV_n K	Ratio $\frac{V_u}{\phi V_n}$	Actual T_u kip-ft	ϕT_n kip-ft	Ratio $\frac{T_u}{\phi T_n}$
L1	150 - 130 (1)	P6.625x0.432	1.28	79.43	0.016	0.00	43.25	0.000
L2	130 - 110 (2)	P8.625x0.5	2.80	120.61	0.023	0.00	86.15	0.000
L3	110 - 100 (3)	P8.625x0.5	3.60	144.73	0.025	0.00	103.39	0.000
L4	100 - 60 (4)	P36x0.375	5.76	454.19	0.013	0.00	1094.28	0.000
L5	60 - 20 (5)	P36x0.375	6.75	454.19	0.015	0.00	1094.28	0.000
L6	20 - 0 (6)	P36x0.375	7.04	454.19	0.015	0.00	1094.28	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	150 - 130 (1)	0.008	0.398	0.000	0.016	0.000	0.407	1.050	
L2	130 - 110 (2)	0.017	0.764	0.000	0.023	0.000	0.781	1.050	

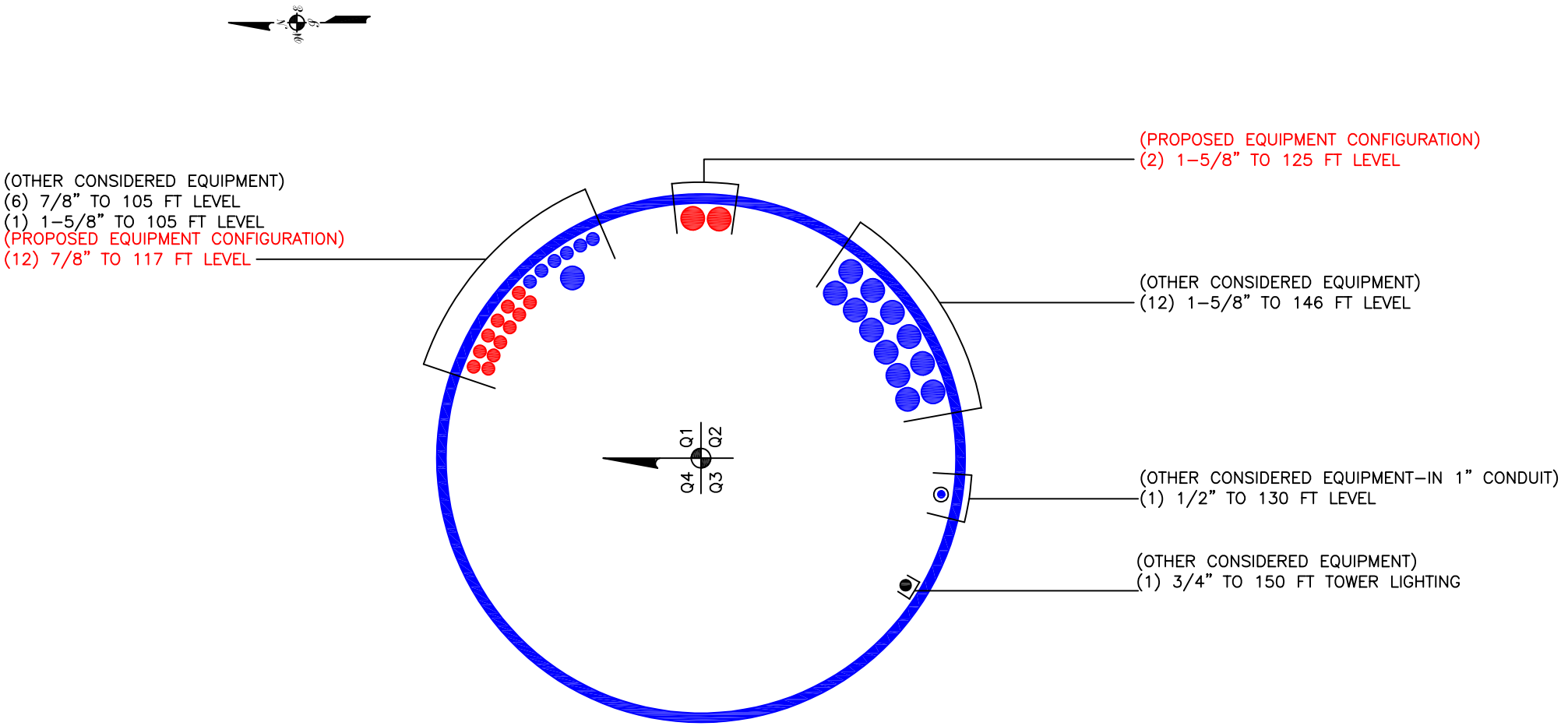
Section No.	Elevation ft	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L3	110 - 100 (3)	0.020	0.995	0.000	0.025	0.000	1.015	1.050	
L4	100 - 60 (4)	0.012	0.228	0.000	0.013	0.000	0.240	1.050	
L5	60 - 20 (5)	0.018	0.416	0.000	0.015	0.000	0.434	1.050	
L6	20 - 0 (6)	0.020	0.519	0.000	0.015	0.000	0.540	1.050	

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
L1	150 - 130	Pole	P6.625x0.432	1	-2.23	277.99	38.8	Pass
L2	130 - 110	Pole	P8.625x0.5	2	-6.64	422.13	74.4	Pass
L3	110 - 100	Pole	P8.625x0.5	3	-9.51	506.55	96.7	Pass
L4	100 - 60	Pole	P36x0.375	4	-18.37	1564.60	22.9	Pass
L5	60 - 20	Pole	P36x0.375	5	-26.39	1564.60	41.3	Pass
L6	20 - 0	Pole	P36x0.375	6	-30.43	1564.60	51.4	Pass
							Summary	
						Pole (L3)	96.7	Pass
						RATING =	**96.7**	**Pass**

APPENDIX B

BASE LEVEL DRAWING


(PROPOSED EQUIPMENT CONFIGURATION)
(2) 1–5/8" TO 125 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(6) 7/8" TO 105 FT LEVEL
(1) 1–5/8" TO 105 FT LEVEL
(PROPOSED EQUIPMENT CONFIGURATION)
(12) 7/8" TO 117 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(12) 1–5/8" TO 146 FT LEVEL
Q1
Q2
Q4
Q3
(OTHER CONSIDERED EQUIPMENT–IN 1" CONDUIT)
(1) 1/2" TO 130 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(1) 3/4" TO 150 FT TOWER LIGHTING

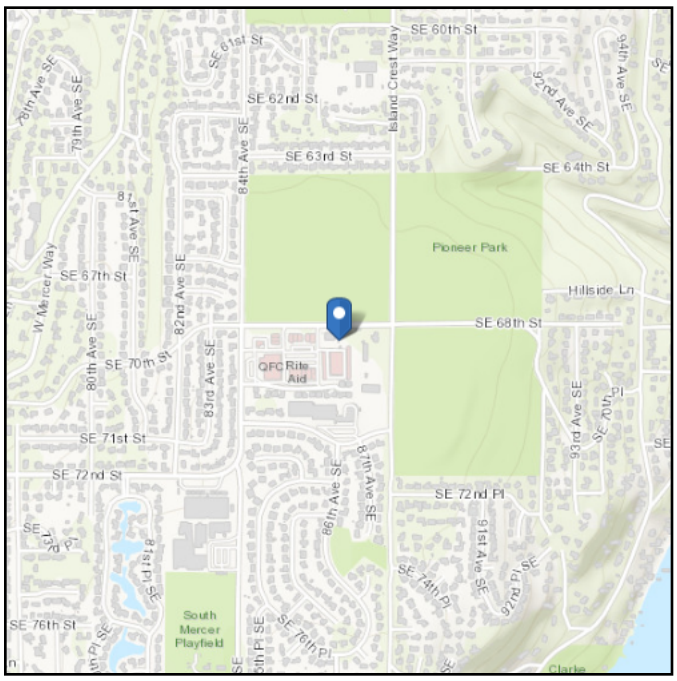
APPENDIX C

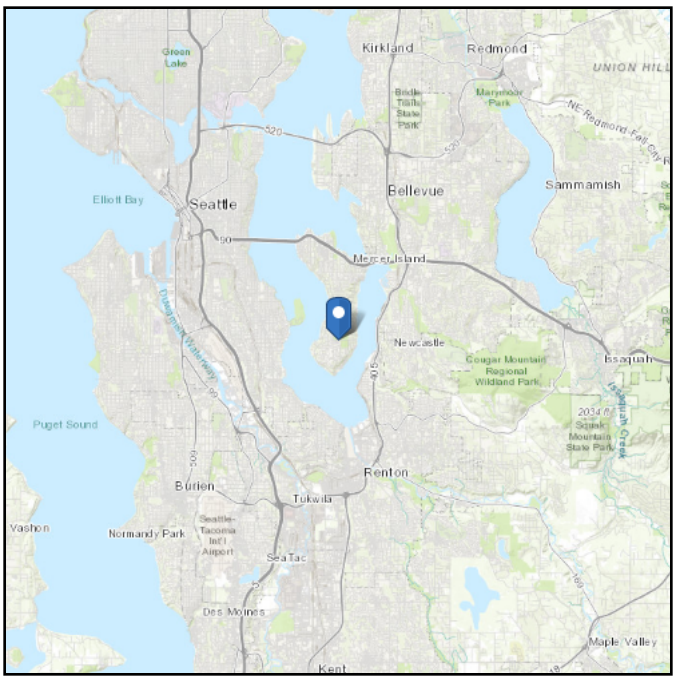
ADDITIONAL CALCULATIONS

ASCE Hazards Report

Address:
No Address at This Location

Standard:	ASCE/SEI 7-16	**Latitude:**	47.541667
Risk Category:	II	**Longitude:**	-122.223611
Soil Class:	D - Default (see Section 11.4.3)	**Elevation:**	350.4819556609603 ft (NAVD 88)





Wind

Results:

Wind Speed	98 Vmph
10-year MRI	67 Vmph
25-year MRI	74 Vmph
50-year MRI	78 Vmph
100-year MRI	83 Vmph

Data Source:	ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed:	Thu Oct 10 2024

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

Seismic

Site Soil Class: D - Default (see Section 11.4.3)

Results:

S_S :	1.461	S_{D1} :	N/A
S_1 :	0.505	T_L :	6
F_a :	1.2	PGA :	0.625
F_v :	N/A	PGA_M :	0.75
S_{MS} :	1.753	F_{PGA} :	1.2
S_{M1} :	N/A	I_e :	1
S_{DS} :	1.168	C_v :	1.392

Ground motion hazard analysis may be required. See ASCE/SEI 7-16 Section 11.4.8.

Data Accessed: Thu Oct 10 2024

Date Source: USGS Seismic Design Maps

Ice

Results:

Ice Thickness:	1.00 in.
Concurrent Temperature:	25 F
Gust Speed	30 mph
Data Source:	Standard ASCE/SEI 7-16, Figs. 10-2 through 10-8
Date Accessed:	Thu Oct 10 2024

Ice thicknesses on structures in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

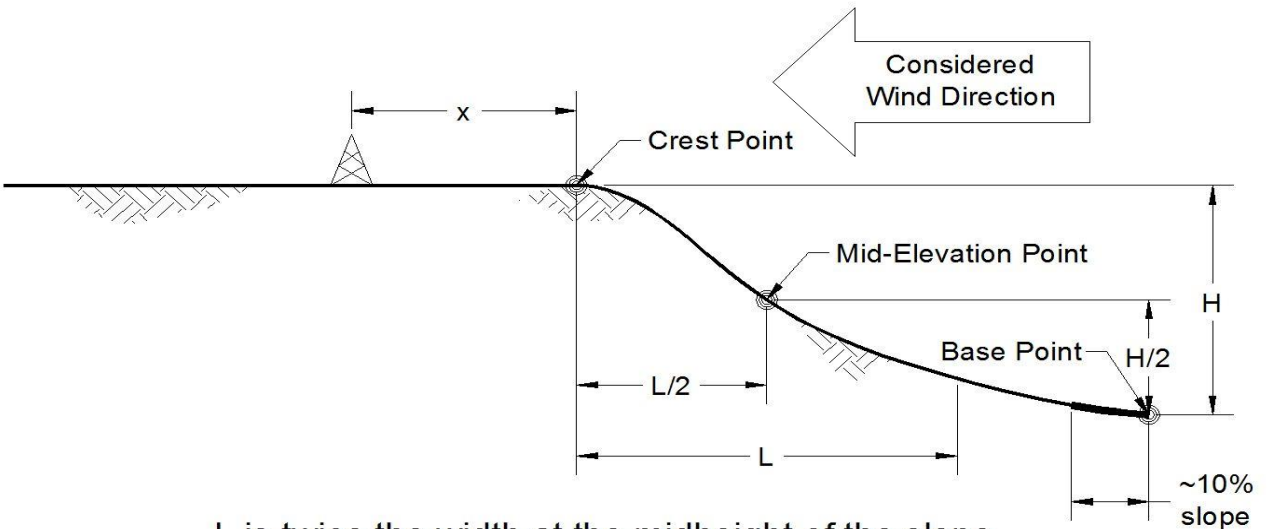
Values provided are equivalent radial ice thicknesses due to freezing rain with concurrent 3-second gust speeds, for a 500-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

Topographic Factors for use in tnxTower

(V. 3.2.3, Effecitve 09-06-2018)

per SEAW RSM-03 Figure 3-3 & ANSI/TIA-222-H Section 2.6.6.2.2

BU:	880416
Site Name:	SEATTLE QWEST - SEA155
Order:	681368 Rev. 1



L is twice the width at the midheight of the slope

Topographic Feature

- ○ Continuous Ridge
- ○ Flat Topped Ridge
- ○ Hill
- ○ Flat Topped Hill
- ◉ Continuous Escarpment
  - ☑ Tower is downwind from crest point

Exposure Category

- ◉ Exposure B
- ○ Exposure C
- ○ Exposure D

Notes:

1) Feature is assumed to be isolated per section 1.8 of the Crown Castle standard for the Determination of Topographic Factors (ENG-PRC-10040).

2) Base Kzt may differ slightly from TNX value due to differences in where the base line is established. This does not effect the results in anyway.

Topographic Input	
Crest Point Elevation (ft. AMSL)	380
Base Point Elevation (ft. AMSL)	20
Mid-Height Elevation (ft. AMSL)	200
Crest to Mid-Height Distance (L/2) (ft.)	1180
Tower Point Elevation (ft. AMSL)	380
Structure Distance from Crest Line (x)(ft.)	2945

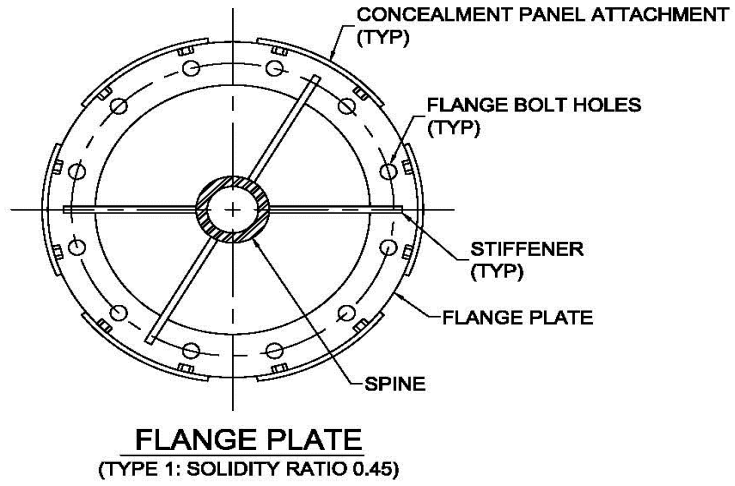
tnxTower Input		K_{ZT} (RSM-03)
Topographic Category	Rigorous Procedure / Category 5	**At Base:** **1.182^2**
Crest Height, H (ft.)	360	
Slope Distance, L (ft.)	2360	
Distance from Crest, x (ft.)	2945	

CCI Flagpole Tool

Site Data	
BU#:	880416
Site Name:	Seattle Qwest - SEA155
Order #:	681368 Rev. 1

Code		
Code:	TIA-222-H	
Ice Thickness:	1	in
Windspeed (V):	98	mph
Ice Wind Speed (V):	30	mph
Exposure Category:	B	
Topographic Feature:	Continuous Escarpment	
Distance From Crest (x):	2945	ft
Slope Distance (L):	2360	ft
Crest Height (H):	360	ft
Risk Category:	II	

Tower Information		
Total Tower Height:	150	ft
Base Tower Height:	100	ft
Total Canister Length:	50	ft
Number of Canister Assembly Sections:	5	



FLANGE PLATE
(TYPE 1: SOLIDITY RATIO 0.45)

Canister Section Number[1]:	Canister Assembly Length (ft):	Canister Assembly Diameter (in):	Ventilated Canister:	Manufacturer[2]:	Number of Sides Canister Section	Plate Type:	Mating Flange Plate Thickness (in)[3]:	Mating Flange Plate Diameter (in):	Solidity Ratio	Plate Weight (Kip):	Canister Weight (Kip)	Vent Length (ft):
1	10	60	No		Round	4	0.25	60	0.55	0.220	0.314	0-0
2	10	60	No		Round	4	0.25	60	0.55	0.220	0.314	0-0
3	10	60	No		Round	5	0.28	60	0.9	0.404	0.314	0-0
4	10	60	No		Round	5	0.30	60	0.9	0.433	0.314	0-0
5	10	60	Yes	Generic	Round	1	2.00	39.25	0.45	0.618	0.314	0-10

[1] Sections are numbered from the top of the tower down

[2] Select manufacturer if available for vented canister. Leave blank to autocalculate Cf values.

[3] Mating Flange Plate Thickness at the bottom of canister section

Flag on Tower:	**No**

Truck Ball on Tower:	**No**

Geometry : Base Tower + Spine 880416_2333549_LC4.7.eri *(last saved 10/10 2:48 pm)*

Pole Height Above Base (ft)	Section Length (ft)	Lap Splice Length (ft)	Number of Sides	Top Diameter (in)	Bottom Diameter (in)	Wall Thickness (in)	Bend Radius (in)	Pole Material	Delete
150	20		0	6.625	6.625	0.432	n/a	A53-B-35	[x]
130	20		0	8.625	8.625	0.5	n/a	A53-B-35	[x]
110	10		0	8.625	8.625	0.5	n/a	A53-B-42	[x]
100	40		0	36	36	0.375	n/a	A53-B-42	[x]
60	40		0	36	36	0.375	n/a	A53-B-42	[x]
20	20		0	36	36	0.375	n/a	A53-B-42	[x]

Discrete Loads : C_FA_F for Canister Assembly								
Canister Loading	Apply C_FA_F at Elevation(z) (ft)	C_FA_F No Ice (ft^2)	C_FA_F 1/2" Ice (ft^2)	C_FA_F 1" Ice (ft^2)	C_FA_F 2" Ice (ft^2)	C_FA_F 4" Ice (ft^2)	Canister Assembly Weight No Ice (Kip)	Canister Assembly Weight 1/2" Ice (Kip)
Canister Load 1	150	11.250	27.958	28.417	29.333	31.167	0.157	0.342
Canister Load 2	140	22.500	55.917	56.833	58.667	62.333	0.535	0.904
Canister Load 3	130	22.500	55.917	56.833	58.667	62.333	0.535	0.904
Canister Load 4	120	22.500	55.917	56.833	58.667	62.333	0.718	1.088
Canister Load 5	110	35.000	55.917	56.833	58.667	62.333	0.747	1.117
Canister Load 6	100	23.750	27.958	28.417	29.333	31.167	0.775	0.959

Deflection Check Required:	**Yes**	Import Deflection Results
3% Spine Deflection Check		
Allowable (3%) Horizontal Spine Deflection (inches)	Actual Deflection[1] (inches)	Sufficient/ Insufficient
18.000	19.169	Insufficient

[1] Relative deflection under service level wind speed

BU:	880416	Structure:	A
WO:	2333549		
Order:	681368	Rev:	1

Location

	Decimal Degrees		Deg	Min	Sec
Lat:	47.541667	+	47	32	30.00
Long:	-122.223611	-	122	13	25.00

Code and Site Parameters

Seismic Design Code:	TIA-222-H-1	
Site Soil:	D (Default)	Default
Risk Category:	II	

USGS Seismic Reference			
	S_S:	1.4610	g
	S_1:	0.5050	g
	T_L:	6	s

Seismic Design Category Determination

Importance Factor, I_e:	1	
Acceleration-based site coefficient, F_a:	1.2000	
Velocity-based site coefficient, F_v:	1.7950	
Design spectral response acceleration short period, S_{DS}:	1.1688	g
Design spectral response acceleration 1 s period, S_{D1}:	0.6043	g
T_s:	0.5170	
Seismic Design Category Based on S_{DS}:	D	
Seismic Design Category Based on S_{D1}:	D	
Seismic Design Category Based on S_1:	N/A	
Controlling Seismic Design Category:	D	

BU:	880416	Structure:	A
WO:	2333549		
Order:	681368	Rev:	1

Tower Details

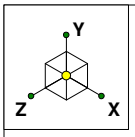
Tower Type:	Stepped Monopole		
Height, h:	150	ft	
Effective Seismic Weight, W:	24.66	kips	
Amplification Factor, A_s:	1.0		2.7.8.1

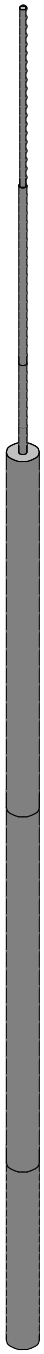
Seismic Base Shear

Response Modification Factor, R:	1.5		
Fundamental Period, T:	2.9540	s	
Seismic Response Coefficient, C_s	0.2046		Table 2-12 Note 3
Seismic Response Coefficient Max 1, C_{smax}	N/A		
Seismic Response Coefficient Max 2, C_{smax}	N/A		
Seismic Response Coefficient Min 1, C_{smin}	0.0514		2.7.7.1.1
Seismic Response Coefficient Min 2, C_{smin}	N/A		2.7.7.1.1
Controlling Seismic Response Coefficient, C_{sc}	0.2046		
Seismic Base Shear, V	5.044	kips	2.7.7.1.1

Vertical Distribution Factors

Period Related Exponent, k:	2.000
Sum of $w_i h_i^k$	181113.26





TEP	Seattle Qwest - SEA155 (BU 880416)	SK - 1
MS		Oct 10, 2024 at 4:52 PM
TEP No. 151934.1008537		880416_2333549_LC4.7_Modal.rt3

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	No
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	7620
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Standard Solver

Hot Rolled Steel Code	AISC 15th(360-16): LRFD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 15th(360-16): ASD
Cold Formed Steel Code	None
Wood Code	None
Wood Temperature	< 100F
Concrete Code	None
Masonry Code	ACI 530-13: ASD
Aluminum Code	AA ADM1-15: ASD - Building
Stainless Steel Code	AISC 14th(360-10): ASD
Adjust Stiffness?	Yes(Iterative)

Number of Shear Regions	4
Region Spacing Increment (in)	2540.005
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_IS1786
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-16
Seismic Base Elevation (ft)	0
Add Base Weight?	Yes
Ct X	1
Ct Z	1
T X (sec)	2.954
T Z (sec)	2.954
R X	1.5
R Z	1.5
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	.604
SDS	1.169
S1	.505
TL (sec)	6
Risk Cat	I or II
Drift Cat	Other
Om Z	1
Om X	1
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

General Material Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (/1E5 F)	Density[k/ft^3]
1	gen_Conc3NW	3155	1372	.15	.6	.145
2	gen_Conc4NW	3644	1584	.15	.6	.145
3	gen_Conc3LW	2085	906	.15	.6	.11
4	gen_Conc4LW	2408	1047	.15	.6	.11
5	gen_Alum	10600	4077	.3	1.29	.173
6	gen_Steel	29000	11154	.3	.65	.49
7	RIGID	1e+6		.3	0	0

General Section Sets

	Label	Shape	Type	Material	A [in2]	Iyy [in4]	Izz [in4]	J [in4]
1	GEN1	RE4X4	Beam	gen_Conc3NW	16	21.333	21.333	31.573

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N92	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Joint	Point	Distributed	Area(Me...	Surface(P...
1	Dead	None		-1			103	6		

Load Combinations

	Description	So...	P...	S...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...	BLC	Fac...
1	Dead Only	Yes	Y		1	1																		
2	(1.2+0.2Sds)*DL...	Yes	Y		1	1.2	1	.234	SX...	1														

Spectra Scaling Factor

Scaling Factor Z:	.968	Scaling Factor X:	.968	

Dynamics Input

Number of Modes	14
Load Combination Number	1 - Dead Only
Acceleration of Gravity	32.2 (ft/sec^2)
Convergence Tolerance	0.0001

Response Spectra Data

X Direction Spectra	ASCE 2016, Parametric Design Spectra
Modes Used	All 14 modes
Mode No. for Signs	
Modal Combination Method	CQC
Damping Ratio	5 Percent

Y Direction Spectra	ASCE 2016, Parametric Design Spectra
Modes Used	All 14 modes
Mode No. for Signs	
Modal Combination Method	CQC
Damping Ratio	5 Percent

Z Direction Spectra	ASCE 2016, Parametric Design Spectra
Modes Used	All 14 modes
Mode No. for Signs	
Modal Combination Method	CQC
Damping Ratio	5 Percent

Frequencies / Participation

Mode Number	Frequency (Hz)	Period (Sec)	Percent Modal Participation X Spectra	Y Spectra	Z Spectra
1	.346	2.892	38.724		10.834
2	.346	2.892	10.834		38.724
3	.854	1.17	14.459		5.578
4	.854	1.17	5.578		14.459
5	2.595	.385	3.256		1.731
6	2.595	.385	1.731		3.256
7	4.627	.216	6.669		3.63
8	4.627	.216	3.63		6.669
9	7.653	.131	.864		.473
10	7.653	.131	.473		.864
11	12.181	.082	1.771		.988
12	12.181	.082	.988		1.771
13	15.121	.066	1.103		.618
14	15.121	.066	.618		1.103
Totals :			90.699		90.699

Member Section Forces (By Combination)

	LC	Member Label	Sec	Axial[k]	y Shear[k]	z Shear[k]	Torque[k-ft]	y-y Moment[k-ft]	z-z Moment[k-ft]
1	2	M3B	1	5.829	1.165	0	0	-.014	29.81
2			2	5.782	1.165	0	0	-.014	29.194
3			3	5.72	1.155	0	0	-.014	28.586
4			4	5.658	1.144	0	0	-.014	27.988

Member Section Forces (By Combination) (Continued)

	LC	Member Label	Sec	Axial[k]	y Shear[k]	z Shear[k]	Torque[k-ft]	y-y Moment[k-ft]	z-z Moment[k-ft]
5			5	5.611	1.144	0	0	-.014	27.399
6	2	M1	1	2.807	1.229	0	0	0	19.334
7			2	2.55	1.217	0	0	0	13.627
8			3	2.292	1.169	0	0	0	8.232
9			4	1.269	.953	0	0	0	3.364
10			5	.546	.553	0	0	0	-.001
11	2	M2	1	8.147	1.977	0	0	-.001	44.177
12			2	7.725	1.959	0	0	0	36.872
13			3	6.625	1.828	0	0	0	30.518
14			4	5.174	1.622	0	0	0	24.816
15			5	3.575	1.326	0	0	0	19.335
16	2	M3A	1	5.844	1.165	0	0	-.014	29.81
17			2	5.643	1.144	0	0	-.014	27.792
18			3	11.023	2.254	0	0	-.027	51.779
19			4	9.449	2.071	0	0	-.001	47.882
20			5	9.218	2.053	0	0	-.001	44.177
21	2	M4	1	22.29	3.224	0	0	-.029	150.142
22			2	19.913	3.097	0	0	-.029	125.01
23			3	17.537	3.023	0	0	-.028	100.475
24			4	15.16	2.892	0	0	-.028	77.97
25			5	12.783	2.564	0	0	-.028	59.621
26	2	M5	1	31.797	4.789	0	0	-.03	267.502
27			2	29.42	4.493	0	0	-.03	233.315
28			3	27.044	4.036	0	0	-.03	203.103
29			4	24.667	3.597	0	0	-.03	175.838
30			5	22.29	3.271	0	0	-.029	150.142
31	2	M6	1	36.551	5.044	0	0	-.031	347.177
32			2	35.362	5.04	0	0	-.031	326.136
33			3	34.174	5.013	0	0	-.031	305.744
34			4	32.986	4.947	0	0	-.03	286.154
35			5	31.797	4.832	0	0	-.03	267.502

Joint Reactions (By Combination)

	LC	Joint Label	X [k]	Y [k]	Z [k]	MX [k-ft]	MY [k-ft]	MZ [k-ft]
1	2	N92	-5.044	36.551	0	.031	0	-347.179
2	2	Totals:	-5.044	36.551	0			
3	2	COG (ft):	X: 0	Y: 74.632	Z: 0			

Mod #	Modification Type	Termination Length (ft)	Bot. Elevation (ft)	Top Elevation (ft)	Termination Length (ft)	Modification Location (° or Flat/Point #)	Location (F/P)	Lateral Offset (in)

MODIFICATION PROPERTIES									
#	Modification	Default Termination (ft)	Stitch (in)	k	Drill Hole (in)	Bolt/Weld Capacity (k)	A_G (in²)	F_Y (ksi)	F_U (ksi)

TEP OpCo, LLC
326 Tryon Road|Raleigh, NC 27603-3530|Office: (919) 661-6351|Fax: (919) 661-6350|www.tepgroup.net

Pole (L3)	55.9%	Pass

Monopole Reinforcement_v1.9.7 - TIA-222-H - Per Section 15.5 - Capacities

Section No.	Elevation (ft)	Type	Size	Critical Element	Pu (k)	φPn (k)	% Capacity (Note 2)	Pass/Fail
L1	150.00-130.00	Pole	TP6.63×6.63×0.4320	1	Note 1	Note 1	43.3	Pass
L2	130.00-110.00	Pole	TP8.63×8.63×0.5000	2	Note 1	Note 1	50.5	Pass
L3	110.00-100.00	Pole	TP8.63×8.63×0.5000	3	Note 1	Note 1	55.9	Pass
L4	100.00-60.00	Pole	TP36.00×36.00×0.3750	4	Note 1	Note 1	12.1	Pass
L5	60.00-20.00	Pole	TP36.00×36.00×0.3750	5	Note 1	Note 1	21.1	Pass
L6	20.00-0.00	Pole	TP36.00×36.00×0.3750	6	Note 1	Note 1	27.0	Pass

	Summary	
Pole (L3)	55.9	Pass
RATING =	55.9	Pass

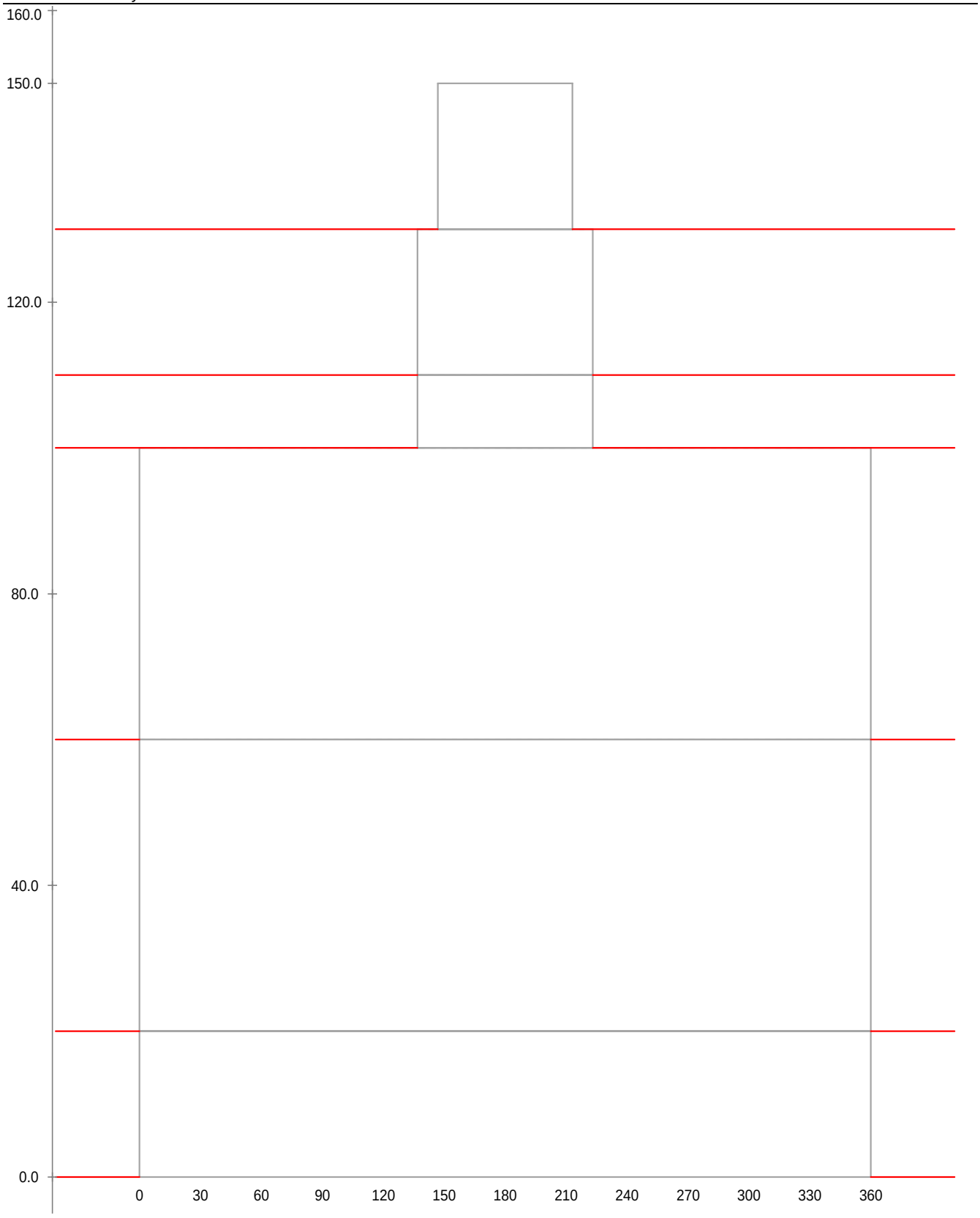
NOTES:

Note 1: See additional documentation in following sheets for details

Note 2: Per TIA-222-H Section 15.5

TEP OpCo, LLC
326 Tryon Road|Raleigh, NC 27603-3530|Office: (919) 661-6351|Fax: (919) 661-6350|www.tepgroup.net

Reinforcement Layout



TEP OpCo, LLC
326 Tryon Road|Raleigh, NC 27603-3530|Office: (919) 661-6351|Fax: (919) 661-6350|www.tepgroup.net

Loads	
Axial:	36.6 k
Moment:	347.2 k·ft
Shear:	5.0 k
Torsion:	0.0 k·ft

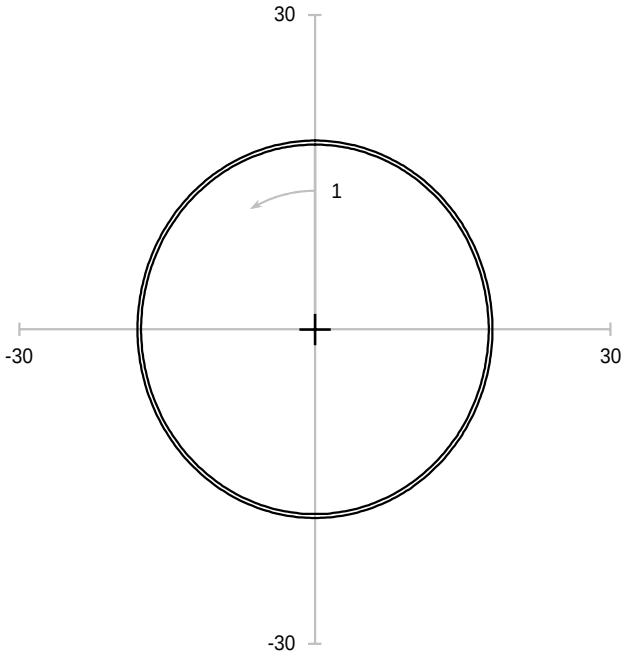
Equivalent Loads to Pole	
Axial:	36.6 k
Moment:	347.2 k·ft
Shear:	5.0 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	36.00 in
t:	0.3750 in
Pole A_G:	41.97 in²
Pole I_G:	6,658.9 in⁴

Controlling	
Angle:	0.00°
I_{CONT}:	6,658.9 in⁴
A_G:	41.97 in²

Minimum	
Angle:	0.00°
I_{MIN}:	6,658.9 in⁴
t_{EFF}:	0.3750 in



Pole Segment: L6, F_Y = 42 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	18.00	6658.9	0.871	11.262	0.120	0.000	35.517	43.428	10.822	17.574	27.0%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

Loads	
Axial:	31.8 k
Moment:	267.5 k·ft
Shear:	4.8 k
Torsion:	0.0 k·ft

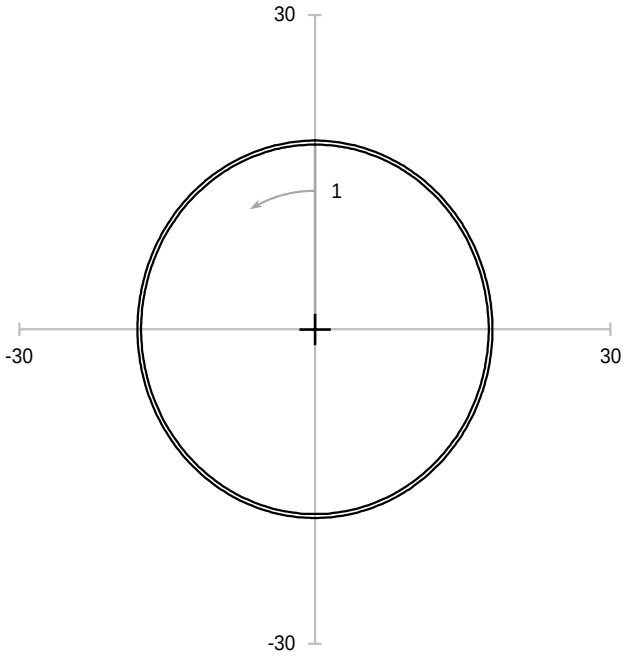
Equivalent Loads to Pole	
Axial:	31.8 k
Moment:	267.5 k·ft
Shear:	4.8 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	36.00 in
t:	0.3750 in
Pole A_G:	41.97 in²
Pole I_G:	6,658.9 in⁴

Controlling	
Angle:	0.00°
I_G:	6,658.9 in⁴
A_G:	41.97 in²

Minimum	
Angle:	0.00°
I_{MIN}:	6,658.9 in⁴
t_{EFF}:	0.3750 in



Pole Segment: L5, F_Y = 42 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	18.00	6658.9	0.758	8.677	0.114	0.000	35.517	43.428	10.822	17.574	21.1%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

TEP OpCo, LLC
326 Tryon Road|Raleigh, NC 27603-3530|Office: (919) 661-6351|Fax: (919) 661-6350|www.tepgroup.net

Loads	
Axial:	22.3 k
Moment:	150.1 k·ft
Shear:	3.2 k
Torsion:	0.0 k·ft

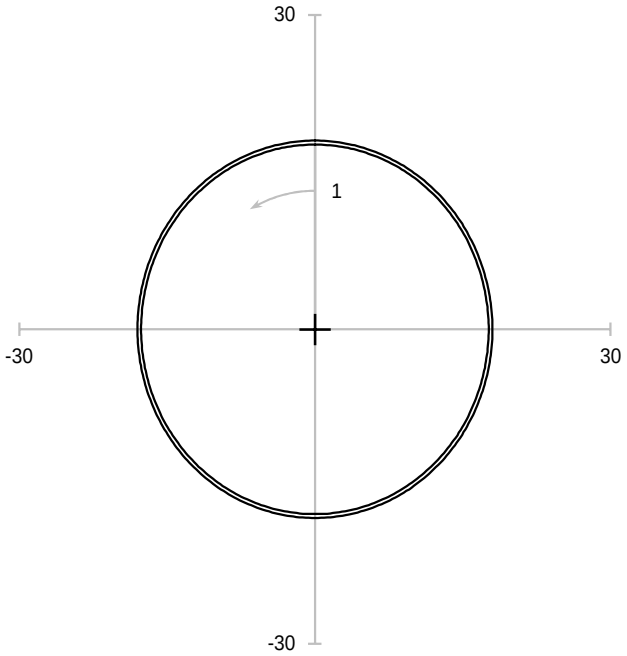
Equivalent Loads to Pole	
Axial:	22.3 k
Moment:	150.1 k·ft
Shear:	3.2 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	36.00 in
t:	0.3750 in
Pole A_G:	41.97 in²
Pole I_G:	6,658.9 in⁴

Controlling	
Angle:	0.00°
I_G:	6,658.9 in⁴
A_G:	41.97 in²

Minimum	
Angle:	0.00°
I_{MIN}:	6,658.9 in⁴
t_{EFF}:	0.3750 in



Pole Segment: L4, F_Y = 42 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	18.00	6658.9	0.531	4.870	0.077	0.000	35.517	43.428	10.822	17.574	12.1%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

Loads	
Axial:	11.3 k
Moment:	58.7 k·ft
Shear:	2.3 k
Torsion:	0.0 k·ft

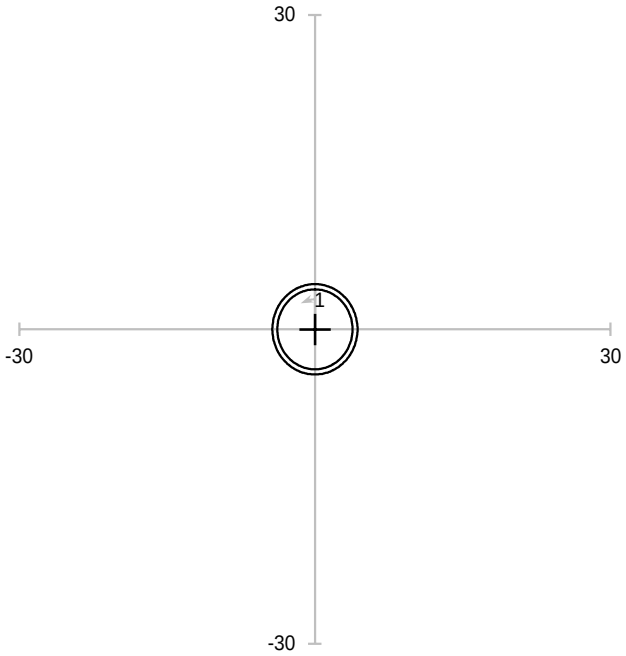
Equivalent Loads to Pole	
Axial:	11.3 k
Moment:	58.7 k·ft
Shear:	2.3 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	8.63 in
t:	0.5000 in
Pole A_G:	12.76 in²
Pole I_G:	105.7 in⁴

Controlling	
Angle:	0.00°
I_G:	105.7 in⁴
A_G:	12.76 in²

Minimum	
Angle:	0.00°
I_{MIN}:	105.7 in⁴
t_{EFF}:	0.5000 in



Pole Segment: L3, F_Y = 42 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	4.31	105.7	0.883	28.720	0.179	0.000	37.800	50.962	11.340	23.940	55.9%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

Loads	
Axial:	8.1 k
Moment:	44.2 k·ft
Shear:	2.0 k
Torsion:	0.0 k·ft

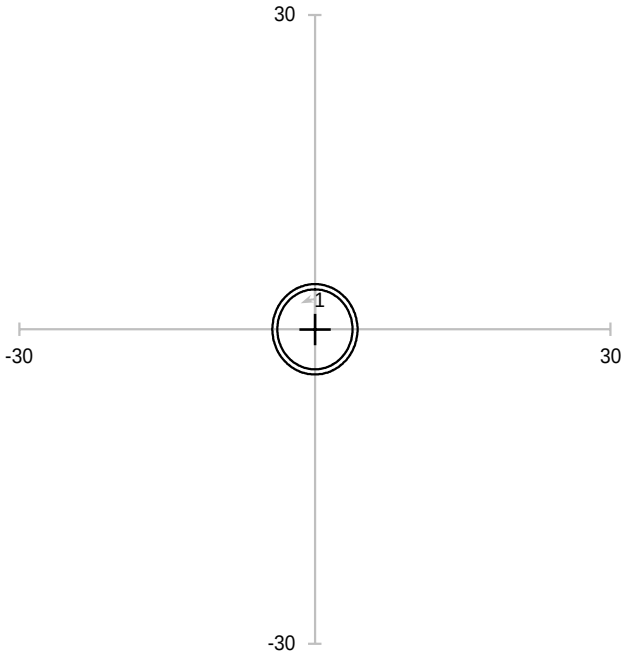
Equivalent Loads to Pole	
Axial:	8.1 k
Moment:	44.2 k·ft
Shear:	2.0 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	8.63 in
t:	0.5000 in
Pole A_G:	12.76 in²
Pole I_G:	105.7 in⁴

Controlling	
Angle:	0.00°
I_G:	105.7 in⁴
A_G:	12.76 in²

Minimum	
Angle:	0.00°
I_{MIN}:	105.7 in⁴
t_{EFF}:	0.5000 in



Pole Segment: L2, F_Y = 35 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	4.31	105.7	0.638	21.625	0.155	0.000	31.500	42.468	9.450	19.950	50.5%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

Loads	
Axial:	2.8 k
Moment:	19.3 k·ft
Shear:	1.2 k
Torsion:	0.0 k·ft

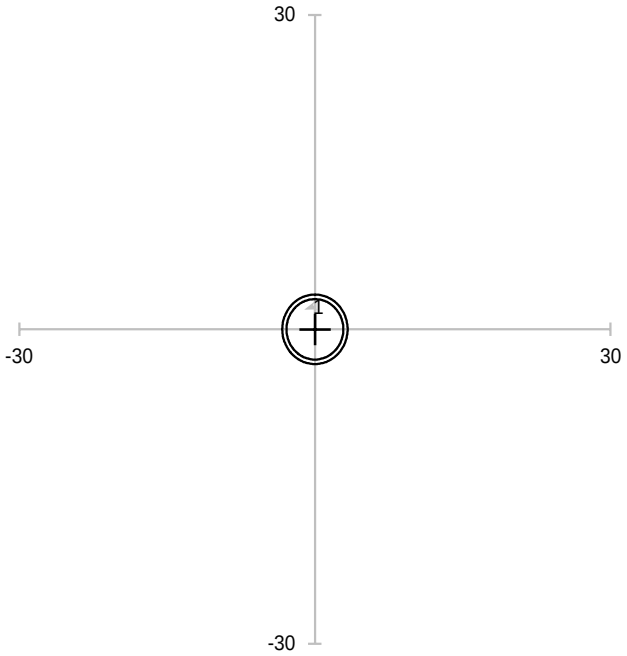
Equivalent Loads to Pole	
Axial:	2.8 k
Moment:	19.3 k·ft
Shear:	1.2 k
Torsion:	0.0 k·ft

Shear Flow N/A

Pole Info	
OD:	6.63 in
t:	0.4320 in
Pole A_G:	8.40 in²
Pole I_G:	40.5 in⁴

Controlling	
Angle:	0.00°
I_G:	40.5 in⁴
A_G:	8.40 in²

Minimum	
Angle:	0.00°
I_{MIN}:	40.5 in⁴
t_{EFF}:	0.4320 in



Pole Segment: L1, F_Y = 35 ksi

POLE CAPACITY											
Angle (°)	y_{CONT} (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	σ_T (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	ϕF_T (ksi)	Capacity
0.00	3.31	40.5	0.334	18.980	0.146	0.000	31.500	42.766	9.450	19.950	43.3%

MODIFICATION CAPACITIES											
Mod Number	#	Angle (°)	$\bar{y}_{CONT}$ (in)	I (in⁴)	σ_A (ksi)	σ_B (ksi)	σ_V (ksi)	ϕF_A (ksi)	ϕF_B (ksi)	ϕF_V (ksi)	Capacity

Monopole Flange Plate Connection

Elevation = 130 ft.

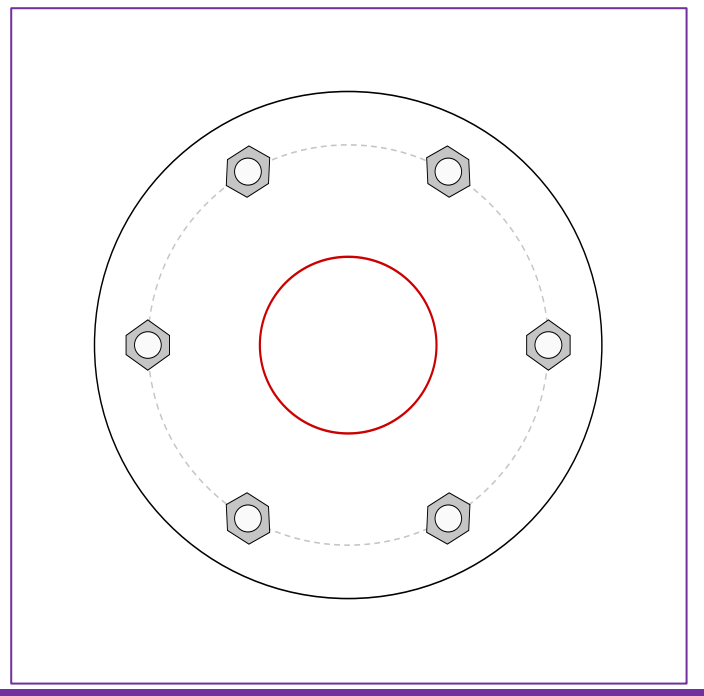
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

TIA-222 Revision	H

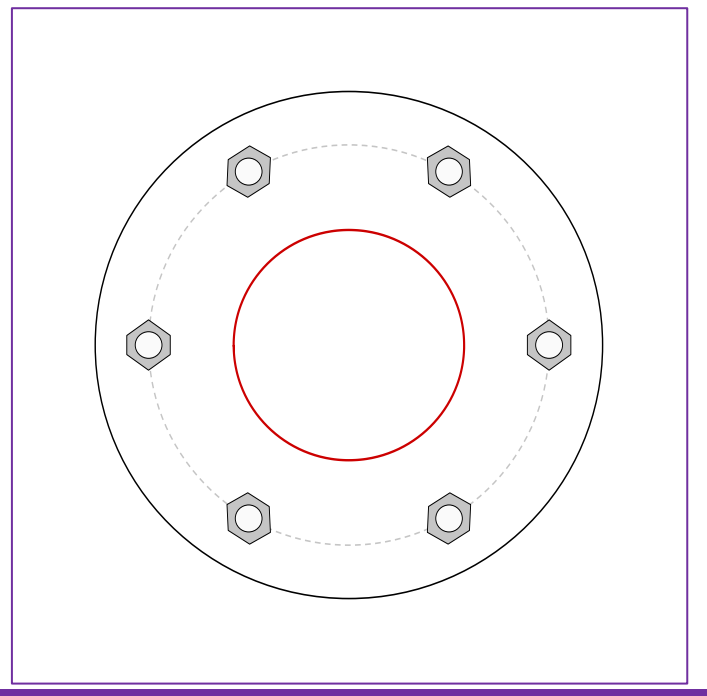
Applied Loads	
Moment (kip-ft)	17.36
Axial Force (kips)	2.23
Shear Force (kips)	1.28

**TIA-222-H Section 15.5 Applied*

Top Plate - External



Bottom Plate - External



Connection Properties

Bolt Data

(6) 1" ø bolts (A325 N; Fy=92 ksi, Fu=120 ksi) on 15" BC

Top Plate Data

19" OD x 1.5" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Bottom Plate Data

19" OD x 1.5" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Top Stiffener Data

N/A

Bottom Stiffener Data

N/A

Top Pole Data

6.625" x 0.432" round pole (A53-B-35; Fy=35 ksi, Fu=60 ksi)

Bottom Pole Data

8.625" x 0.5" round pole (A53-B-35; Fy=35 ksi, Fu=60 ksi)

Analysis Results

Bolt Capacity

Max Load (kips)	8.87	
Allowable (kips)	54.54	
Stress Rating:	**15.5%**	**Pass**

Top Plate Capacity

Max Stress (ksi):	7.04	(Flexural)
Allowable Stress (ksi):	45.00	
Stress Rating:	**14.9%**	**Pass**
Tension Side Stress Rating:	**16.1%**	**Pass**

Bottom Plate Capacity

Max Stress (ksi):	5.30	(Flexural)
Allowable Stress (ksi):	45.00	
Stress Rating:	**11.2%**	**Pass**
Tension Side Stress Rating:	**8.6%**	**Pass**

Monopole Flange Plate Connection

Elevation = 110 ft.

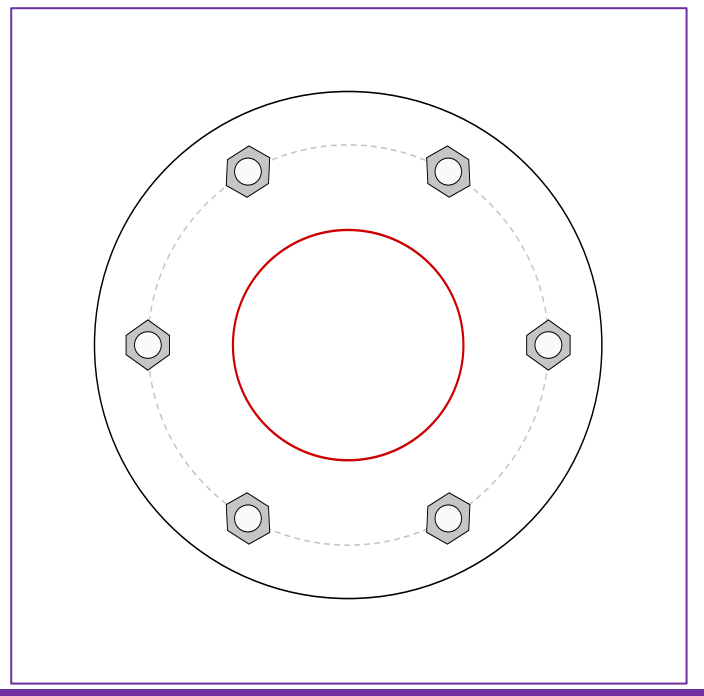
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

TIA-222 Revision	H

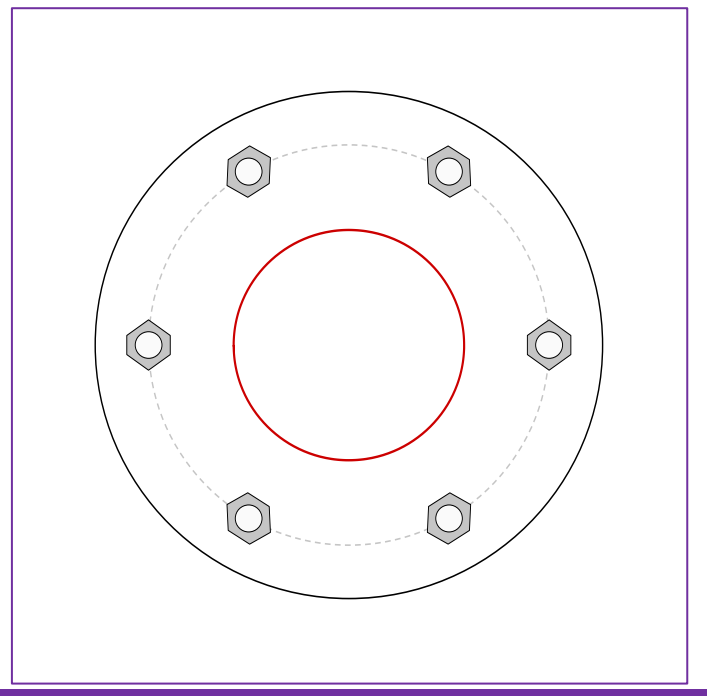
Applied Loads	
Moment (kip-ft)	66.28
Axial Force (kips)	6.64
Shear Force (kips)	2.80

**TIA-222-H Section 15.5 Applied*

Top Plate - External



Bottom Plate - External



Connection Properties

Bolt Data

(6) 1" ø bolts (A325 N; Fy=92 ksi, Fu=120 ksi) on 15" BC

Top Plate Data

19" OD x 1.5" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Bottom Plate Data

19" OD x 2" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Top Stiffener Data

N/A

Bottom Stiffener Data

N/A

Top Pole Data

8.625" x 0.5" round pole (A53-B-35; Fy=35 ksi, Fu=60 ksi)

Bottom Pole Data

8.625" x 0.5" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Analysis Results

Bolt Capacity

Max Load (kips)	34.18	
Allowable (kips)	54.54	
Stress Rating:	**59.7%**	**Pass**

Top Plate Capacity

Max Stress (ksi):	20.03	(Flexural)
Allowable Stress (ksi):	45.00	
Stress Rating:	**42.4%**	**Pass**
Tension Side Stress Rating:	**33.3%**	**Pass**

Bottom Plate Capacity

Max Stress (ksi):	11.26	(Flexural)
Allowable Stress (ksi):	45.00	
Stress Rating:	**23.8%**	**Pass**
Tension Side Stress Rating:	**18.7%**	**Pass**

Monopole Flange Plate Connection

Elevation = 100 ft.

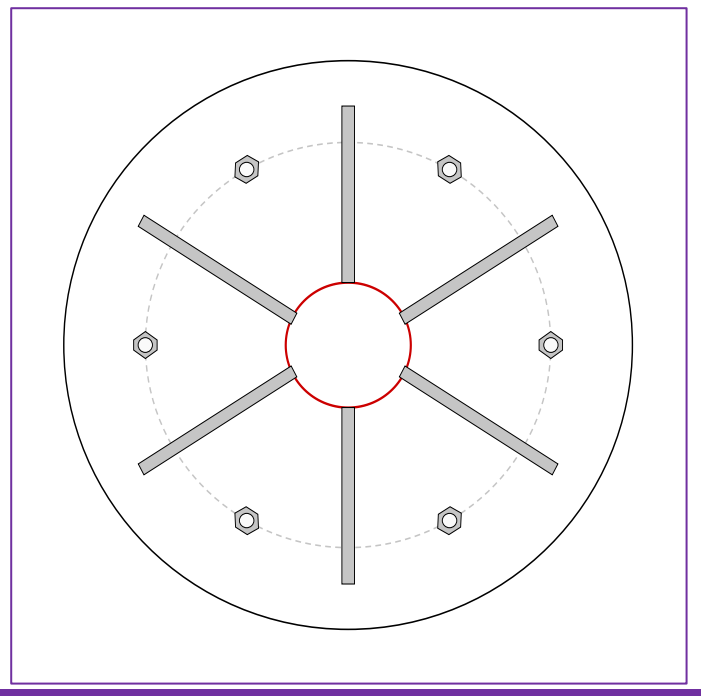
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

TIA-222 Revision	H

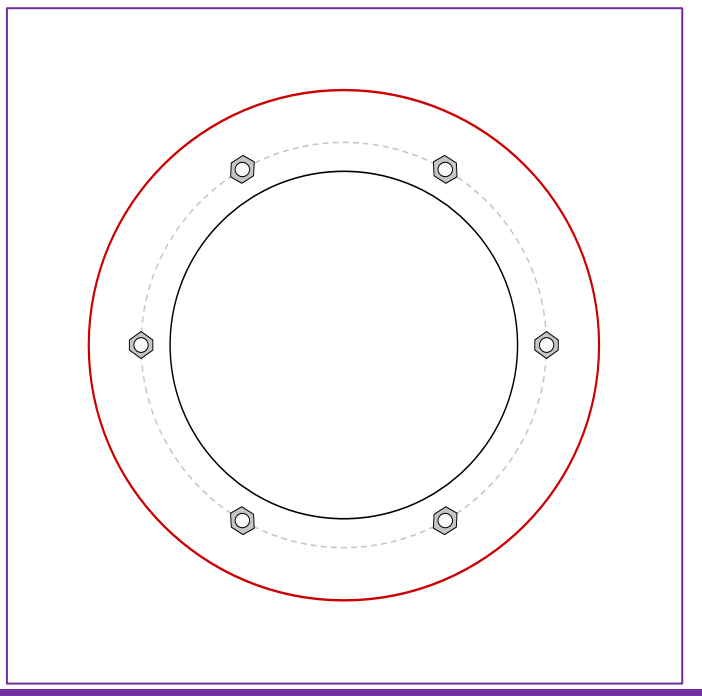
Applied Loads	
Moment (kip-ft)	103.56
Axial Force (kips)	9.51
Shear Force (kips)	3.60

**TIA-222-H Section 15.5 Applied*

Top Plate - External



Bottom Plate - Internal



Connection Properties

Bolt Data

(6) 1" ø bolts (A325 N; Fy=92 ksi, Fu=120 ksi) on 28" BC

Top Plate Data

39.25" OD x 2" Plate (A572-50; Fy=50 ksi, Fu=65 ksi)

Bottom Plate Data

24" ID x 1.5" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Top Stiffener Data

(6) 18"H x 12.1875"W x 0.875"T, Notch: 7.6875" horiz. x 0" vert.
plate: Fy= 50 ksi ; weld: Fy= 70 ksi
horiz. weld: 0.4375" groove, 45° dbl bevel, 0.25" fillet
vert. weld: 0.3125" fillet

Bottom Stiffener Data

N/A

Top Pole Data

8.625" x 0.5" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Bottom Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

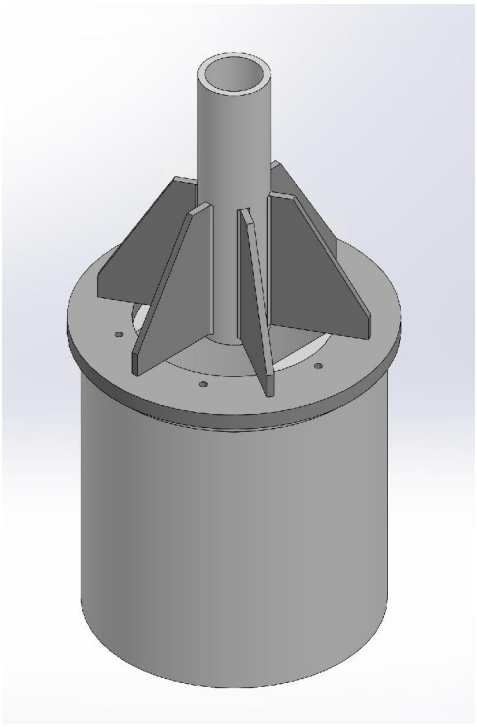
Analysis Results

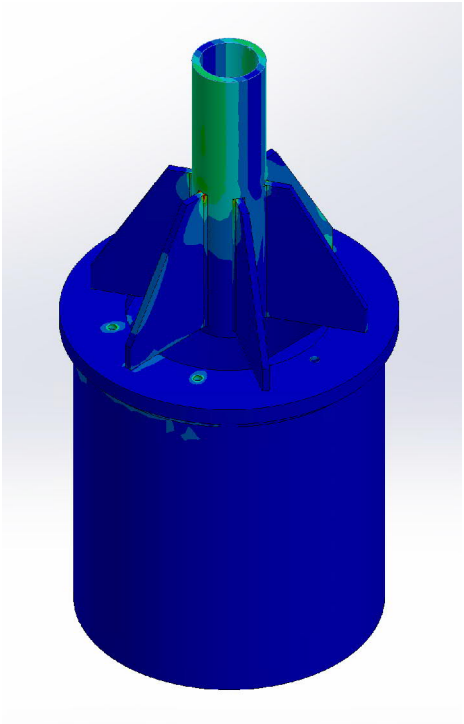
Bolt Capacity

Max Load (kips)	27.99	
Allowable (kips)	54.53	
Stress Rating:	**48.9%**	**Pass**

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	1

Simulation of Concealment Flange - 100-ft Elevation





Model Loads

Axial	9,506	lb
Shear	3,602	lb
Moment	103,557	lb-ft
Self-Weight Factor	1.2	

Overall Results

Sufficient

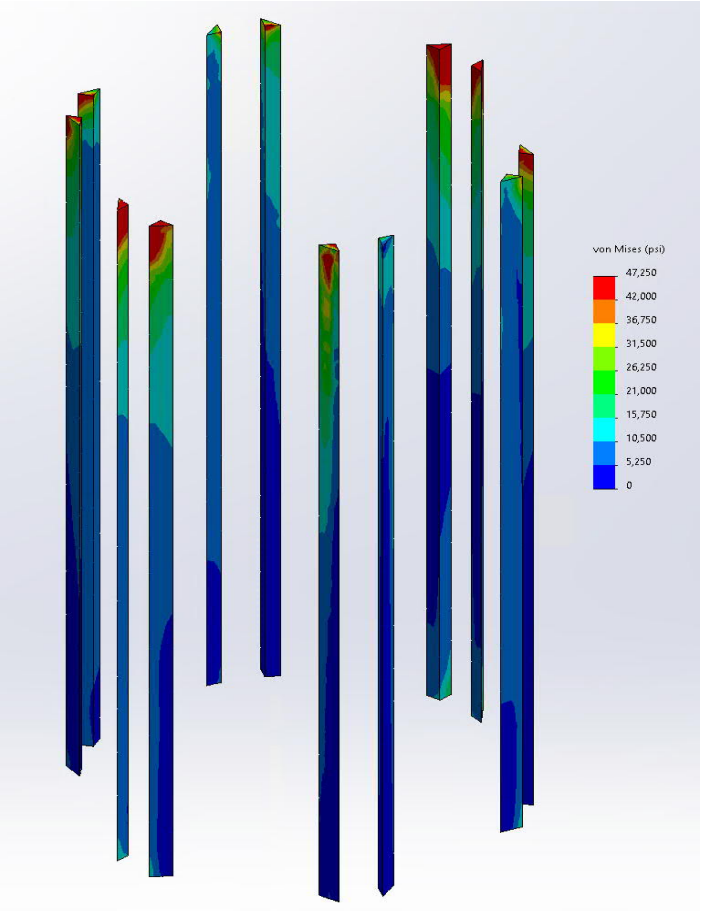
Model Part Information

Part	Part Grade
Spine Stub Section	A53-B-42
Spine to Top Flange Welds	E70XX
Stiffeners	A572-50
Top Flange	A572-50
Bottom Flange	A36
Tower Stub Section	A53-B-42

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	2

Study: 0 Degree

Spine to Top Flange Welds

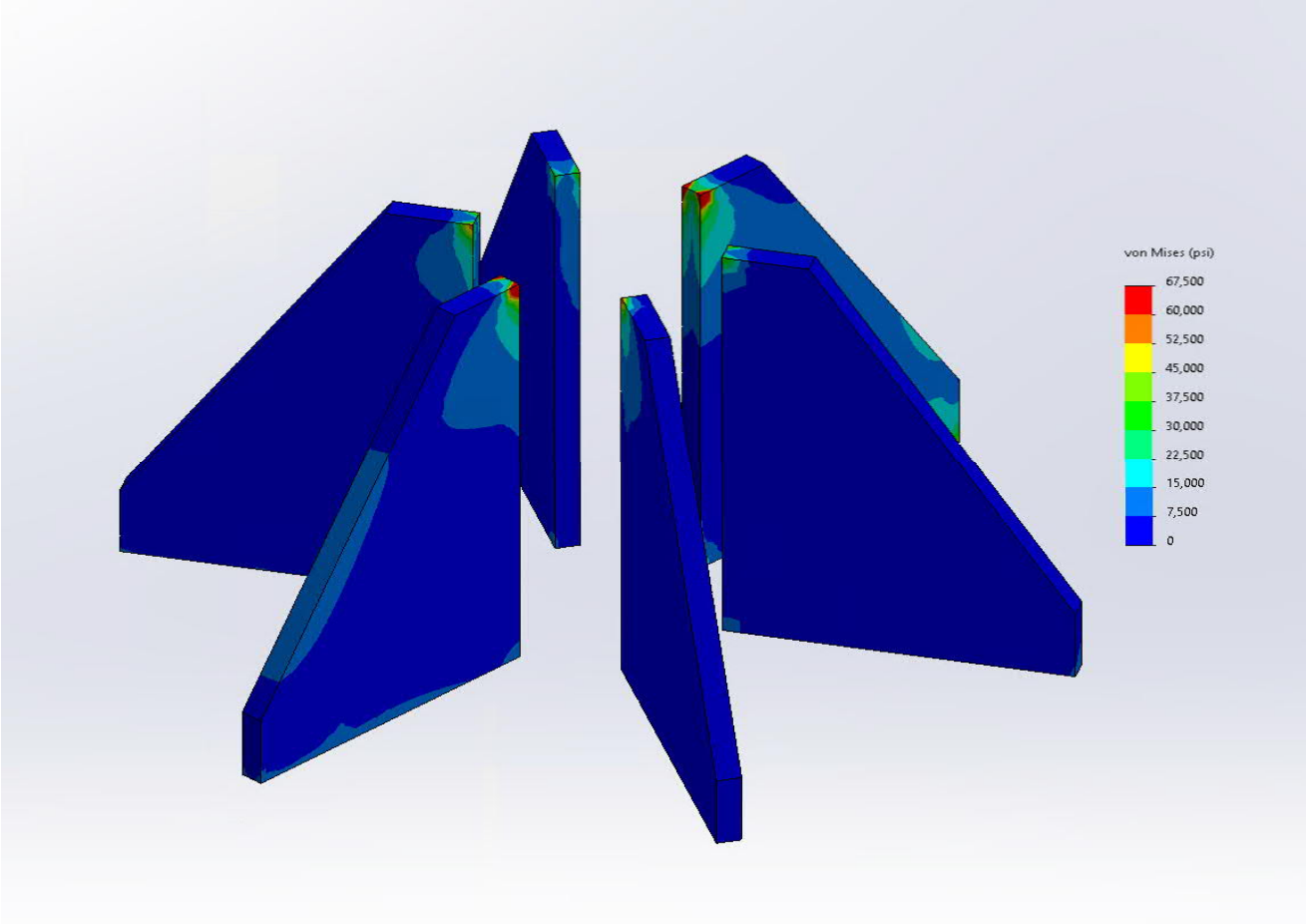


Assumptions	Results
N/A	Sufficient

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	3

Study: 0 Degree

Stiffeners

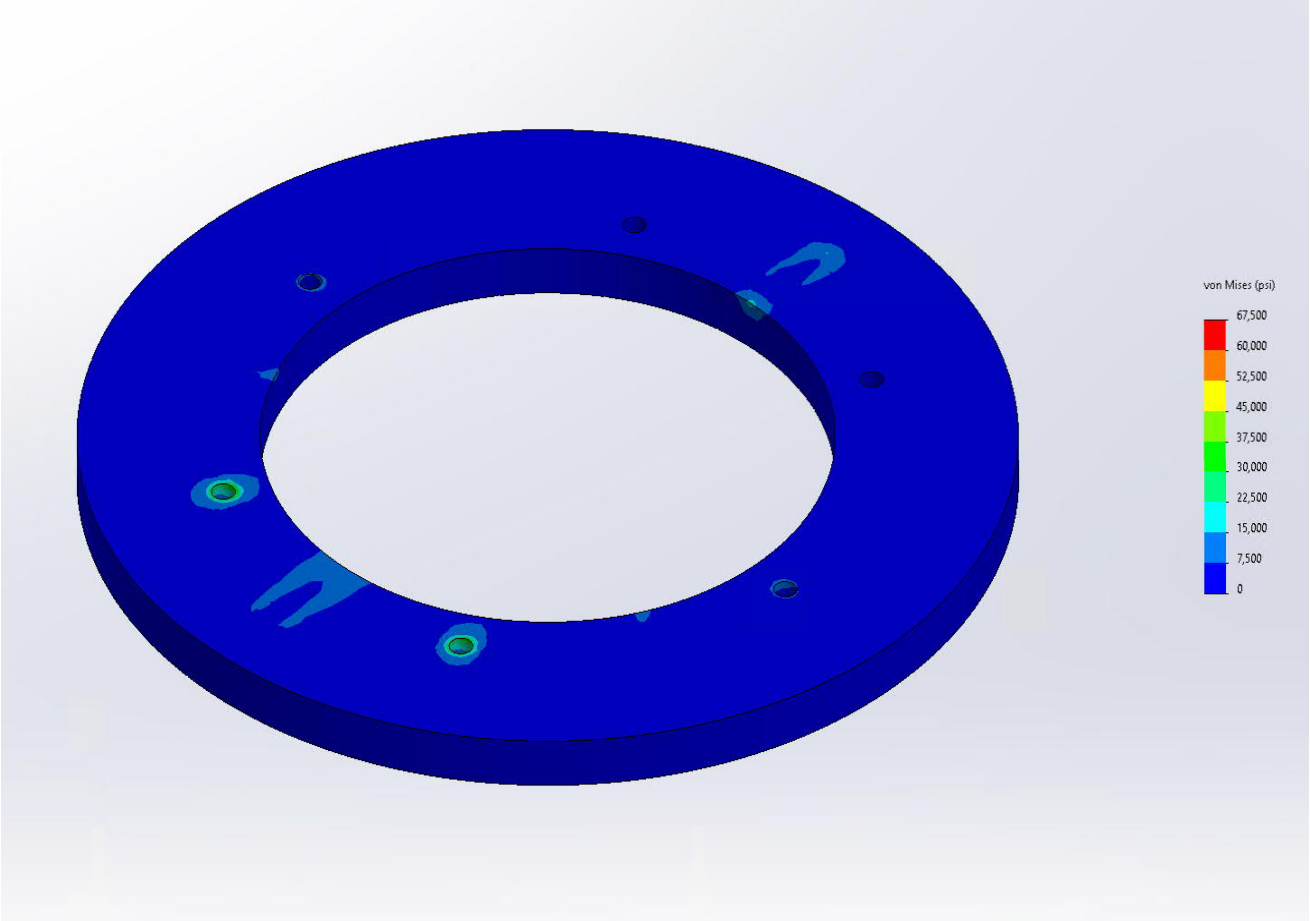


Assumptions	Results
N/A	Sufficient

Client Site Name:	Seattle Qwest - SEA155		Engineer:	MS
Client Site Number:	BU 880416		Check:	SMS
Client Order Number:	640386 Rev. 5		Date:	10/11/2024
TEP Project Number:	151934.1008537		Page:	4

Study: 0 Degree

Top Flange

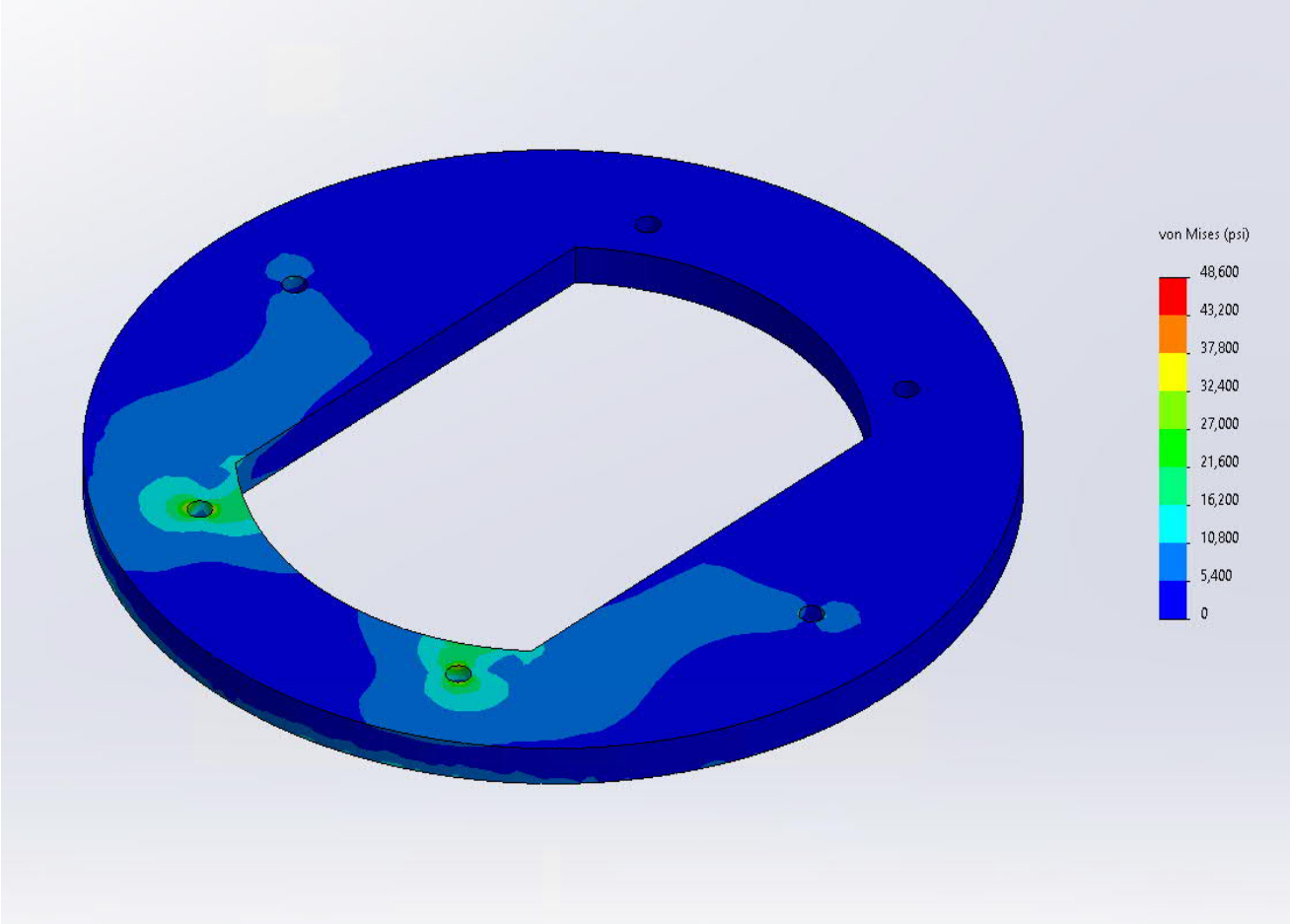


Assumptions	Results
N/A	Sufficient

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	5

Study: 0 Degree

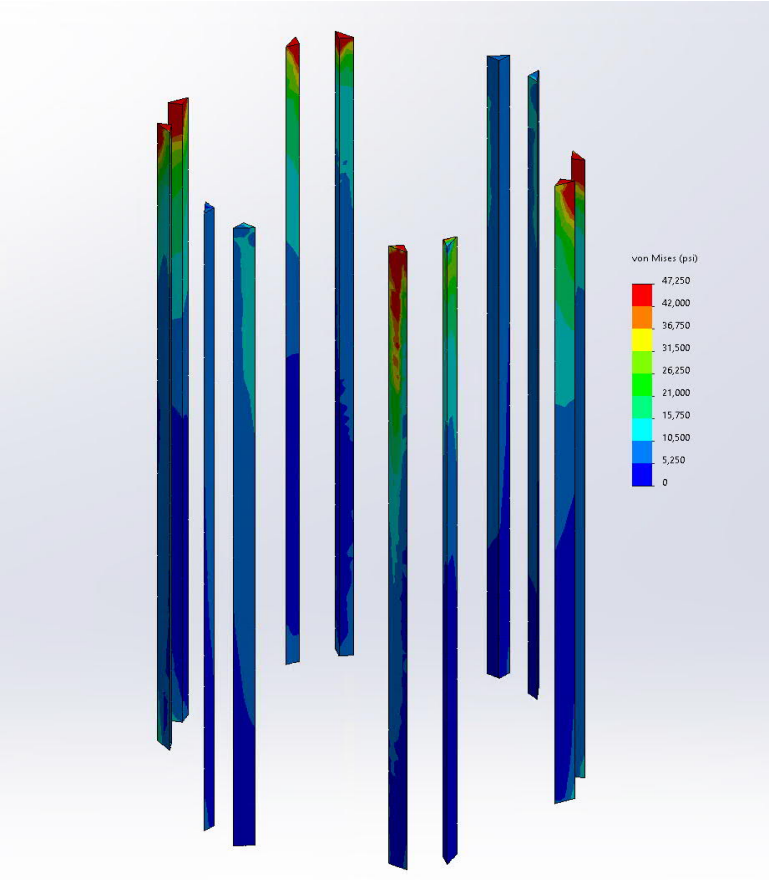
Bottom Flange



Assumptions	Results
N/A	Sufficient

Study: 90 Degree

Spine to Top Flange Welds

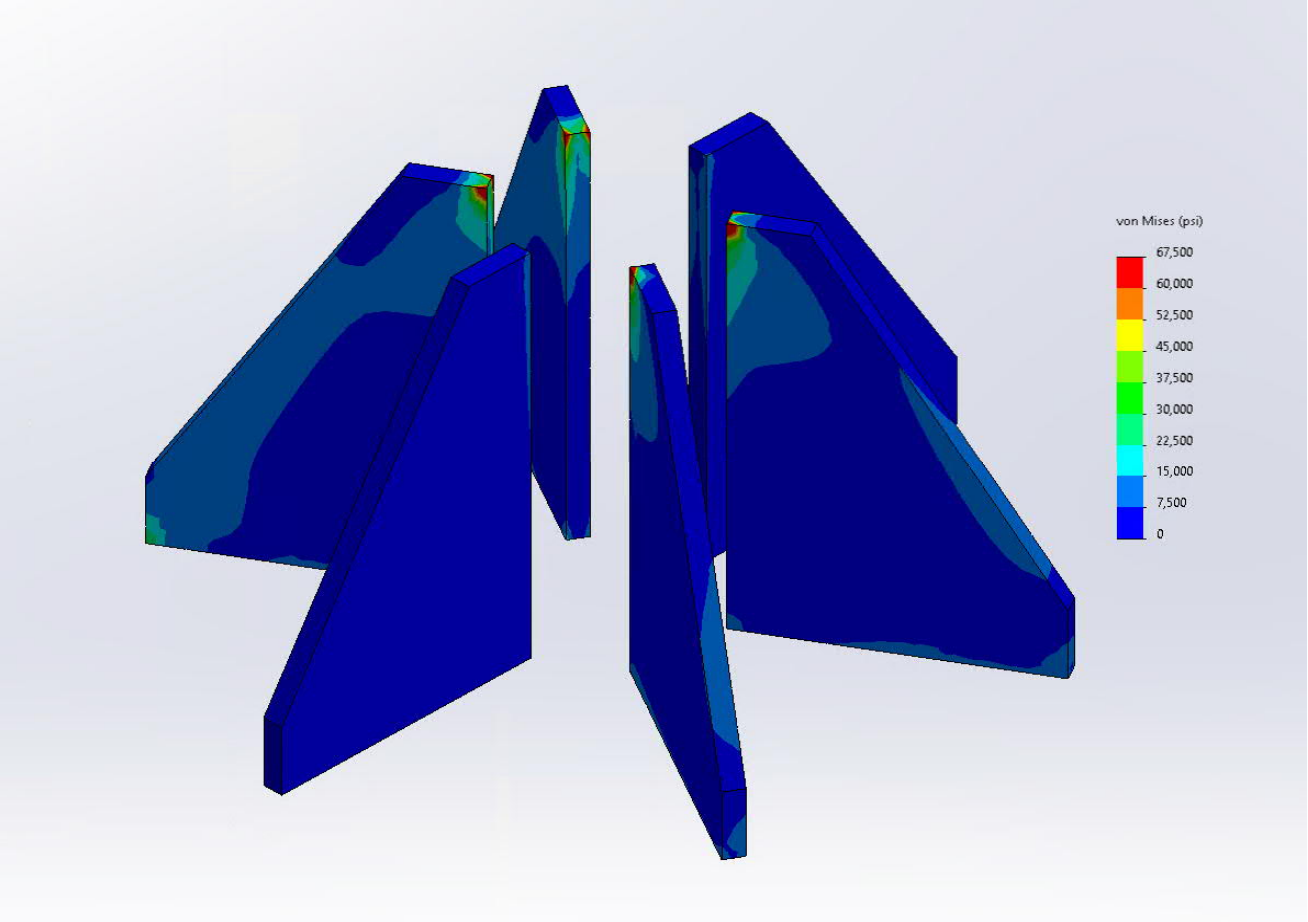


Assumptions	Results
N/A	Sufficient

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	7

Study: 90 Degree

Stiffeners

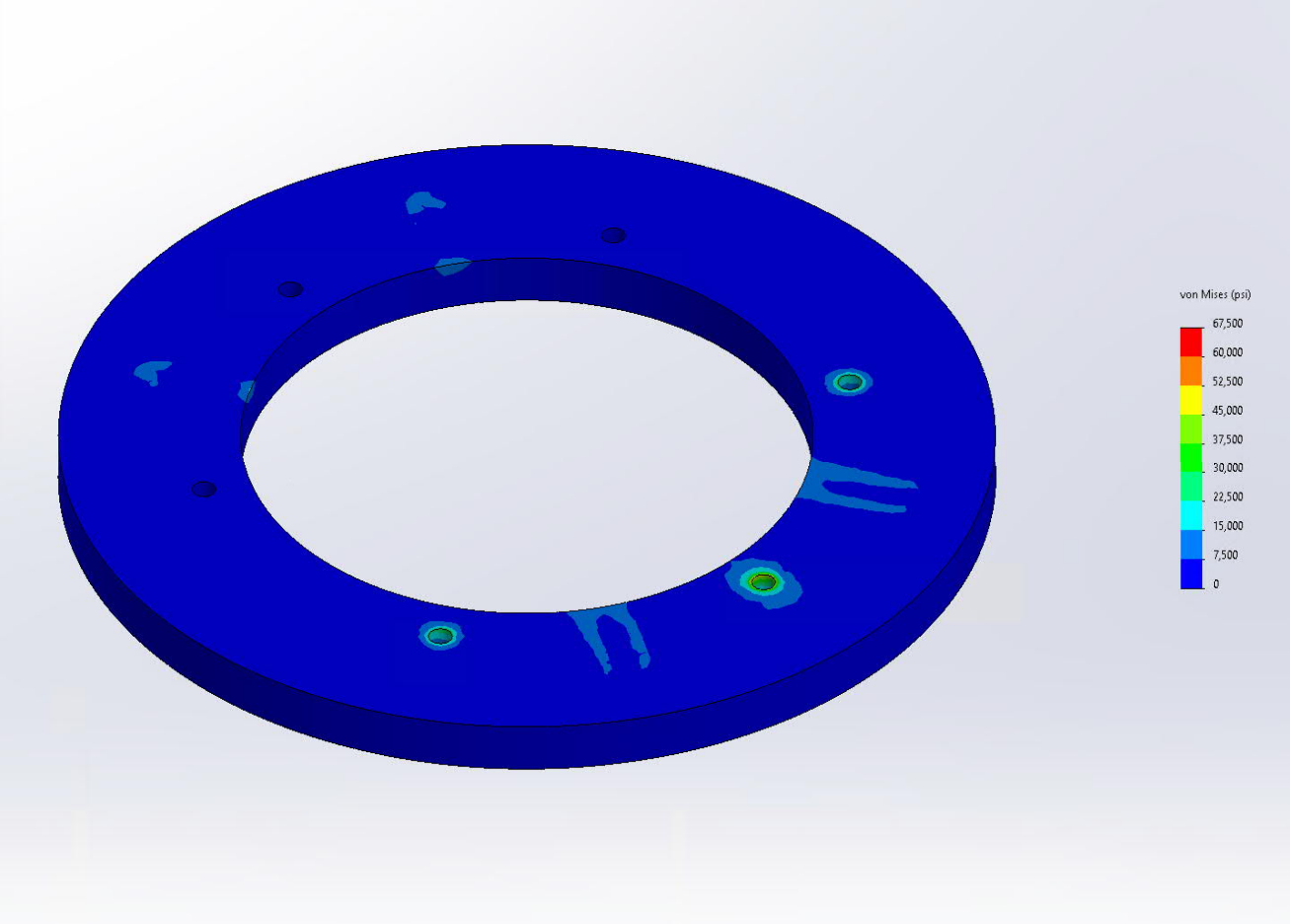


Assumptions	Results
N/A	Sufficient

Client Site Name:	Seattle Qwest - SEA155	Engineer:	MS
Client Site Number:	BU 880416	Check:	SMS
Client Order Number:	640386 Rev. 5	Date:	10/11/2024
TEP Project Number:	151934.1008537	Page:	8

Study: 90 Degree

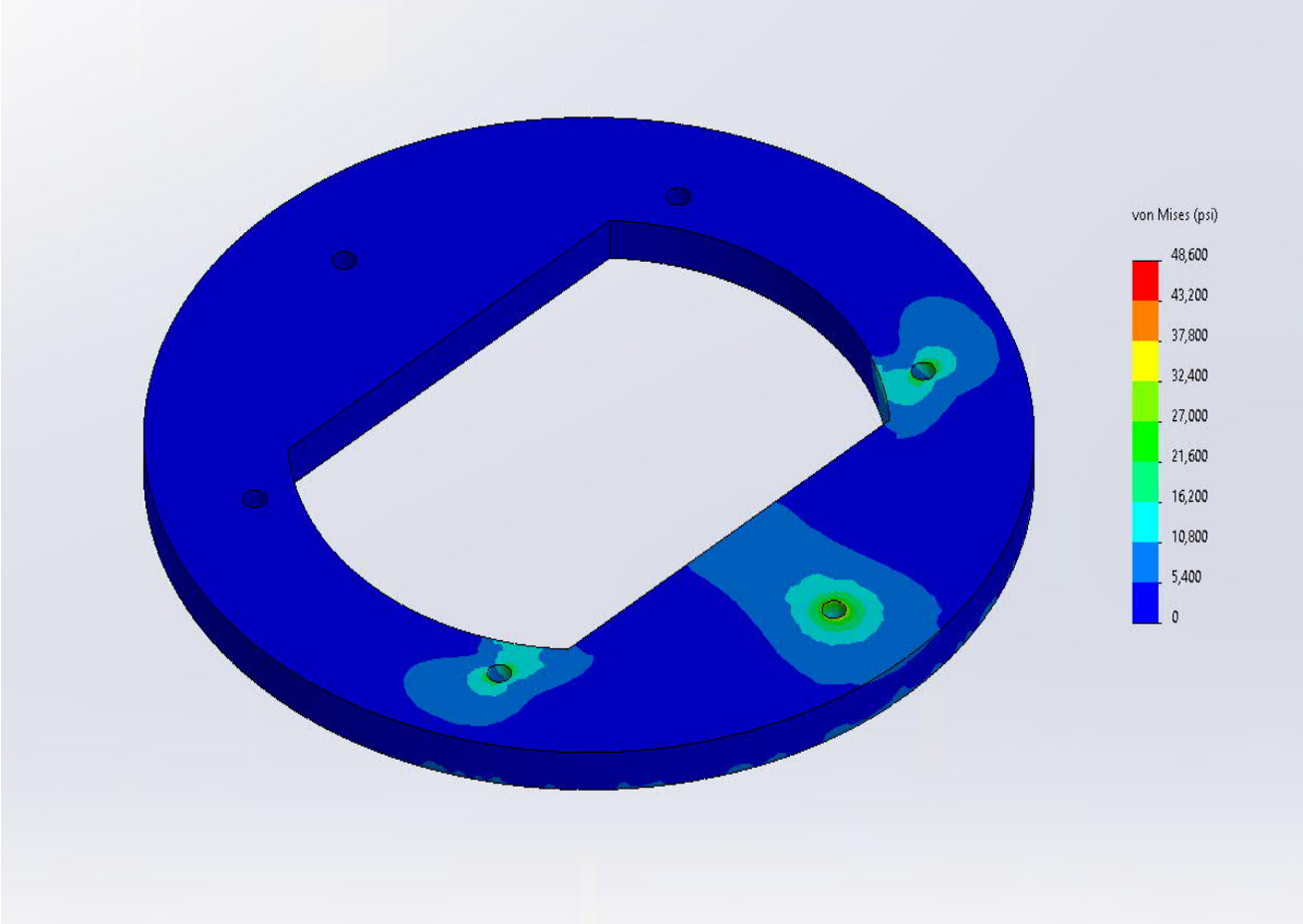
Top Flange



Assumptions	Results
N/A	Sufficient

Study: 90 Degree

Bottom Flange



Assumptions	Results
N/A	Sufficient

Monopole Flange Plate Connection

Elevation = 60 ft.

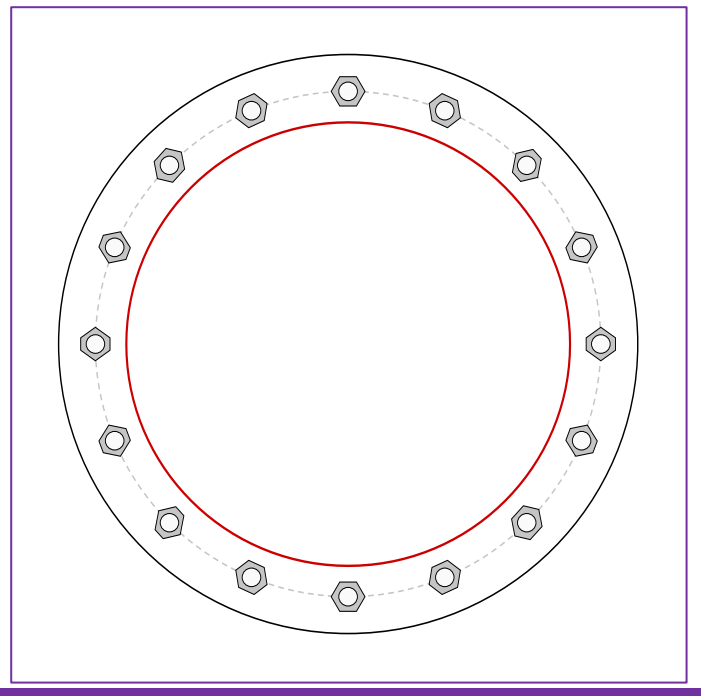
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

TIA-222 Revision	H

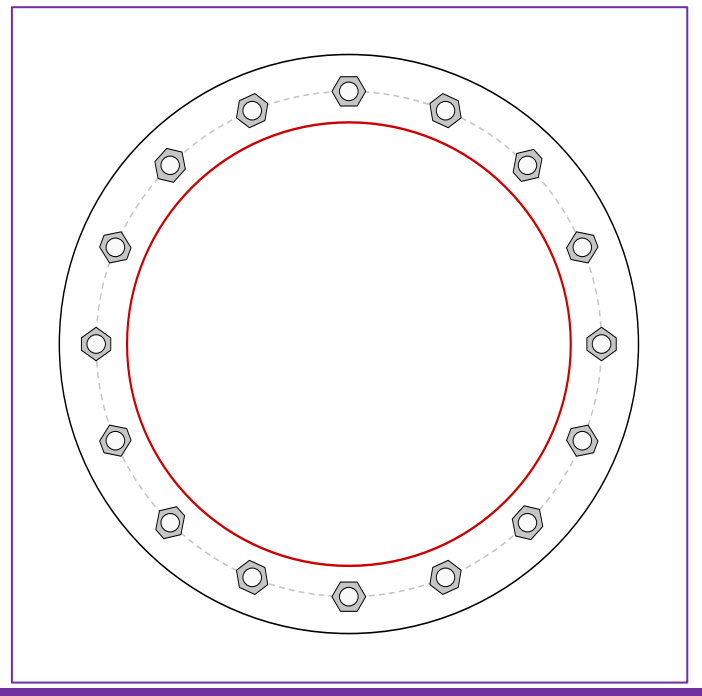
Applied Loads	
Moment (kip-ft)	304.77
Axial Force (kips)	18.37
Shear Force (kips)	5.76

**TIA-222-H Section 15.5 Applied*

Top Plate - External



Bottom Plate - External



Connection Properties

Bolt Data

(16) 1-1/2" ø bolts (A325 N; Fy=81 ksi, Fu=120 ksi) on 41" BC

Top Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Bottom Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Top Stiffener Data

N/A

Bottom Stiffener Data

N/A

Top Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Bottom Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Analysis Results

Bolt Capacity

Max Load (kips)	21.14	
Allowable (kips)	126.90	
Stress Rating:	**15.9%**	**Pass**

Top Plate Capacity

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**
Tension Side Stress Rating:	**Rohn OK**

Bottom Plate Capacity

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**
Tension Side Stress Rating:	**Rohn OK**

Monopole Flange Plate Connection

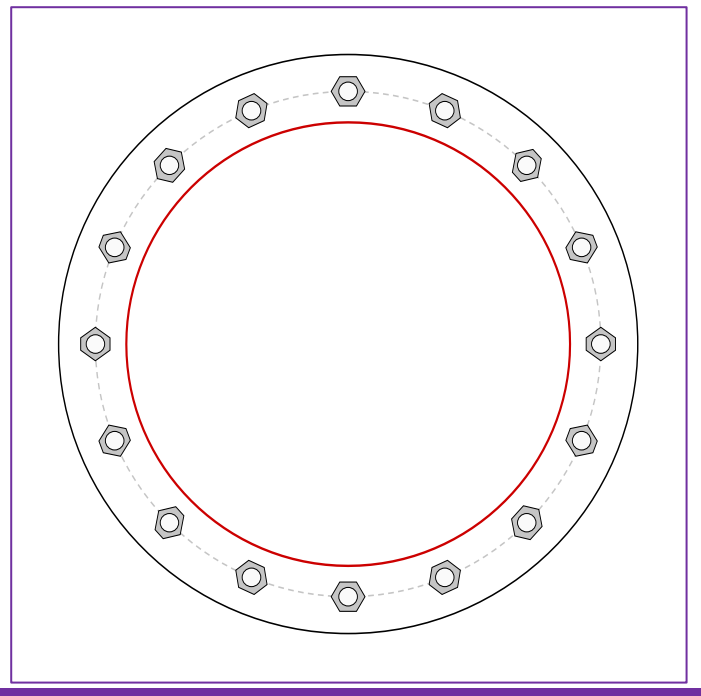
Elevation = 20 ft.

BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1
TIA-222 Revision	H

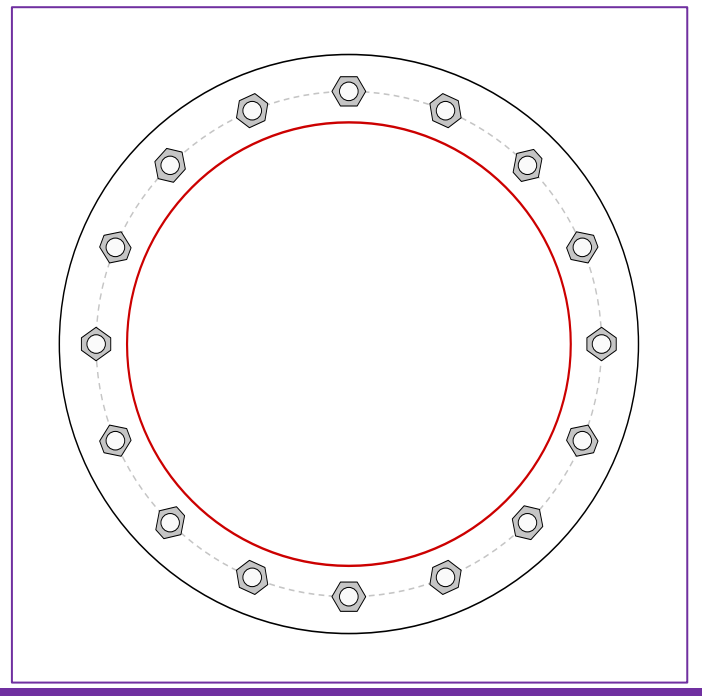
Applied Loads	
Moment (kip-ft)	556.73
Axial Force (kips)	26.39
Shear Force (kips)	6.75

**TIA-222-H Section 15.5 Applied*

Top Plate - External



Bottom Plate - External



Connection Properties

Bolt Data

(16) 1-1/2" ø bolts (A325 N; Fy=81 ksi, Fu=120 ksi) on 41" BC

Top Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Top Stiffener Data

N/A

Top Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Bottom Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Bottom Stiffener Data

N/A

Bottom Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Analysis Results

Bolt Capacity

Max Load (kips)	39.07	
Allowable (kips)	126.90	
Stress Rating:	**29.3%**	**Pass**

Top Plate Capacity

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**
Tension Side Stress Rating:	**Rohn OK**

Bottom Plate Capacity

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**
Tension Side Stress Rating:	**Rohn OK**

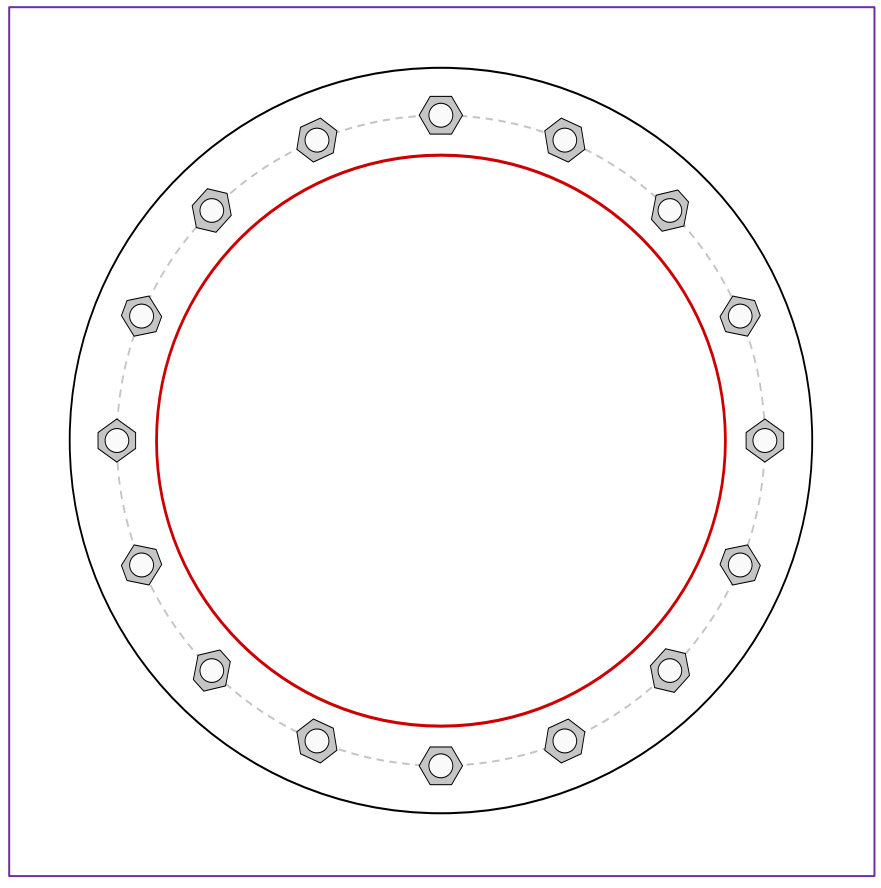
Monopole Base Plate Connection

Site Info	
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

Analysis Considerations	
TIA-222 Revision	H
Grout Considered:	No
l_{ar} (in)	1.5

Applied Loads	
Moment (kip-ft)	694.68
Axial Force (kips)	30.43
Shear Force (kips)	7.04

**TIA-222-H Section 15.5 Applied*



Connection Properties

Anchor Rod Data

(16) 1-1/2" ø bolts (A354-BC N; Fy=109 ksi, Fu=125 ksi) on 41" BC

Base Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Stiffener Data

N/A

Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Analysis Results

Anchor Rod Summary *(units of kips, kip-in)*

Pu_t = 48.9	ϕPn_t = 132.19	**Stress Rating**
Vu = 0.44	ϕVn = 82.83	**35.2%**
Mu = n/a	ϕMn = n/a	**Pass**

Base Plate Summary

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**

Monopole Base Plate Connection - Seismic

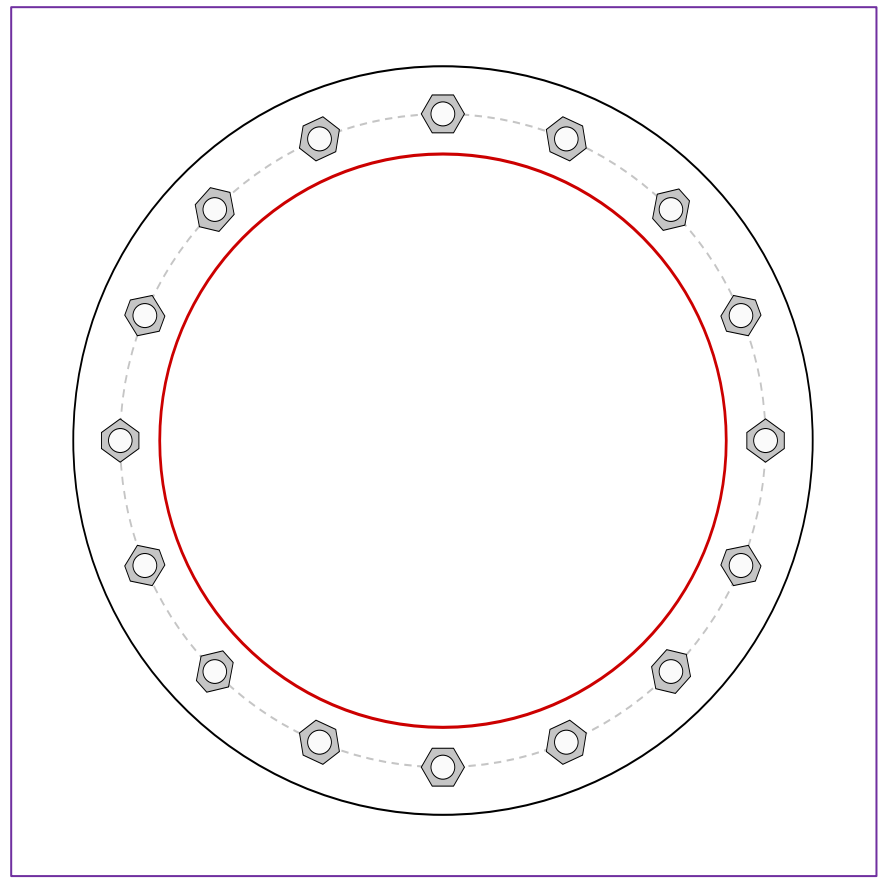
Site Info	
BU #	880416
Site Name	Seattle Qwest - SEA155
Order #	681368 Rev. 1

Analysis Considerations	
TIA-222 Revision	H
Grout Considered:	No
l_{ar} (in)	1.5

Applied Loads	
Moment (kip-ft)	347.18
Axial Force (kips)	36.55
Shear Force (kips)	5.04

**TIA-222-H Section 15.5 Applied*

**1.5 Overstrength Factor Applied*



Connection Properties

Anchor Rod Data

(16) 1-1/2" ø bolts (A354-BC N; Fy=109 ksi, Fu=125 ksi) on 41" BC

Base Plate Data

47" OD x 2" Plate (A36; Fy=36 ksi, Fu=58 ksi)

Stiffener Data

N/A

Pole Data

36" x 0.375" round pole (A53-B-42; Fy=42 ksi, Fu=63 ksi)

Analysis Results

Anchor Rod Summary *(units of kips, kip-in)*

Pu_t = 35.8	ϕPn_t = 132.19	**Stress Rating**
Vu = 0.47	ϕVn = 82.83	**25.8%**
Mu = n/a	ϕMn = n/a	**Pass**

Base Plate Summary

Max Stress (ksi):	-
Allowable Stress (ksi):	-
Stress Rating:	**Rohn OK**

Drilled Pier Foundation

BU # :	880416
Site Name:	Seattle Qwest - SEA155
Order Number:	681368 Rev. 1
TIA-222 Revison:	H
Tower Type:	Monopole

Applied Loads	Comp.	Uplift
Moment (kip-ft)	695	
Axial Force (kips)	30	
Shear Force (kips)	7	

Material Properties		
Concrete Strength, f'c:	3	ksi
Rebar Strength, Fy:	60	ksi
Tie Yield Strength, Fyt:	60	ksi

Pier Design Data		
Depth	20	ft
Ext. Above Grade	0.5	ft
Pier Section 1		
From 0.5' above grade to 20' below grade		
Pier Diameter	6	ft
Rebar Quantity	24	
Rebar Size	9	
Rebar Cage Diameter	63	in
Tie Size	5	
Tie Spacing	12	in

Rebar & Pier Options

Embedded Pole Inputs

Belled Pier Inputs

Analysis Results		
Soil Lateral Check	*Compression*	*Uplift*
$D_{v=0}$ (ft from TOC)	5.14	-
Soil Safety Factor	3.75	-
Max Moment (kip-ft)	739.47	-
Rating*	*33.8%*	-
Soil Vertical Check	*Compression*	*Uplift*
Skin Friction (kips)	168.23	-
End Bearing (kips)	1908.52	-
Weight of Concrete (kips)	104.33	-
Total Capacity (kips)	2076.75	-
Axial (kips)	134.33	-
Rating*	*6.2%*	-
Reinforced Concrete Flexure	*Compression*	*Uplift*
Critical Depth (ft from TOC)	4.86	-
Critical Moment (kip-ft)	739.27	-
Critical Moment Capacity	3260.74	-
Rating*	*21.6%*	-
Reinforced Concrete Shear	*Compression*	*Uplift*
Critical Depth (ft from TOC)	14.40	-
Critical Shear (kip)	96.18	-
Critical Shear Capacity	521.32	-
Rating*	*17.6%*	-

Structural Foundation Rating*	**21.6%**
Soil Interaction Rating*	**33.8%**

*Rating per TIA-222-H Section 15.5

Check Limitation	
Apply TIA-222-H Section 15.5:	☑
N/A	☐
Design Options	
Input Effective Depths (else Actual):	☐
Consider non-tapered moment capacity:	☐
Check Shear along Depth of Pier:	☑
Utilize Shear-Friction Methodology:	☐
Override Critical Depth:	☐

Go to Soil Calculations

Soil Profile

Groundwater Depth	N/A	# of Layers	2

Layer	Top (ft)	Bottom (ft)	Thickness (ft)	γ_{soil} (pcf)	$\gamma_{concrete}$ (pcf)	Cohesion (ksf)	Angle of Friction (degrees)	Calculated Ultimate Skin Friction Comp (ksf)	Calculated Ultimate Skin Friction Uplift (ksf)	Ultimate Skin Friction Comp Override (ksf)	Ultimate Skin Friction Uplift Override (ksf)	Ult. Gross Bearing Capacity (ksf)	SPT Blow Count	Soil Type
1	0	3	3	100	150	0		0.000	0.000	0.00	0.00			Cohesionless
2	3	20	17	100	150		23.58	0.000	0.000	0.70	0.70	90		Cohesionless