Date: **April 22, 2021**

Crown Castle
2000 Corporate Drive
Canonsburg, PA
(724) 416-2000

Subject:	**Structural Analysis Report**	
Carrier Designation:	***DISH Network* Co-Locate**	
	Site Number:	BOBDL00053A
	Site Name:	CT-CCI-T-806478
Crown Castle Designation:	**BU Number:**	806478
	Site Name:	HRT 080 953381
	JDE Job Number:	645651
	Work Order Number:	1945873
	Order Number:	553396 Rev. 0
Engineering Firm Designation:	**Crown Castle Project Number:**	1945873
Site Data:	**539 PLAINS RD, HADDAM, MIDDLESEX County, CT** **Latitude *41° 26' 35"*, Longitude *-72° 30' 22.4"*** **180 Foot - Self Support Tower**	

Crown Castle 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:

LC7: Proposed Equipment Configuration **Sufficient Capacity**

This analysis utilizes an ultimate 3-second gust wind speed of 130 mph as required by the 2018 Connecticut State Building Code. Applicable Standard references and design criteria are listed in Section 2 - "Analysis Criteria".

Structural analysis prepared by: Mishka Stueber

Respectfully submitted by:

Digitally signed by Maham Barimani
Date: 2021.04.22 16:41:37 -04'00'

STATE OF CONNECTICUT
MAHAM BARIMANI
30501
LICENSED
PROFESSIONAL ENGINEER

Maham Barimani, P.E.
Senior Project Engineer

TABLE OF CONTENTS

1) INTRODUCTION

This tower is a 180 ft Self Support tower designed by ROHN. The tower has been modified multiple times to accommodate additional loading.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	II
Wind Speed:	130 mph
Exposure Category:	B
Topographic Factor:	1
Ice Thickness:	1.5 in
Wind Speed with Ice:	50 mph
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)
140.0	140.0	3	fujitsu	TA08025-B604	1	1-1/2
		3	fujitsu	TA08025-B605		
		3	jma wireless	MX08FRO665-20 w/ Mount Pipe		
		1	raycap	RDIDC-9181-PF-48		
		1	tower mounts	Commscope MTC3975083 (3)		

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)
182.0	186.0	3	ems wireless	RR90-17-02DP w/ Mount Pipe	6	1-5/8
	179.0	3	ericsson	KRY 112 489/1		
178.0	179.0	6	antel	LPA-80080/6CF	8	1-5/8
		3	commscope	CBC78T-DS-43-2X		
		6	commscope	JAHH-65B-R3B w/ Mount Pipe		
		3	samsung telecommunications	RFV01U-D1A		
		3	samsung telecommunications	RFV01U-D2A		
		3	vzw	Sub6 Antenna - VZS01 w/ Mount Pipe		
	178.0	1	rfs/celwave	DB-B1-6C-8AB-0Z		
		1	rfs/celwave	DB-T1-6Z-8AB-0Z		
		1	tower mounts	Sector Mount [SM 510-3]		
165.0	167.0	3	cci antennas	DMP65R-BU8D w/ Mount Pipe	1	Conduit
		3	cci antennas	OPA65R-BU6D w/ Mount Pipe	2	3/8
		3	ericsson	RRUS 32 B2	2	7/16
		3	ericsson	RRUS 32 B30	4	3/4
		3	ericsson	RRUS 4449 B5/B12	12	1-1/4

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)
		3	ericsson	RRUS 4478 B14		
		3	powerwave technologies	7770.00 w/ Mount Pipe		
		6	powerwave technologies	LGP21401		
		3	quintel technology	QS66512-2 w/ Mount Pipe		
		3	raycap	DC6-48-60-18-8F		
	165.0	1	tower mounts	Sector Mount [SM 510-3]		
150.0	150.0	3	alcatel lucent	PCS 1900MHZ 4X45W-65MHZ	4	1-1/4
		6	alcatel lucent	RRH2X50-800		
		3	alcatel lucent	TD-RRH8X20-25		
		3	commscope	NNVV-65B-R4 w/ Mount Pipe		
		3	rfs celwave	APXVTM14-ALU-I20 w/ Mount Pipe		
		1	tower mounts	Sector Mount [SM 502-3]		
50.0	50.0	1	gps	GPS_A	1	1/2
		1	tower mounts	Side Arm Mount [SO 305-1]		

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Reference	Source
4-GEOTECHNICAL REPORTS	1240448	CCISITES
4-POST-MODIFICATION INSPECTION	6011748	CCISITES
4-POST-MODIFICATION INSPECTION	2393878	CCISITES
4-TOWER FOUNDATION DRAWINGS/DESIGN/SPECS	300985	CCISITES
4-TOWER MANUFACTURER DRAWINGS	1067089	CCISITES
4-TOWER REINFORCEMENT DESIGN/DRAWINGS/DATA	5864073	CCISITES
4-TOWER REINFORCEMENT DESIGN/DRAWINGS/DATA	1274944	CCISITES
4-TOWER REINFORCEMENT DESIGN/DRAWINGS/DATA	1004663	CCISITES

3.1) Analysis Method

tnxTower (version 8.0.9.0), 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.

tnxTower was used to determine the loads on the modified structure. Additional calculations were performed to determine the stresses in the reinforcing elements. These calculations are included in Appendix C.

3.2) Assumptions

1) 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.

This analysis may be affected if any assumptions are not valid or have been made in error. Crown Castle 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)	SF*P_allow (K)	% Capacity	Pass / Fail
T1	180 - 160	Leg	ROHN 2 STD	2	-26.206	38.684	67.7	Pass
T2	160 - 155	Leg	ROHN 2.5 EH	38	-35.350	78.151	45.2	Pass
T3	155 - 150	Leg	ROHN 2.5 EH	47	-43.741	78.148	56.0	Pass
T4	150 - 145	Leg	ROHN 2.5 EH	56	-53.793	78.149	68.8	Pass
T5	145 - 140	Leg	ROHN 2.5 EH	65	-63.708	98.081	65.0	Pass
T6	140 - 133.333	Leg	ROHN 3 EH	77	-75.455	99.059	76.2	Pass
T7	133.333 - 126.667	Leg	ROHN 3 EH	86	-89.011	129.274	68.9	Pass
T8	126.667 - 120	Leg	ROHN 3 EH	98	-100.685	141.695	71.1	Pass
T9	120 - 113.333	Leg	ROHN 3.5 EH	140	-114.070	161.556	70.6	Pass
T10	113.333 - 106.667	Leg	ROHN 3.5 EH	152	-125.783	161.594	77.8	Pass
T11	106.667 - 100	Leg	BT100140- Rohn 3.5EH w/ 2" SR	164	-138.334	244.582	47.0[1]	Pass[1]
T12	100 - 80	Leg	BT100140- Rohn 4EH w/ 2" SR	173	-172.302	286.747	59.9[1]	Pass[1]
T13	80 - 60	Leg	BT100140- Rohn 5EH w/ 2" SR (60-80)	194	-202.914	319.408	63.4[1]	Pass[1]
T14	60 - 40	Leg	BT100140- Rohn 5EH w/ 2" SR (40-60)	209	-233.537	400.743	58.0[1]	Pass[1]
T15	40 - 30	Leg	BT100140- Rohn 6EHS w/ 2" SR (30-40)	230	-250.927	373.300	57.3[1]	Pass[1]
T16	30 - 20	Leg	BT100140- Rohn 6EHS w/ 2" SR (20-30)	239	-265.219	439.396	51.5[1]	Pass[1]
T17	20 - 0	Leg	BT100140- Rohn 6EH w/ 2" SR	251	-297.529	437.361	67.9[1]	Pass[1]
T1	180 - 160	Diagonal	L2x2x1/4	10	-5.294	21.921	24.2	Pass
T2	160 - 155	Diagonal	L1 3/4x1 3/4x3/16	43	-4.592	8.960	51.2	Pass
T3	155 - 150	Diagonal	L1 3/4x1 3/4x3/16	52	-4.502	8.115	55.5	Pass
T4	150 - 145	Diagonal	L2x2x1/4	61	-5.640	14.435	39.1	Pass
T5	145 - 140	Diagonal	2L1 3/4x1 3/4x3/16x3/16	70	-5.539	10.763	51.5	Pass
T6	140 - 133.333	Diagonal	2L2x2x3/16x1/2	82	-6.930	34.333	20.2	Pass
T7	133.333 - 126.667	Diagonal	2L2x2x3/16x1/2	91	-7.063	31.258	22.6	Pass
T8	126.667 - 120	Diagonal	2L2x2x3/16x1/2	108	-7.697	40.133	19.2	Pass
T9	120 - 113.333	Diagonal	2L2 1/2x2 1/2x3/16x1/2	145	-7.370	43.852	16.8	Pass
T10	113.333 - 106.667	Diagonal	2L2 1/2x2 1/2x3/16x1/2	157	-7.624	41.968	18.2	Pass
T11	106.667 - 100	Diagonal	2L2 1/2x2 1/2x3/16x1/2	169	-7.043	41.098	17.1	Pass
T12	100 - 80	Diagonal	2L3x3x3/16x1/2	178	-7.813	48.925	16.0	Pass

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
T13	80 - 60	Diagonal	2L3x3x3/16x1/4	199	-9.370	36.097	26.0	Pass
T14	60 - 40	Diagonal	2L3x3x1/4x1/4	213	-10.539	41.581	25.3	Pass
T15	40 - 30	Diagonal	2L3 1/2x3 1/2x1/4x1/4	234	-10.168	60.389	16.8	Pass
T16	30 - 20	Diagonal	2L3 1/2x3 1/2x1/4x1/4	243	-11.889	54.955	21.6	Pass
T17	20 - 0	Diagonal	L4x4x1/4	255	-11.317	20.932	54.1	Pass
T8	126.667 - 120	Horizontal	L2 1/2x2 1/2x1/4	100	-1.746	14.671	11.9	Pass
T5	145 - 140	Secondary Horizontal	L2x2x1/4	73	-1.105	11.066	10.0	Pass
T7	133.333 - 126.667	Secondary Horizontal	L2x2x1/4	94	-1.544	8.365	18.5	Pass
T9	120 - 113.333	Secondary Horizontal	L2 1/2x2 1/2x1/4	148	-1.978	12.994	15.2	Pass
T10	113.333 - 106.667	Secondary Horizontal	L2 1/2x2 1/2x1/4	160	-2.181	11.476	19.0	Pass
T14	60 - 40	Secondary Horizontal	L3x3x1/4	217	-4.050	8.153	49.7	Pass
T16	30 - 20	Secondary Horizontal	L3 1/2x3 1/2x1/4	247	-4.600	10.692	43.0	Pass
T1	180 - 160	Top Girt	L2x2x1/8	6	-0.100	4.273	2.3	Pass
T8	126.667 - 120	Redund Horz 1 Bracing	L2x2x1/4	105	1.746	25.709	6.8	Pass
T8	126.667 - 120	Redund Diag 1 Bracing	L2x2x1/4	129	-1.158	26.237	4.4	Pass
							Summary	
						Leg (T10)	77.8	Pass
						Diagonal (T3)	55.5	Pass
						Horizontal (T8)	11.9	Pass
						Secondary Horizontal (T14)	49.7	Pass
						Top Girt (T1)	2.3	Pass
						Redund Horz 1 Bracing (T8)	6.8	Pass
						Redund Diag 1 Bracing (T8)	4.4	Pass
						Bolt Checks	74.8	Pass
						Rating =	77.8	Pass

Table 5 - Tower Component Stresses vs. Capacity - LC7

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	59.0	Pass
1	Base Foundation (Structure)	0	30.0	Pass
1	Base Foundation (Soil Interaction)	0	96.2	Pass

Structure Rating (max from all components) =	96.2%

Notes:
1) See additional documentation in “Appendix C – Additional Calculations” for calculations supporting the % capacity consumed.

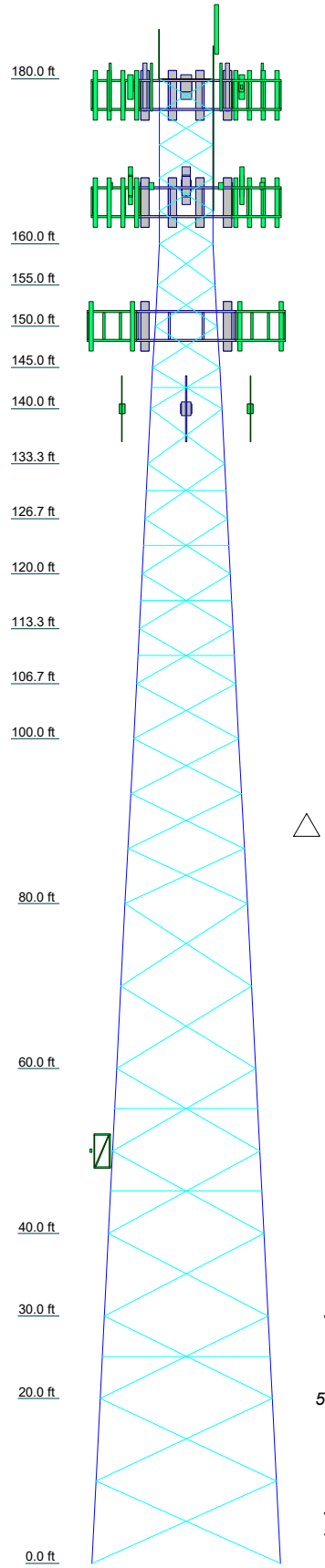
4.1) Recommendations

The tower and its foundation have sufficient capacity to carry the proposed load configuration. No modifications are required at this time.

APPENDIX A

TNXTOWER OUTPUT

Section	T17	T16	T15	T14	T13	T12	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1
Legs	G	F	E	D	C	B	A	ROHN 3.5 EH		ROHN 3 EH				ROHN 2.5 EH			ROHN 2 STD
Leg Grade	A572-50																
Diagonals	L4x4x1/4	2L3 1/2x3 1/2x1/4x1/4		2L3x3x1/4x1/4	2L3x3x3/16x1/4	2L3x3x3/16x1/2	2L2 1/2x2 1/2x3/16x1/2			2L2x2x3/16x1/2			J	I	H		L2x2x1/4
Diagonal Grade		A572-50			A36									K	A36		A572-50
Top Girts					N.A.								I				L2x2x1/8
Sec. Horizontals	N.A.	L	N.A.	L3x3x1/4	N.A.			L2 1/2x2 1/2x1/4				N.A.	I				N.A.
Face Width (ft)	22.8646	20.8646	19.8594	18.8542	16.7708	14.7708	12.6771	11.9974	11.3151	10.6354	9.95833	9.28125	8.60417	7.93708	7.27	6.5625	6.52083
# Panels @ (ft)				8 @ 10			9 @ 6.66667							4 @ 5			5 @ 4
Weight (K)	29.9	4.5	3.1	2.6	5.1	3.7	3.8	1.0	0.9	0.9	0.8	0.7	0.6	0.5	0.3	0.2	0.2	1.0



SYMBOL LIST

MARK	SIZE	MARK	SIZE
A	BT100140- Rohn 3.5EH w/ 2" SR	G	BT100140- Rohn 6EH w/ 2" SR
B	BT100140- Rohn 4EH w/ 2" SR	H	L1 3/4x1 3/4x3/16
C	BT100140- Rohn 5EH w/ 2" SR (60-80)	I	L2x2x1/4
D	BT100140- Rohn 5EH w/ 2" SR (40-60)	J	2L1 3/4x1 3/4x3/16x3/16
E	BT100140- Rohn 6EHS w/ 2" SR (30-40)	K	A572-50
F	BT100140- Rohn 6EHS w/ 2" SR (20-30)	L	L3 1/2x3 1/2x1/4

MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	50 ksi	65 ksi	A36	36 ksi	58 ksi

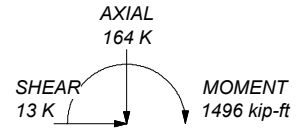
TOWER DESIGN NOTES

1. Tower is located in Middlesex County, Connecticut.
2. Tower designed for Exposure B to the TIA-222-H Standard.
3. Tower designed for a 130 mph basic wind in accordance with the TIA-222-H Standard.
4. Tower is also designed for a 50 mph basic wind with 1.50 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 1 with Crest Height of 0.000 ft
8. TOWER RATING: 77.6%

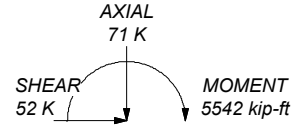
ALL REACTIONS ARE FACTORED

MAX. CORNER REACTIONS AT BASE:
DOWN: 303 K
SHEAR: 32 K

UPLIFT: -251 K
SHEAR: 27 K



TORQUE 19 kip-ft
50 mph WIND - 1.500 in ICE



TORQUE 66 kip-ft
REACTIONS - 130 mph WIND

Crown Castle
2000 Corporate Drive
Canonsburg, PA
The Pathway to Possible
Phone: (724) 416-2000
FAX:

Job: 806478			
Project:			
Client: Crown Castle	Drawn by: Mishka Stueber	App'd:	
Code: TIA-222-H	Date: 04/21/21	Scale: NTS	
Path: C:\Users\MStueber\OneDrive - Crown Castle USA Inc\Desktop\Working\806478\WO 1945873 - SA\Prod\806478.eri		Dwg No. E-1	

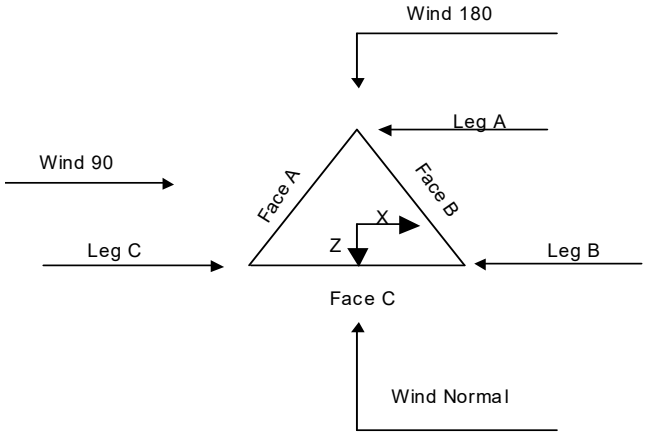
Tower Input Data

The main tower is a 3x free standing tower with an overall height of 180.000 ft above the ground line.
The base of the tower is set at an elevation of 0.000 ft above the ground line.
The face width of the tower is 6.521 ft at the top and 22.865 ft at the base.
This tower is designed using the TIA-222-H standard.
The following design criteria apply:

- Tower is located in Middlesex County, Connecticut.
- Tower base elevation above sea level: 504.000 ft.
- Basic wind speed of 130 mph.
- Risk Category II.
- Exposure Category B.
- Simplified Topographic Factor Procedure for wind speed-up calculations is used.
- Topographic Category: 1.
- Crest Height: 0.000 ft.
- Nominal ice thickness of 1.500 in.
- Ice thickness is considered to increase with height.
- Ice density of 56.000 pcf.
- A wind speed of 50 mph is used in combination with ice.
- Temperature drop of 50.000 °F.
- Deflections calculated using a wind speed of 60 mph.
- Pressures are calculated at each section.
- Stress ratio used in tower member 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		Distribute Leg Loads As Uniform		Use ASCE 10 X-Brace Ly Rules
	Consider Moments - Horizontals		Assume Legs Pinned	√	Calculate Redundant Bracing Forces
	Consider Moments - Diagonals	√	Assume Rigid Index Plate		Ignore Redundant Members in FEA
	Use Moment Magnification	√	Use Clear Spans For Wind Area	√	SR Leg Bolts Resist Compression
√	Use Code Stress Ratios	√	Use Clear Spans For KL/r		All Leg Panels Have Same Allowable
√	Use Code Safety Factors - Guys		Retension Guys To Initial Tension		Offset Girt At Foundation
	Escalate Ice	√	Bypass Mast Stability Checks	√	Consider Feed Line Torque
	Always Use Max Kz	√	Use Azimuth Dish Coefficients	√	Include Angle Block Shear Check
	Use Special Wind Profile	√	Project Wind Area of Appurt.		Use TIA-222-H Bracing Resist. Exemption
	Include Bolts In Member Capacity		Autocalc Torque Arm Areas		Use TIA-222-H Tension Splice Exemption
	Leg Bolts Are At Top Of Section		Add IBC .6D+W Combination		Poles
√	Secondary Horizontal Braces Leg	√	Sort Capacity Reports By Component		Include Shear-Torsion Interaction
	Use Diamond Inner Bracing (4 Sided)		Triangulate Diamond Inner Bracing		Always Use Sub-Critical Flow
	SR Members Have Cut Ends		Treat Feed Line Bundles As Cylinder		Use Top Mounted Sockets
	SR Members Are Concentric		Ignore KL/ry For 60 Deg. Angle Legs		Pole Without Linear Attachments
					Pole With Shroud Or No Appurtenances
					Outside and Inside Corner Radii Are Known



Triangular Tower

Tower Section Geometry

Tower Section	Tower Elevation ft	Assembly Database	Description	Section Width ft	Number of Sections	Section Length ft
T1	180.000-160.000			6.521	1	20.000
T2	160.000-155.000			6.563	1	5.000
T3	155.000-150.000			7.068	1	5.000
T4	150.000-145.000			7.581	1	5.000
T5	145.000-140.000			8.091	1	5.000
T6	140.000-133.333			8.604	1	6.667
T7	133.333-126.667			9.281	1	6.667
T8	126.667-120.000			9.958	1	6.667
T9	120.000-113.333			10.635	1	6.667
T10	113.333-106.667			11.315	1	6.667
T11	106.667-100.000			11.997	1	6.667
T12	100.000-80.000			12.677	1	20.000
T13	80.000-60.000			14.771	1	20.000
T14	60.000-40.000			16.771	1	20.000
T15	40.000-30.000			18.854	1	10.000
T16	30.000-20.000			19.859	1	10.000
T17	20.000-0.000			20.865	1	20.000

Tower Section Geometry *(cont'd)*

Tower Section	Tower Elevation ft	Diagonal Spacing ft	Bracing Type	Has K Brace End Panels	Has Horizontals	Top Girt Offset in	Bottom Girt Offset in
T1	180.000-160.000	4.000	X Brace	No	No	0.000	0.000
T2	160.000-155.000	5.000	X Brace	No	No	0.000	0.000
T3	155.000-150.000	5.000	X Brace	No	No	0.000	0.000
T4	150.000-145.000	5.000	X Brace	No	No	0.000	0.000
T5	145.000-140.000	5.000	X Brace	No	Yes	0.000	0.000
T6	140.000-133.333	6.667	X Brace	No	No	0.000	0.000
T7	133.333-126.667	6.667	X Brace	No	Yes	0.000	0.000
T8	126.667-120.000	3.333	Double K1	No	Yes	0.000	0.000
T9	120.000-113.333	6.667	X Brace	No	Yes	0.000	0.000
T10	113.333-106.667	6.667	X Brace	No	Yes	0.000	0.000
T11	106.667-100.000	6.667	X Brace	No	No	0.000	0.000
T12	100.000-80.000	6.667	X Brace	No	No	0.000	0.000
T13	80.000-60.000	10.000	X Brace	No	No	0.000	0.000
T14	60.000-40.000	10.000	X Brace	No	Yes	0.000	0.000
T15	40.000-30.000	10.000	X Brace	No	No	0.000	0.000
T16	30.000-20.000	10.000	X Brace	No	Yes	0.000	0.000
T17	20.000-0.000	10.000	X Brace	No	No	0.000	0.000

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Leg Type	Leg Size	Leg Grade	Diagonal Type	Diagonal Size	Diagonal Grade
T1 180.000-160.000	Pipe	ROHN 2 STD	A572-50 (50 ksi)	Equal Angle	L2x2x1/4	A572-50 (50 ksi)
T2 160.000-155.000	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Single Angle	L1 3/4x1 3/4x3/16	A36 (36 ksi)
T3 155.000-150.000	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Single Angle	L1 3/4x1 3/4x3/16	A36 (36 ksi)
T4 150.000-145.000	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Equal Angle	L2x2x1/4	A572-50 (50 ksi)
T5 145.000-140.000	Pipe	ROHN 2.5 EH	A572-50 (50 ksi)	Double Equal Angle	2L1 3/4x1 3/4x3/16x3/16	A36 (36 ksi)
T6 140.000-133.333	Pipe	ROHN 3 EH	A572-50 (50 ksi)	Double Equal Angle	2L2x2x3/16x1/2	A36 (36 ksi)
T7 133.333-126.667	Pipe	ROHN 3 EH	A572-50 (50 ksi)	Double Equal Angle	2L2x2x3/16x1/2	A36 (36 ksi)
T8 126.667-120.000	Pipe	ROHN 3 EH	A572-50 (50 ksi)	Double Equal Angle	2L2x2x3/16x1/2	A36 (36 ksi)
T9 120.000-113.333	Pipe	ROHN 3.5 EH	A572-50 (50 ksi)	Double Equal Angle	2L2 1/2x2 1/2x3/16x1/2	A36 (36 ksi)
T10 113.333-106.667	Pipe	ROHN 3.5 EH	A572-50 (50 ksi)	Double Equal Angle	2L2 1/2x2 1/2x3/16x1/2	A36 (36 ksi)
T11 106.667-100.000	Arbitrary Shape	BT100140- Rohn 3.5EH w/ 2" SR	A572-50 (50 ksi)	Double Equal Angle	2L2 1/2x2 1/2x3/16x1/2	A36 (36 ksi)
T12 100.000-80.000	Arbitrary Shape	BT100140- Rohn 4EH w/ 2" SR	A572-50 (50 ksi)	Double Equal Angle	2L3x3x3/16x1/2	A36 (36 ksi)
T13 80.000-60.000	Arbitrary Shape	BT100140- Rohn 5EH w/ 2" SR (60-80)	A572-50 (50 ksi)	Double Equal Angle	2L3x3x3/16x1/4	A36 (36 ksi)
T14 60.000-40.000	Arbitrary Shape	BT100140- Rohn 5EH w/ 2" SR (40-60)	A572-50 (50 ksi)	Double Equal Angle	2L3x3x1/4x1/4	A572-50 (50 ksi)
T15 40.000-30.000	Arbitrary Shape	BT100140- Rohn 6EHS w/ 2" SR (30-40)	A572-50 (50 ksi)	Double Equal Angle	2L3 1/2x3 1/2x1/4x1/4	A572-50 (50 ksi)

Tower Elevation ft	*Leg Type*	*Leg Size*	*Leg Grade*	*Diagonal Type*	*Diagonal Size*	*Diagonal Grade*
T16 30.000-20.000	Arbitrary Shape	BT100140- Rohn 6EHS w/ 2" SR (20-30)	A572-50 (50 ksi)	Double Equal Angle	2L3 1/2x3 1/2x1/4x1/4	A572-50 (50 ksi)
T17 20.000-0.000	Arbitrary Shape	BT100140- Rohn 6EH w/ 2" SR	A572-50 (50 ksi)	Equal Angle	L4x4x1/4	A572-50 (50 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Top Girt Type*	*Top Girt Size*	*Top Girt Grade*	*Bottom Girt Type*	*Bottom Girt Size*	*Bottom Girt Grade*
T1 180.000-160.000	Single Angle	L2x2x1/8	A36 (36 ksi)	Flat Bar		A36 (36 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*No. of Mid Girts*	*Mid Girt Type*	*Mid Girt Size*	*Mid Girt Grade*	*Horizontal Type*	*Horizontal Size*	*Horizontal Grade*
T8 126.667-120.000	None	Solid Round		A36 (36 ksi)	Equal Angle	L2 1/2x2 1/2x1/4	A36 (36 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Secondary Horizontal Type*	*Secondary Horizontal Size*	*Secondary Horizontal Grade*	*Inner Bracing Type*	*Inner Bracing Size*	*Inner Bracing Grade*
T5 145.000-140.000	Equal Angle	L2x2x1/4	A572-50 (50 ksi)	Solid Round		A36 (36 ksi)
T7 133.333-126.667	Equal Angle	L2x2x1/4	A572-50 (50 ksi)	Solid Round		A36 (36 ksi)
T9 120.000-113.333	Equal Angle	L2 1/2x2 1/2x1/4	A36 (36 ksi)	Solid Round		A36 (36 ksi)
T10 113.333-106.667	Equal Angle	L2 1/2x2 1/2x1/4	A36 (36 ksi)	Solid Round		A36 (36 ksi)
T14 60.000-40.000	Equal Angle	L3x3x1/4	A36 (36 ksi)	Solid Round		A36 (36 ksi)
T16 30.000-20.000	Equal Angle	L3 1/2x3 1/2x1/4	A36 (36 ksi)	Solid Round		A36 (36 ksi)

Tower Section Geometry *(cont'd)*

Tower Elevation ft	*Redundant Bracing Grade*		*Redundant Type*	*Redundant Size*	*K Factor*
T8 126.667-120.000	A36 (36 ksi)	Horizontal (1)	Equal Angle	L2x2x1/4	1
		Diagonal (1)	Equal Angle	L2x2x1/4	1

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
T1 180.000-160.000	0.000	0.188	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T2 160.000-155.000	0.000	0.188	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T3 155.000-150.000	0.000	0.188	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T4 150.000-145.000	0.000	0.188	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T5 145.000-140.000	0.000	0.188	A36 (36 ksi)	1.03	1	1.05	58.500	Mid-Pt	Mid-Pt
T6 140.000-133.333	0.000	0.500	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T7 133.333-126.667	0.000	0.500	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T8 126.667-120.000	0.000	0.500	A36 (36 ksi)	1.1	1	1.1	Mid-Pt	Mid-Pt	Mid-Pt
T9 120.000-113.333	0.000	0.500	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T10 113.333-106.667	0.000	0.500	A36 (36 ksi)	1.03	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T11 106.667-100.000	0.000	0.500	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T12 100.000-80.000	0.000	0.500	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T13 80.000-60.000	0.000	0.250	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T14 60.000-40.000	0.000	0.250	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T15 40.000-30.000	0.000	0.250	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T16 30.000-20.000	0.000	0.250	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt
T17 20.000-0.000	0.000	0.500	A36 (36 ksi)	1.1	1	1.05	Mid-Pt	Mid-Pt	Mid-Pt

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	K Factors[1] Legs	X Brace Diags X Y	K Brace Diags X Y	Single Diags X Y	Girts X Y	Horiz. X Y	Sec. Horiz. X Y	Inner Brace X Y
T1 180.000-160.000	Yes	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T2 160.000-155.000	Yes	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T3 155.000-150.000	Yes	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T4 150.000-145.000	Yes	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T5 145.000-140.000	No	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T6 140.000-133.333	Yes	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T7 133.333-126.667	No	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1
T8 126.667-120.000	No	No	0.5	1 1	1 1	1 1	1 1	1 1	1 1	1 1

Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	K Factors[1] Legs	X Brace Diags X Y	K Brace Diags X Y	Single Diags X Y	Girts X Y	Horiz. X Y	Sec. Horiz. X Y	Inner Brace X Y
T9 120.000-113.333	No	No	1	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T10 113.333-106.667	No	No	1	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T11 106.667-100.000	Yes	No	0.78	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T12 100.000-80.000	Yes	No	0.8	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T13 80.000-60.000	Yes	No	0.83	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T14 60.000-40.000	No	No	0.85	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T15 40.000-30.000	Yes	No	0.85	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T16 30.000-20.000	No	No	0.85	1	1	1	1	1	1	1
				1	1	1	1	1	1	1
T17 20.000-0.000	Yes	No	0.865	1	1	1	1	1	1	1
				1	1	1	1	1	1	1

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

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Leg Net Width Deduct in	U	Diagonal Net Width Deduct in	U	Top Girt Net Width Deduct in	U	Bottom Girt Net Width Deduct in	U	Mid Girt Net Width Deduct in	U	Long Horizontal Net Width Deduct in	U	Short Horizontal Net Width Deduct in	U
T1 180.000-160.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T2 160.000-155.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T3 155.000-150.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T4 150.000-145.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T5 145.000-140.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T6 140.000-133.333	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T7 133.333-126.667	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T8 126.667-120.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T9 120.000-113.333	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T10 113.333-106.667	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T11 106.667-100.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T12 100.000-80.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T13 80.000-60.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T14 60.000-40.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75

Tower Elevation ft	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U
T15 40.000-30.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T16 30.000-20.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T17 20.000-0.000	0.000	1	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75

Tower Elevation ft	Redundant Horizontal		Redundant Diagonal		Redundant Sub-Diagonal		Redundant Sub-Horizontal		Redundant Vertical		Redundant Hip		Redundant Hip Diagonal	
	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U
T1 180.000-160.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T2 160.000-155.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T3 155.000-150.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T4 150.000-145.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T5 145.000-140.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T6 140.000-133.333	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T7 133.333-126.667	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T8 126.667-120.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T9 120.000-113.333	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T10 113.333-106.667	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T11 106.667-100.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T12 100.000-80.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T13 80.000-60.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T14 60.000-40.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T15 40.000-30.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T16 30.000-20.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75
T17 20.000-0.000	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75	0.000	0.75

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Leg Connection Type	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
		Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.
T1 180.000-160.000	Flange	0.625 A325N	4	0.500 A325X	1	0.500 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0

Tower Elevation ft	Leg Connection Type	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
		Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.
T2 160.000-155.000	Flange	0.750 A325N	0	0.500 A325N	1	0.500 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T3 155.000-150.000	Flange	0.750 A325N	0	0.500 A325N	1	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T4 150.000-145.000	Flange	0.750 A325N	0	0.500 A325X	1	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T5 145.000-140.000	Flange	0.750 A325N	4	0.500 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325X	0 *
T6 140.000-133.333	Flange	0.875 A325N	0	0.500 A325N	2	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T7 133.333-126.667	Flange	0.875 A325N	0	0.500 A325N	2	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325X	0 *
T8 126.667-120.000	Flange	0.875 A325N	4	0.500 A325N	2	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0 *
T9 120.000-113.333	Flange	0.875 A325N	0	0.500 A325N	2	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0 *
T10 113.333-106.667	Flange	0.875 A325N	0	0.500 A325N	2	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0 *
T11 106.667-100.000	Flange	0.875 A325N	4	0.500 A325N	2	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T12 100.000-80.000	Flange	1.000 A325N	4	0.500 A325N	2	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T13 80.000-60.000	Flange	1.000 A325N	4	0.625 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T14 60.000-40.000	Flange	1.000 A325N	6	0.625 A325N	1	0.625 A325X	0	0.625 A325X	0	0.625 A325X	0	0.625 A325X	0	0.625 A325N	0 *
T15 40.000-30.000	Flange	1.000 A325N	0	0.625 A325N	1	0.625 A325N	0	0.000 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T16 30.000-20.000	Flange	1.000 A325N	6	0.625 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0 *
T17 20.000-0.000	Flange	1.000 A449	0	0.625 A325N	2	0.625 A325X	0	0.625 A325X	0	0.625 A325X	0	0.625 A325X	0	0.625 A325N	0

* Out-of-plane partial restraint assumed

Tower Section Geometry *(cont'd)*

Tower Elevation ft	Redundant Horizontal		Redundant Diagonal		Redundant Sub-Diagonal		Redundant Sub-Horizontal		Redundant Vertical		Redundant Hip		Redundant Hip Diagonal	
	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.
T1 180.000-160.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T2 160.000-155.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T3 155.000-150.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T4 150.000-145.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T5 145.000-140.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T6 140.000-133.333	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T7 133.333-126.667	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T8 126.667-120.000	0.625 A325N	1	0.625 A325N	1	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T9 120.000-113.333	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T10 113.333-106.667	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0

Tower Elevation ft	Redundant Horizontal		Redundant Diagonal		Redundant Sub-Diagonal		Redundant Sub-Horizontal		Redundant Vertical		Redundant Hip		Redundant Hip Diagonal	
	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.
T11 106.667-100.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T12 100.000-80.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T13 80.000-60.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T14 60.000-40.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T15 40.000-30.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T16 30.000-20.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0
T17 20.000-0.000	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0	0.625 A325N	0

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Face Offset in	Lateral Offset (Frac FW)	#	# Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight klf
FLC 158-50J(1-5/8")	A	No	No	Ar (CaAa)	178.000 - 0.000	0.000	0.39	8	8	1.500 0.750	2.015		0.001
Feedline Ladder (Af) *	A	No	No	Af (CaAa)	180.000 - 0.000	0.000	0.385	1	1	3.000	3.000		0.008
LDF6-50A(1-1/4")	B	No	No	Ar (CaAa)	165.000 - 0.000	0.000	-0.4	12	6	0.500	1.550		0.001
2-1/2" Rigid Conduit	B	No	No	Ar (CaAa)	165.000 - 0.000	0.000	-0.36	1	1	0.850 0.750	2.500		0.003
WR-VG122ST-BRDA(7/16)	B	No	No	Ar (CaAa)	165.000 - 0.000	0.000	-0.37	3	2	0.500	0.000		0.000
FB-L98B-002-75000(3/8)	B	No	No	Ar (CaAa)	165.000 - 0.000	4.500	-0.39	1	1	0.394	0.394		0.000
WR-VG86ST-BRD(3/4)	B	No	No	Ar (CaAa)	165.000 - 0.000	4.500	-0.41	4	4	0.850 0.750	0.795		0.001
Feedline Ladder (Af) *	B	No	No	Af (CaAa)	180.000 - 0.000	0.000	-0.39	1	1	3.000	3.000		0.008
HB114-1-0813U4-M5J(1-1/4)	C	No	No	Ar (CaAa)	150.000 - 0.000	0.000	-0.37	4	4	0.850 0.750	1.540		0.001
LDF4-50A(1/2")	C	No	No	Ar (CaAa)	50.000 - 0.000	0.000	-0.35	1	1	0.630	0.630		0.000
Feedline Ladder (Af) *	C	No	No	Af (CaAa)	150.000 - 0.000	-0.750	-0.42	2	1	3.000	3.000		0.008
HCS 6X12 4AWG(1-5/8)	C	No	No	Ar (CaAa)	180.000 - 0.000	-1.500	-0.37	7	7	0.500	1.660		0.002
Feedline Ladder (Af) *	C	No	No	Af (CaAa)	180.000 - 150.000	-0.750	-0.41	1	1	3.000	3.000		0.008
Safety Line 3/8	A	No	No	Ar (CaAa)	180.000 - 0.000	0.000	0.02	1	1	0.375	0.375		0.000
Thin Flat Bar Climbing Ladder *	A	No	No	Af (CaAa)	180.000 - 0.000	0.000	0	1	1	2.000	2.000		0.004
2" SR	A	No	No	Ar (CaAa)	110.000 - 0.000	0.000	0.5	1	1	2.000	2.000		0.000

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Face Offset in	Lateral Offset (Frac FW)	#	# Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight klf
2" SR	B	No	No	Ar (CaAa)	110.000 - 0.000	0.000	0.5	1	1	2.000	2.000		0.000
2" SR *	C	No	No	Ar (CaAa)	110.000 - 0.000	0.000	0.5	1	1	2.000	2.000		0.000
CU12PSM9P6XXX(1-1/2) ****** ***	A	No	No	Ar (CaAa)	140.000 - 0.000	-2.000	0.5	1	1	1.600	1.600		0.002

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 klf
****** ***								

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
T1	180.000-160.000	A	0.000	0.000	46.433	0.000	0.385
		B	0.000	0.000	22.337	0.000	0.237
		C	0.000	0.000	33.240	0.000	0.504
T2	160.000-155.000	A	0.000	0.000	12.414	0.000	0.100
		B	0.000	0.000	14.837	0.000	0.111
		C	0.000	0.000	8.310	0.000	0.126
T3	155.000-150.000	A	0.000	0.000	12.414	0.000	0.100
		B	0.000	0.000	14.837	0.000	0.111
		C	0.000	0.000	8.310	0.000	0.126
T4	150.000-145.000	A	0.000	0.000	12.414	0.000	0.100
		B	0.000	0.000	14.837	0.000	0.111
		C	0.000	0.000	13.890	0.000	0.192
T5	145.000-140.000	A	0.000	0.000	12.414	0.000	0.100
		B	0.000	0.000	14.837	0.000	0.111
		C	0.000	0.000	13.890	0.000	0.192
T6	140.000-133.333	A	0.000	0.000	17.619	0.000	0.149
		B	0.000	0.000	19.782	0.000	0.148
		C	0.000	0.000	18.520	0.000	0.256
T7	133.333-126.667	A	0.000	0.000	17.619	0.000	0.149
		B	0.000	0.000	19.782	0.000	0.148
		C	0.000	0.000	18.520	0.000	0.256
T8	126.667-120.000	A	0.000	0.000	17.619	0.000	0.149
		B	0.000	0.000	19.782	0.000	0.148
		C	0.000	0.000	18.520	0.000	0.256
T9	120.000-113.333	A	0.000	0.000	17.619	0.000	0.149
		B	0.000	0.000	19.782	0.000	0.148
		C	0.000	0.000	18.520	0.000	0.256
T10	113.333-106.667	A	0.000	0.000	18.286	0.000	0.149
		B	0.000	0.000	20.449	0.000	0.148
		C	0.000	0.000	19.187	0.000	0.256
T11	106.667-100.000	A	0.000	0.000	18.952	0.000	0.149
		B	0.000	0.000	21.116	0.000	0.148
		C	0.000	0.000	19.853	0.000	0.256
T12	100.000-80.000	A	0.000	0.000	56.857	0.000	0.447

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
		B	0.000	0.000	63.347	0.000	0.443
		C	0.000	0.000	59.560	0.000	0.768
T13	80.000-60.000	A	0.000	0.000	56.857	0.000	0.447
		B	0.000	0.000	63.347	0.000	0.443
		C	0.000	0.000	59.560	0.000	0.768
T14	60.000-40.000	A	0.000	0.000	56.857	0.000	0.447
		B	0.000	0.000	63.347	0.000	0.443
		C	0.000	0.000	60.190	0.000	0.769
T15	40.000-30.000	A	0.000	0.000	28.428	0.000	0.223
		B	0.000	0.000	31.674	0.000	0.221
		C	0.000	0.000	30.410	0.000	0.386
T16	30.000-20.000	A	0.000	0.000	28.428	0.000	0.223
		B	0.000	0.000	31.674	0.000	0.221
		C	0.000	0.000	30.410	0.000	0.386
T17	20.000-0.000	A	0.000	0.000	56.857	0.000	0.447
		B	0.000	0.000	63.347	0.000	0.443
		C	0.000	0.000	60.820	0.000	0.771

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft^2	A_F ft^2	C_AA_A In Face ft^2	C_AA_A Out Face ft^2	Weight K
T1	180.000-160.000	A	1.502	0.000	0.000	103.047	0.000	1.645
		B		0.000	0.000	39.641	0.000	0.708
		C		0.000	0.000	61.586	0.000	1.196
T2	160.000-155.000	A	1.491	0.000	0.000	27.589	0.000	0.435
		B		0.000	0.000	27.543	0.000	0.425
		C		0.000	0.000	15.368	0.000	0.298
T3	155.000-150.000	A	1.486	0.000	0.000	27.567	0.000	0.434
		B		0.000	0.000	27.504	0.000	0.424
		C		0.000	0.000	15.355	0.000	0.297
T4	150.000-145.000	A	1.481	0.000	0.000	27.546	0.000	0.433
		B		0.000	0.000	27.464	0.000	0.422
		C		0.000	0.000	27.143	0.000	0.492
T5	145.000-140.000	A	1.476	0.000	0.000	27.523	0.000	0.432
		B		0.000	0.000	27.423	0.000	0.421
		C		0.000	0.000	27.116	0.000	0.491
T6	140.000-133.333	A	1.470	0.000	0.000	39.687	0.000	0.626
		B		0.000	0.000	36.498	0.000	0.560
		C		0.000	0.000	36.113	0.000	0.653
T7	133.333-126.667	A	1.462	0.000	0.000	39.634	0.000	0.624
		B		0.000	0.000	36.419	0.000	0.557
		C		0.000	0.000	36.063	0.000	0.651
T8	126.667-120.000	A	1.455	0.000	0.000	39.578	0.000	0.621
		B		0.000	0.000	36.337	0.000	0.555
		C		0.000	0.000	36.010	0.000	0.649
T9	120.000-113.333	A	1.447	0.000	0.000	39.520	0.000	0.618
		B		0.000	0.000	36.250	0.000	0.552
		C		0.000	0.000	35.955	0.000	0.646
T10	113.333-106.667	A	1.438	0.000	0.000	41.084	0.000	0.636
		B		0.000	0.000	37.785	0.000	0.570
		C		0.000	0.000	37.522	0.000	0.664
T11	106.667-100.000	A	1.429	0.000	0.000	42.632	0.000	0.652
		B		0.000	0.000	39.302	0.000	0.587
		C		0.000	0.000	39.074	0.000	0.681
T12	100.000-80.000	A	1.410	0.000	0.000	127.391	0.000	1.935
		B		0.000	0.000	117.195	0.000	1.740
		C		0.000	0.000	116.742	0.000	2.023
T13	80.000-60.000	A	1.375	0.000	0.000	126.491	0.000	1.896
		B		0.000	0.000	115.929	0.000	1.703
		C		0.000	0.000	115.884	0.000	1.988
T14	60.000-40.000	A	1.329	0.000	0.000	125.321	0.000	1.845
		B		0.000	0.000	114.283	0.000	1.657
		C		0.000	0.000	118.058	0.000	1.977
T15	40.000-30.000	A	1.283	0.000	0.000	62.061	0.000	0.897

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
		B		0.000	0.000	56.299	0.000	0.805
		C		0.000	0.000	60.010	0.000	0.981
T16	30.000-20.000	A	1.240	0.000	0.000	61.516	0.000	0.874
		B		0.000	0.000	55.533	0.000	0.784
		C		0.000	0.000	59.407	0.000	0.959
T17	20.000-0.000	A	1.132	0.000	0.000	120.242	0.000	1.634
		B		0.000	0.000	107.146	0.000	1.462
		C		0.000	0.000	115.730	0.000	1.807

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
T1	180.000-160.000	4.649	-13.012	4.763	-13.252
T2	160.000-155.000	5.241	-19.348	5.348	-19.624
T3	155.000-150.000	5.522	-20.436	5.641	-20.750
T4	150.000-145.000	7.493	-16.591	8.235	-17.876
T5	145.000-140.000	7.260	-16.299	8.075	-17.640
T6	140.000-133.333	8.387	-19.396	9.185	-21.276
T7	133.333-126.667	8.064	-18.968	9.057	-21.156
T8	126.667-120.000	6.840	-16.584	7.943	-18.861
T9	120.000-113.333	8.079	-19.304	9.530	-22.466
T10	113.333-106.667	8.169	-19.569	9.588	-22.641
T11	106.667-100.000	9.115	-21.598	10.413	-24.467
T12	100.000-80.000	9.105	-21.845	10.834	-25.631
T13	80.000-60.000	10.917	-25.966	12.721	-29.914
T14	60.000-40.000	10.425	-24.837	13.031	-29.359
T15	40.000-30.000	11.892	-27.608	15.034	-32.111
T16	30.000-20.000	10.485	-24.820	13.928	-30.067
T17	20.000-0.000	12.058	-28.333	15.878	-33.981

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T1	1	FLC 158-50J(1-5/8")	160.00 - 178.00	0.6000	0.6000
T1	2	Feedline Ladder (Af)	160.00 - 180.00	0.6000	0.6000
T1	4	LDF6-50A(1-1/4")	160.00 - 165.00	0.6000	0.6000
T1	5	2-1/2" Rigid Conduit	160.00 - 165.00	0.6000	0.6000
T1	6	WR-VG122ST-BRDA(7/16)	160.00 - 165.00	0.6000	0.6000
T1	7	FB-L98B-002-75000(3/8)	160.00 - 165.00	0.6000	0.6000
T1	8	WR-VG86ST-BRD(3/4)	160.00 - 165.00	0.6000	0.6000
T1	9	Feedline Ladder (Af)	160.00 - 180.00	0.6000	0.6000
T1	15	HCS 6X12 4AWG(1-5/8)	160.00 - 180.00	0.6000	0.6000
T1	16	Feedline Ladder (Af)	160.00 - 180.00	0.6000	0.6000
T1	18	Safety Line 3/8	160.00 - 180.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T1	19	Thin Flat Bar Climbing Ladder	160.00 - 180.00	0.6000	0.6000
T2	1	FLC 158-50J(1-5/8")	155.00 - 160.00	0.6000	0.6000
T2	2	Feedline Ladder (Af)	155.00 - 160.00	0.6000	0.6000
T2	4	LDF6-50A(1-1/4")	155.00 - 160.00	0.6000	0.6000
T2	5	2-1/2" Rigid Conduit	155.00 - 160.00	0.6000	0.6000
T2	6	WR-VG122ST-BRDA(7/16)	155.00 - 160.00	0.6000	0.6000
T2	7	FB-L98B-002-75000(3/8)	155.00 - 160.00	0.6000	0.6000
T2	8	WR-VG86ST-BRD(3/4)	155.00 - 160.00	0.6000	0.6000
T2	9	Feedline Ladder (Af)	155.00 - 160.00	0.6000	0.6000
T2	15	HCS 6X12 4AWG(1-5/8)	155.00 - 160.00	0.6000	0.6000
T2	16	Feedline Ladder (Af)	155.00 - 160.00	0.6000	0.6000
T2	18	Safety Line 3/8	155.00 - 160.00	0.6000	0.6000
T2	19	Thin Flat Bar Climbing Ladder	155.00 - 160.00	0.6000	0.6000
T3	1	FLC 158-50J(1-5/8")	150.00 - 155.00	0.6000	0.6000
T3	2	Feedline Ladder (Af)	150.00 - 155.00	0.6000	0.6000
T3	4	LDF6-50A(1-1/4")	150.00 - 155.00	0.6000	0.6000
T3	5	2-1/2" Rigid Conduit	150.00 - 155.00	0.6000	0.6000
T3	6	WR-VG122ST-BRDA(7/16)	150.00 - 155.00	0.6000	0.6000
T3	7	FB-L98B-002-75000(3/8)	150.00 - 155.00	0.6000	0.6000
T3	8	WR-VG86ST-BRD(3/4)	150.00 - 155.00	0.6000	0.6000
T3	9	Feedline Ladder (Af)	150.00 - 155.00	0.6000	0.6000
T3	15	HCS 6X12 4AWG(1-5/8)	150.00 - 155.00	0.6000	0.6000
T3	16	Feedline Ladder (Af)	150.00 - 155.00	0.6000	0.6000
T3	18	Safety Line 3/8	150.00 - 155.00	0.6000	0.6000
T3	19	Thin Flat Bar Climbing Ladder	150.00 - 155.00	0.6000	0.6000
T4	1	FLC 158-50J(1-5/8")	145.00 - 150.00	0.6000	0.6000
T4	2	Feedline Ladder (Af)	145.00 - 150.00	0.6000	0.6000
T4	4	LDF6-50A(1-1/4")	145.00 - 150.00	0.6000	0.6000
T4	5	2-1/2" Rigid Conduit	145.00 - 150.00	0.6000	0.6000
T4	6	WR-VG122ST-BRDA(7/16)	145.00 - 150.00	0.6000	0.6000
T4	7	FB-L98B-002-75000(3/8)	145.00 - 150.00	0.6000	0.6000
T4	8	WR-VG86ST-BRD(3/4)	145.00 - 150.00	0.6000	0.6000
T4	9	Feedline Ladder (Af)	145.00 - 150.00	0.6000	0.6000
T4	11	HB114-1-0813U4-M5J(1-1/4)	145.00 - 150.00	0.6000	0.6000
T4	13	Feedline Ladder (Af)	145.00 -	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T4	15	HCS 6X12 4AWG(1-5/8)	145.00 - 150.00	0.6000	0.6000
T4	18	Safety Line 3/8	145.00 - 150.00	0.6000	0.6000
T4	19	Thin Flat Bar Climbing Ladder	145.00 - 150.00	0.6000	0.6000
T5	1	FLC 158-50J(1-5/8")	140.00 - 145.00	0.6000	0.6000
T5	2	Feedline Ladder (Af)	140.00 - 145.00	0.6000	0.6000
T5	4	LDF6-50A(1-1/4")	140.00 - 145.00	0.6000	0.6000
T5	5	2-1/2" Rigid Conduit	140.00 - 145.00	0.6000	0.6000
T5	6	WR-VG122ST-BRDA(7/16)	140.00 - 145.00	0.6000	0.6000
T5	7	FB-L98B-002-75000(3/8)	140.00 - 145.00	0.6000	0.6000
T5	8	WR-VG86ST-BRD(3/4)	140.00 - 145.00	0.6000	0.6000
T5	9	Feedline Ladder (Af)	140.00 - 145.00	0.6000	0.6000
T5	11	HB114-1-0813U4-M5J(1-1/4)	140.00 - 145.00	0.6000	0.6000
T5	13	Feedline Ladder (Af)	140.00 - 145.00	0.6000	0.6000
T5	15	HCS 6X12 4AWG(1-5/8)	140.00 - 145.00	0.6000	0.6000
T5	18	Safety Line 3/8	140.00 - 145.00	0.6000	0.6000
T5	19	Thin Flat Bar Climbing Ladder	140.00 - 145.00	0.6000	0.6000
T6	1	FLC 158-50J(1-5/8")	133.33 - 140.00	0.6000	0.6000
T6	2	Feedline Ladder (Af)	133.33 - 140.00	0.6000	0.6000
T6	4	LDF6-50A(1-1/4")	133.33 - 140.00	0.6000	0.6000
T6	5	2-1/2" Rigid Conduit	133.33 - 140.00	0.6000	0.6000
T6	6	WR-VG122ST-BRDA(7/16)	133.33 - 140.00	0.6000	0.6000
T6	7	FB-L98B-002-75000(3/8)	133.33 - 140.00	0.6000	0.6000
T6	8	WR-VG86ST-BRD(3/4)	133.33 - 140.00	0.6000	0.6000
T6	9	Feedline Ladder (Af)	133.33 - 140.00	0.6000	0.6000
T6	11	HB114-1-0813U4-M5J(1-1/4)	133.33 - 140.00	0.6000	0.6000
T6	13	Feedline Ladder (Af)	133.33 - 140.00	0.6000	0.6000
T6	15	HCS 6X12 4AWG(1-5/8)	133.33 - 140.00	0.6000	0.6000
T6	18	Safety Line 3/8	133.33 - 140.00	0.6000	0.6000
T6	19	Thin Flat Bar Climbing Ladder	133.33 - 140.00	0.6000	0.6000
T6	25	CU12PSM9P6XXX(1-1/2)	133.33 - 140.00	0.6000	0.6000
T7	1	FLC 158-50J(1-5/8")	126.67 - 133.33	0.6000	0.6000
T7	2	Feedline Ladder (Af)	126.67 - 133.33	0.6000	0.6000
T7	4	LDF6-50A(1-1/4")	126.67 - 133.33	0.6000	0.6000
T7	5	2-1/2" Rigid Conduit	126.67 - 133.33	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T7	6	WR-VG122ST-BRDA(7/16)	126.67 - 133.33	0.6000	0.6000
T7	7	FB-L98B-002-75000(3/8)	126.67 - 133.33	0.6000	0.6000
T7	8	WR-VG86ST-BRD(3/4)	126.67 - 133.33	0.6000	0.6000
T7	9	Feedline Ladder (Af)	126.67 - 133.33	0.6000	0.6000
T7	11	HB114-1-0813U4-M5J(1-1/4)	126.67 - 133.33	0.6000	0.6000
T7	13	Feedline Ladder (Af)	126.67 - 133.33	0.6000	0.6000
T7	15	HCS 6X12 4AWG(1-5/8)	126.67 - 133.33	0.6000	0.6000
T7	18	Safety Line 3/8	126.67 - 133.33	0.6000	0.6000
T7	19	Thin Flat Bar Climbing Ladder	126.67 - 133.33	0.6000	0.6000
T7	25	CU12PSM9P6XXX(1-1/2)	126.67 - 133.33	0.6000	0.6000
T8	1	FLC 158-50J(1-5/8")	120.00 - 126.67	0.6000	0.5698
T8	2	Feedline Ladder (Af)	120.00 - 126.67	0.6000	0.5698
T8	4	LDF6-50A(1-1/4")	120.00 - 126.67	0.6000	0.5698
T8	5	2-1/2" Rigid Conduit	120.00 - 126.67	0.6000	0.5698
T8	6	WR-VG122ST-BRDA(7/16)	120.00 - 126.67	0.6000	0.5698
T8	7	FB-L98B-002-75000(3/8)	120.00 - 126.67	0.6000	0.5698
T8	8	WR-VG86ST-BRD(3/4)	120.00 - 126.67	0.6000	0.5698
T8	9	Feedline Ladder (Af)	120.00 - 126.67	0.6000	0.5698
T8	11	HB114-1-0813U4-M5J(1-1/4)	120.00 - 126.67	0.6000	0.5698
T8	13	Feedline Ladder (Af)	120.00 - 126.67	0.6000	0.5698
T8	15	HCS 6X12 4AWG(1-5/8)	120.00 - 126.67	0.6000	0.5698
T8	18	Safety Line 3/8	120.00 - 126.67	0.6000	0.5698
T8	19	Thin Flat Bar Climbing Ladder	120.00 - 126.67	0.6000	0.5698
T8	25	CU12PSM9P6XXX(1-1/2)	120.00 - 126.67	0.6000	0.5698
T9	1	FLC 158-50J(1-5/8")	113.33 - 120.00	0.6000	0.6000
T9	2	Feedline Ladder (Af)	113.33 - 120.00	0.6000	0.6000
T9	4	LDF6-50A(1-1/4")	113.33 - 120.00	0.6000	0.6000
T9	5	2-1/2" Rigid Conduit	113.33 - 120.00	0.6000	0.6000
T9	6	WR-VG122ST-BRDA(7/16)	113.33 - 120.00	0.6000	0.6000
T9	7	FB-L98B-002-75000(3/8)	113.33 - 120.00	0.6000	0.6000
T9	8	WR-VG86ST-BRD(3/4)	113.33 - 120.00	0.6000	0.6000
T9	9	Feedline Ladder (Af)	113.33 - 120.00	0.6000	0.6000
T9	11	HB114-1-0813U4-M5J(1-1/4)	113.33 - 120.00	0.6000	0.6000
T9	13	Feedline Ladder (Af)	113.33 - 120.00	0.6000	0.6000
T9	15	HCS 6X12 4AWG(1-5/8)	113.33 -	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T9	18	Safety Line 3/8	120.00 - 113.33	0.6000	0.6000
T9	19	Thin Flat Bar Climbing Ladder	120.00 - 113.33	0.6000	0.6000
T9	25	CU12PSM9P6XXX(1-1/2)	120.00 - 113.33	0.6000	0.6000
T10	1	FLC 158-50J(1-5/8")	120.00 - 106.67	0.6000	0.6000
T10	2	Feedline Ladder (Af)	113.33 - 106.67	0.6000	0.6000
T10	4	LDF6-50A(1-1/4")	113.33 - 106.67	0.6000	0.6000
T10	5	2-1/2" Rigid Conduit	113.33 - 106.67	0.6000	0.6000
T10	6	WR-VG122ST-BRDA(7/16)	113.33 - 106.67	0.6000	0.6000
T10	7	FB-L98B-002-75000(3/8)	113.33 - 106.67	0.6000	0.6000
T10	8	WR-VG86ST-BRD(3/4)	113.33 - 106.67	0.6000	0.6000
T10	9	Feedline Ladder (Af)	113.33 - 106.67	0.6000	0.6000
T10	11	HB114-1-0813U4-M5J(1-1/4)	113.33 - 106.67	0.6000	0.6000
T10	13	Feedline Ladder (Af)	113.33 - 106.67	0.6000	0.6000
T10	15	HCS 6X12 4AWG(1-5/8)	113.33 - 106.67	0.6000	0.6000
T10	18	Safety Line 3/8	113.33 - 106.67	0.6000	0.6000
T10	19	Thin Flat Bar Climbing Ladder	113.33 - 106.67	0.6000	0.6000
T10	21	2" SR	113.33 - 110.00	0.6000	0.6000
T10	22	2" SR	110.00 - 106.67	0.6000	0.6000
T10	23	2" SR	110.00 - 106.67	0.6000	0.6000
T10	25	CU12PSM9P6XXX(1-1/2)	113.33 - 106.67	0.6000	0.6000
T11	1	FLC 158-50J(1-5/8")	106.67 - 100.00	0.6000	0.6000
T11	2	Feedline Ladder (Af)	106.67 - 100.00	0.6000	0.6000
T11	4	LDF6-50A(1-1/4")	106.67 - 100.00	0.6000	0.6000
T11	5	2-1/2" Rigid Conduit	106.67 - 100.00	0.6000	0.6000
T11	6	WR-VG122ST-BRDA(7/16)	106.67 - 100.00	0.6000	0.6000
T11	7	FB-L98B-002-75000(3/8)	106.67 - 100.00	0.6000	0.6000
T11	8	WR-VG86ST-BRD(3/4)	106.67 - 100.00	0.6000	0.6000
T11	9	Feedline Ladder (Af)	106.67 - 100.00	0.6000	0.6000
T11	11	HB114-1-0813U4-M5J(1-1/4)	106.67 - 100.00	0.6000	0.6000
T11	13	Feedline Ladder (Af)	106.67 - 100.00	0.6000	0.6000
T11	15	HCS 6X12 4AWG(1-5/8)	106.67 - 100.00	0.6000	0.6000
T11	18	Safety Line 3/8	106.67 - 100.00	0.6000	0.6000
T11	19	Thin Flat Bar Climbing Ladder	106.67 - 100.00	0.6000	0.6000
T11	21	2" SR	106.67 - 100.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T11	22	2" SR	100.00 - 106.67	0.6000	0.6000
T11	23	2" SR	100.00 - 106.67	0.6000	0.6000
T11	25	CU12PSM9P6XXX(1-1/2)	100.00 - 106.67	0.6000	0.6000
T12	1	FLC 158-50J(1-5/8")	80.00 - 100.00	0.6000	0.6000
T12	2	Feedline Ladder (Af)	80.00 - 100.00	0.6000	0.6000
T12	4	LDF6-50A(1-1/4")	80.00 - 100.00	0.6000	0.6000
T12	5	2-1/2" Rigid Conduit	80.00 - 100.00	0.6000	0.6000
T12	6	WR-VG122ST-BRDA(7/16)	80.00 - 100.00	0.6000	0.6000
T12	7	FB-L98B-002-75000(3/8)	80.00 - 100.00	0.6000	0.6000
T12	8	WR-VG86ST-BRD(3/4)	80.00 - 100.00	0.6000	0.6000
T12	9	Feedline Ladder (Af)	80.00 - 100.00	0.6000	0.6000
T12	11	HB114-1-0813U4-M5J(1-1/4)	80.00 - 100.00	0.6000	0.6000
T12	13	Feedline Ladder (Af)	80.00 - 100.00	0.6000	0.6000
T12	15	HCS 6X12 4AWG(1-5/8)	80.00 - 100.00	0.6000	0.6000
T12	18	Safety Line 3/8	80.00 - 100.00	0.6000	0.6000
T12	19	Thin Flat Bar Climbing Ladder	80.00 - 100.00	0.6000	0.6000
T12	21	2" SR	80.00 - 100.00	0.6000	0.6000
T12	22	2" SR	80.00 - 100.00	0.6000	0.6000
T12	23	2" SR	80.00 - 100.00	0.6000	0.6000
T12	25	CU12PSM9P6XXX(1-1/2)	80.00 - 100.00	0.6000	0.6000
T13	1	FLC 158-50J(1-5/8")	60.00 - 80.00	0.6000	0.6000
T13	2	Feedline Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T13	4	LDF6-50A(1-1/4")	60.00 - 80.00	0.6000	0.6000
T13	5	2-1/2" Rigid Conduit	60.00 - 80.00	0.6000	0.6000
T13	6	WR-VG122ST-BRDA(7/16)	60.00 - 80.00	0.6000	0.6000
T13	7	FB-L98B-002-75000(3/8)	60.00 - 80.00	0.6000	0.6000
T13	8	WR-VG86ST-BRD(3/4)	60.00 - 80.00	0.6000	0.6000
T13	9	Feedline Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T13	11	HB114-1-0813U4-M5J(1-1/4)	60.00 - 80.00	0.6000	0.6000
T13	13	Feedline Ladder (Af)	60.00 - 80.00	0.6000	0.6000
T13	15	HCS 6X12 4AWG(1-5/8)	60.00 - 80.00	0.6000	0.6000
T13	18	Safety Line 3/8	60.00 - 80.00	0.6000	0.6000
T13	19	Thin Flat Bar Climbing Ladder	60.00 - 80.00	0.6000	0.6000
T13	21	2" SR	60.00 - 80.00	0.6000	0.6000
T13	22	2" SR	60.00 -	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T13	23	2" SR	80.00 60.00 - 80.00	0.6000	0.6000
T13	25	CU12PSM9P6XXX(1-1/2)	80.00 60.00 - 80.00	0.6000	0.6000
T14	1	FLC 158-50J(1-5/8")	80.00 40.00 - 60.00	0.6000	0.6000
T14	2	Feedline Ladder (Af)	60.00 40.00 - 60.00	0.6000	0.6000
T14	4	LDF6-50A(1-1/4")	60.00 40.00 - 60.00	0.6000	0.6000
T14	5	2-1/2" Rigid Conduit	60.00 40.00 - 60.00	0.6000	0.6000
T14	6	WR-VG122ST-BRDA(7/16)	60.00 40.00 - 60.00	0.6000	0.6000
T14	7	FB-L98B-002-75000(3/8)	60.00 40.00 - 60.00	0.6000	0.6000
T14	8	WR-VG86ST-BRD(3/4)	60.00 40.00 - 60.00	0.6000	0.6000
T14	9	Feedline Ladder (Af)	60.00 40.00 - 60.00	0.6000	0.6000
T14	11	HB114-1-0813U4-M5J(1-1/4)	60.00 40.00 - 60.00	0.6000	0.6000
T14	12	LDF4-50A(1/2")	40.00 - 50.00	0.6000	0.6000
T14	13	Feedline Ladder (Af)	50.00 40.00 - 60.00	0.6000	0.6000
T14	15	HCS 6X12 4AWG(1-5/8)	60.00 40.00 - 60.00	0.6000	0.6000
T14	18	Safety Line 3/8	60.00 40.00 - 60.00	0.6000	0.6000
T14	19	Thin Flat Bar Climbing Ladder	60.00 40.00 - 60.00	0.6000	0.6000
T14	21	2" SR	60.00 40.00 - 60.00	0.6000	0.6000
T14	22	2" SR	60.00 40.00 - 60.00	0.6000	0.6000
T14	23	2" SR	60.00 40.00 - 60.00	0.6000	0.6000
T14	25	CU12PSM9P6XXX(1-1/2)	60.00 40.00 - 60.00	0.6000	0.6000
T15	1	FLC 158-50J(1-5/8")	60.00 30.00 - 40.00	0.6000	0.6000
T15	2	Feedline Ladder (Af)	40.00 30.00 - 40.00	0.6000	0.6000
T15	4	LDF6-50A(1-1/4")	40.00 30.00 - 40.00	0.6000	0.6000
T15	5	2-1/2" Rigid Conduit	40.00 30.00 - 40.00	0.6000	0.6000
T15	6	WR-VG122ST-BRDA(7/16)	40.00 30.00 - 40.00	0.6000	0.6000
T15	7	FB-L98B-002-75000(3/8)	40.00 30.00 - 40.00	0.6000	0.6000
T15	8	WR-VG86ST-BRD(3/4)	40.00 30.00 - 40.00	0.6000	0.6000
T15	9	Feedline Ladder (Af)	40.00 30.00 - 40.00	0.6000	0.6000
T15	11	HB114-1-0813U4-M5J(1-1/4)	40.00 30.00 - 40.00	0.6000	0.6000
T15	12	LDF4-50A(1/2")	40.00 30.00 - 40.00	0.6000	0.6000
T15	13	Feedline Ladder (Af)	40.00 30.00 - 40.00	0.6000	0.6000
T15	15	HCS 6X12 4AWG(1-5/8)	40.00 30.00 - 40.00	0.6000	0.6000
T15	18	Safety Line 3/8	40.00 30.00 - 40.00	0.6000	0.6000
T15	19	Thin Flat Bar Climbing Ladder	40.00 30.00 - 40.00	0.6000	0.6000

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T15	21	2" SR	30.00 - 40.00	0.6000	0.6000
T15	22	2" SR	30.00 - 40.00	0.6000	0.6000
T15	23	2" SR	30.00 - 40.00	0.6000	0.6000
T15	25	CU12PSM9P6XXX(1-1/2)	30.00 - 40.00	0.6000	0.6000
T16	1	FLC 158-50J(1-5/8")	20.00 - 30.00	0.6000	0.6000
T16	2	Feedline Ladder (Af)	20.00 - 30.00	0.6000	0.6000
T16	4	LDF6-50A(1-1/4")	20.00 - 30.00	0.6000	0.6000
T16	5	2-1/2" Rigid Conduit	20.00 - 30.00	0.6000	0.6000
T16	6	WR-VG122ST-BRDA(7/16)	20.00 - 30.00	0.6000	0.6000
T16	7	FB-L98B-002-75000(3/8)	20.00 - 30.00	0.6000	0.6000
T16	8	WR-VG86ST-BRD(3/4)	20.00 - 30.00	0.6000	0.6000
T16	9	Feedline Ladder (Af)	20.00 - 30.00	0.6000	0.6000
T16	11	HB114-1-0813U4-M5J(1-1/4)	20.00 - 30.00	0.6000	0.6000
T16	12	LDF4-50A(1/2")	20.00 - 30.00	0.6000	0.6000
T16	13	Feedline Ladder (Af)	20.00 - 30.00	0.6000	0.6000
T16	15	HCS 6X12 4AWG(1-5/8)	20.00 - 30.00	0.6000	0.6000
T16	18	Safety Line 3/8	20.00 - 30.00	0.6000	0.6000
T16	19	Thin Flat Bar Climbing Ladder	20.00 - 30.00	0.6000	0.6000
T16	21	2" SR	20.00 - 30.00	0.6000	0.6000
T16	22	2" SR	20.00 - 30.00	0.6000	0.6000
T16	23	2" SR	20.00 - 30.00	0.6000	0.6000
T16	25	CU12PSM9P6XXX(1-1/2)	20.00 - 30.00	0.6000	0.6000
T17	1	FLC 158-50J(1-5/8")	0.00 - 20.00	0.6000	0.6000
T17	2	Feedline Ladder (Af)	0.00 - 20.00	0.6000	0.6000
T17	4	LDF6-50A(1-1/4")	0.00 - 20.00	0.6000	0.6000
T17	5	2-1/2" Rigid Conduit	0.00 - 20.00	0.6000	0.6000
T17	6	WR-VG122ST-BRDA(7/16)	0.00 - 20.00	0.6000	0.6000
T17	7	FB-L98B-002-75000(3/8)	0.00 - 20.00	0.6000	0.6000
T17	8	WR-VG86ST-BRD(3/4)	0.00 - 20.00	0.6000	0.6000
T17	9	Feedline Ladder (Af)	0.00 - 20.00	0.6000	0.6000
T17	11	HB114-1-0813U4-M5J(1-1/4)	0.00 - 20.00	0.6000	0.6000
T17	12	LDF4-50A(1/2")	0.00 - 20.00	0.6000	0.6000
T17	13	Feedline Ladder (Af)	0.00 - 20.00	0.6000	0.6000
T17	15	HCS 6X12 4AWG(1-5/8)	0.00 - 20.00	0.6000	0.6000
T17	18	Safety Line 3/8	0.00 - 20.00	0.6000	0.6000
T17	19	Thin Flat Bar Climbing Ladder	0.00 - 20.00	0.6000	0.6000
T17	21	2" SR	0.00 - 20.00	0.6000	0.6000
T17	22	2" SR	0.00 - 20.00	0.6000	0.6000
T17	23	2" SR	0.00 - 20.00	0.6000	0.6000
T17	25	CU12PSM9P6XXX(1-1/2)	0.00 - 20.00	0.6000	0.6000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
Lightning Rod 5/8" x 6'	C	From Leg	0.000 0.000 3.000	0.000	180.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.375 0.989 1.619 2.464	0.375 0.989 1.619 2.464	0.006 0.010 0.019 0.047
*									
19" Accelerator	B	From Leg	0.000 0.000 4.000	0.000	182.000	No Ice 1/2" Ice 1" Ice 2" Ice	7.600 8.110 8.620 9.640	7.600 8.110 8.620 9.640	0.250 0.331 0.412 0.574
(3) RR90-17-02DP w/ Mount Pipe	B	From Leg	0.500 0.000 4.000	0.000	182.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.470 5.080 5.700 7.010	2.920 3.500 4.100 5.350	0.034 0.067 0.108 0.216
(3) KRY 112 489/1	B	From Leg	0.500 0.000 -3.000	0.000	182.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.560 0.659 0.765 1.000	0.366 0.449 0.543 0.754	0.015 0.021 0.027 0.046
15' x 4" Mount Pipe	B	From Leg	0.000 0.000 -8.000	0.000	182.000	No Ice 1/2" Ice 1" Ice 2" Ice	5.032 8.296 9.858 12.224	5.032 8.296 9.858 12.224	0.180 0.227 0.283 0.426
*** 178 P ***									
(2) LPA-80080/6CF	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.326 4.764 5.210 6.123	8.619 9.075 9.539 10.486	0.021 0.069 0.123 0.251
(2) LPA-80080/6CF	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.326 4.764 5.210 6.123	8.619 9.075 9.539 10.486	0.021 0.069 0.123 0.251
(2) LPA-80080/6CF	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.326 4.764 5.210 6.123	8.619 9.075 9.539 10.486	0.021 0.069 0.123 0.251
(2) JAHH-65B-R3B w/ Mount Pipe	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	5.500 5.970 6.450 7.440	4.380 4.840 5.300 6.260	0.096 0.169 0.254 0.457
(2) JAHH-65B-R3B w/ Mount Pipe	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	5.500 5.970 6.450 7.440	4.380 4.840 5.300 6.260	0.096 0.169 0.254 0.457
(2) JAHH-65B-R3B w/ Mount Pipe	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	5.500 5.970 6.450 7.440	4.380 4.840 5.300 6.260	0.096 0.169 0.254 0.457
Sub6 Antenna - VZS01 w/ Mount Pipe	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice	4.915 5.264 5.623 6.371	2.687 3.151 3.631 4.639	0.101 0.141 0.186 0.294

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
						2" Ice			
Sub6 Antenna - VZS01 w/ Mount Pipe	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.915 5.264 5.623 6.371	2.687 3.151 3.631 4.639	0.101 0.141 0.186 0.294
Sub6 Antenna - VZS01 w/ Mount Pipe	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.915 5.264 5.623 6.371	2.687 3.151 3.631 4.639	0.101 0.141 0.186 0.294
RFV01U-D1A	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.250 1.393 1.543 1.865	0.084 0.103 0.124 0.175
RFV01U-D1A	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.250 1.393 1.543 1.865	0.084 0.103 0.124 0.175
RFV01U-D1A	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.250 1.393 1.543 1.865	0.084 0.103 0.124 0.175
RFV01U-D2A	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.013 1.145 1.284 1.585	0.070 0.087 0.106 0.153
RFV01U-D2A	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.013 1.145 1.284 1.585	0.070 0.087 0.106 0.153
RFV01U-D2A	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.875 2.045 2.223 2.601	1.013 1.145 1.284 1.585	0.070 0.087 0.106 0.153
DB-B1-6C-8AB-0Z	A	From Leg	4.000 0.000 0.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	5.600 5.915 6.240 6.914	2.333 2.558 2.791 3.284	0.044 0.080 0.120 0.213
CBC78T-DS-43-2X	A	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.368 0.446 0.531 0.723	0.512 0.605 0.705 0.927	0.021 0.027 0.035 0.057
CBC78T-DS-43-2X	B	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.368 0.446 0.531 0.723	0.512 0.605 0.705 0.927	0.021 0.027 0.035 0.057
CBC78T-DS-43-2X	C	From Leg	4.000 0.000 1.000	0.000	178.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.368 0.446 0.531 0.723	0.512 0.605 0.705 0.927	0.021 0.027 0.035 0.057
DB-T1-6Z-8AB-0Z	B	From Leg	4.000 0.000 0.000	0.000	178.000	No Ice 1/2" Ice 1" Ice	5.600 5.915 6.240 6.914	2.333 2.558 2.791 3.284	0.044 0.080 0.120 0.213

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
						2" Ice			
Sector Mount [SM 510-3]	C	None		0.000	178.000	No Ice	39.970	39.970	2.396
						1/2" Ice	56.450	56.450	3.077
						1" Ice	72.590	72.590	3.960
						2" Ice	104.060	104.060	6.296
*** 165 ***									
7770.00 w/ Mount Pipe	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	5.746	4.254	0.055
						1/2" Ice	6.179	5.014	0.103
						1" Ice	6.607	5.711	0.157
						2" Ice	7.488	7.155	0.287
7770.00 w/ Mount Pipe	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	5.746	4.254	0.055
						1/2" Ice	6.179	5.014	0.103
						1" Ice	6.607	5.711	0.157
						2" Ice	7.488	7.155	0.287
7770.00 w/ Mount Pipe	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	5.746	4.254	0.055
						1/2" Ice	6.179	5.014	0.103
						1" Ice	6.607	5.711	0.157
						2" Ice	7.488	7.155	0.287
DMP65R-BU8D w/ Mount Pipe	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	15.890	7.890	0.139
						1/2" Ice	16.810	8.740	0.252
						1" Ice	17.760	9.600	0.380
						2" Ice	19.700	11.370	0.679
DMP65R-BU8D w/ Mount Pipe	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	15.890	7.890	0.139
						1/2" Ice	16.810	8.740	0.252
						1" Ice	17.760	9.600	0.380
						2" Ice	19.700	11.370	0.679
DMP65R-BU8D w/ Mount Pipe	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	15.890	7.890	0.139
						1/2" Ice	16.810	8.740	0.252
						1" Ice	17.760	9.600	0.380
						2" Ice	19.700	11.370	0.679
OPA65R-BU6D w/ Mount Pipe	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	12.250	6.050	0.089
						1/2" Ice	13.000	6.710	0.176
						1" Ice	13.760	7.390	0.275
						2" Ice	15.340	8.790	0.508
OPA65R-BU6D w/ Mount Pipe	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	12.250	6.050	0.089
						1/2" Ice	13.000	6.710	0.176
						1" Ice	13.760	7.390	0.275
						2" Ice	15.340	8.790	0.508
OPA65R-BU6D w/ Mount Pipe	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	12.250	6.050	0.089
						1/2" Ice	13.000	6.710	0.176
						1" Ice	13.760	7.390	0.275
						2" Ice	15.340	8.790	0.508
QS66512-2 w/ Mount Pipe	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	4.040	4.180	0.137
						1/2" Ice	4.420	4.570	0.206
						1" Ice	4.820	4.970	0.287
						2" Ice	5.630	5.790	0.482
QS66512-2 w/ Mount Pipe	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	4.040	4.180	0.137
						1/2" Ice	4.420	4.570	0.206
						1" Ice	4.820	4.970	0.287
						2" Ice	5.630	5.790	0.482
QS66512-2 w/ Mount Pipe	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice	4.040	4.180	0.137
						1/2" Ice	4.420	4.570	0.206
						Ice	4.820	4.970	0.287

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
						1" Ice 2" Ice	5.630	5.790	0.482
(2) LGP21401	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.104 1.239 1.381 1.688	0.207 0.274 0.348 0.521	0.014 0.021 0.030 0.055
(2) LGP21401	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.104 1.239 1.381 1.688	0.207 0.274 0.348 0.521	0.014 0.021 0.030 0.055
(2) LGP21401	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.104 1.239 1.381 1.688	0.207 0.274 0.348 0.521	0.014 0.021 0.030 0.055
RRUS 4449 B5/B12	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.968 2.144 2.328 2.718	1.408 1.564 1.727 2.075	0.071 0.090 0.111 0.163
RRUS 4449 B5/B12	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.968 2.144 2.328 2.718	1.408 1.564 1.727 2.075	0.071 0.090 0.111 0.163
RRUS 4449 B5/B12	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.968 2.144 2.328 2.718	1.408 1.564 1.727 2.075	0.071 0.090 0.111 0.163
RRUS 4478 B14	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.843 2.012 2.190 2.566	1.059 1.197 1.342 1.656	0.060 0.076 0.094 0.140
RRUS 4478 B14	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.843 2.012 2.190 2.566	1.059 1.197 1.342 1.656	0.060 0.076 0.094 0.140
RRUS 4478 B14	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.843 2.012 2.190 2.566	1.059 1.197 1.342 1.656	0.060 0.076 0.094 0.140
DC6-48-60-18-8F	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.212 1.892 2.105 2.570	1.212 1.892 2.105 2.570	0.020 0.042 0.067 0.126
DC6-48-60-18-8F	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.212 1.892 2.105 2.570	1.212 1.892 2.105 2.570	0.020 0.042 0.067 0.126
DC6-48-60-18-8F	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.212 1.892 2.105 2.570	1.212 1.892 2.105 2.570	0.020 0.042 0.067 0.126
RRUS 32 B30	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice Ice	2.692 2.912 3.138	1.573 1.756 1.945	0.060 0.080 0.104

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
						1" Ice 2" Ice	3.614	2.346	0.161
RRUS 32 B30	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	2.692 2.912 3.138 3.614	1.573 1.756 1.945 2.346	0.060 0.080 0.104 0.161
RRUS 32 B30	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	2.692 2.912 3.138 3.614	1.573 1.756 1.945 2.346	0.060 0.080 0.104 0.161
RRUS 32 B2	A	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	2.731 2.953 3.182 3.663	1.668 1.855 2.049 2.458	0.053 0.074 0.098 0.157
RRUS 32 B2	B	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	2.731 2.953 3.182 3.663	1.668 1.855 2.049 2.458	0.053 0.074 0.098 0.157
RRUS 32 B2	C	From Leg	4.000 0.000 2.000	0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	2.731 2.953 3.182 3.663	1.668 1.855 2.049 2.458	0.053 0.074 0.098 0.157
Sector Mount [SM 510-3]	C	None		0.000	165.000	No Ice 1/2" Ice 1" Ice 2" Ice	39.970 56.450 72.590 104.060	39.970 56.450 72.590 104.060	2.396 3.077 3.960 6.296
*									
APXVTM14-ALU-I20 w/ Mount Pipe	A	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.090 4.480 4.880 5.710	2.860 3.230 3.610 4.400	0.077 0.127 0.185 0.331
APXVTM14-ALU-I20 w/ Mount Pipe	B	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.090 4.480 4.880 5.710	2.860 3.230 3.610 4.400	0.077 0.127 0.185 0.331
APXVTM14-ALU-I20 w/ Mount Pipe	C	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	4.090 4.480 4.880 5.710	2.860 3.230 3.610 4.400	0.077 0.127 0.185 0.331
NNVV-65B-R4 w/ Mount Pipe	A	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	7.550 8.040 8.530 9.560	4.230 4.670 5.120 6.050	0.110 0.197 0.296 0.529
NNVV-65B-R4 w/ Mount Pipe	B	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	7.550 8.040 8.530 9.560	4.230 4.670 5.120 6.050	0.110 0.197 0.296 0.529
NNVV-65B-R4 w/ Mount Pipe	C	From Leg	4.000 0.000 0.000	0.000	150.000	No Ice 1/2" Ice 1" Ice 2" Ice	7.550 8.040 8.530 9.560	4.230 4.670 5.120 6.050	0.110 0.197 0.296 0.529
TD-RRH8X20-25	A	From Leg	4.000 0.000	0.000	150.000	No Ice 1/2"	4.045 4.298	1.535 1.714	0.070 0.097

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
			0.000			Ice	4.557	1.901	0.128
						1" Ice	5.098	2.295	0.201
						2" Ice			
TD-RRH8X20-25	B	From Leg	4.000	0.000	150.000	No Ice	4.045	1.535	0.070
			0.000			1/2"	4.298	1.714	0.097
			0.000			Ice	4.557	1.901	0.128
						1" Ice	5.098	2.295	0.201
						2" Ice			
TD-RRH8X20-25	C	From Leg	4.000	0.000	150.000	No Ice	4.045	1.535	0.070
			0.000			1/2"	4.298	1.714	0.097
			0.000			Ice	4.557	1.901	0.128
						1" Ice	5.098	2.295	0.201
						2" Ice			
(2) RRH2X50-800	A	From Leg	4.000	0.000	150.000	No Ice	1.701	1.282	0.053
			0.000			1/2"	1.864	1.428	0.070
			0.000			Ice	2.035	1.580	0.090
						1" Ice	2.398	1.908	0.138
						2" Ice			
(2) RRH2X50-800	B	From Leg	4.000	0.000	150.000	No Ice	1.701	1.282	0.053
			0.000			1/2"	1.864	1.428	0.070
			0.000			Ice	2.035	1.580	0.090
						1" Ice	2.398	1.908	0.138
						2" Ice			
(2) RRH2X50-800	C	From Leg	4.000	0.000	150.000	No Ice	1.701	1.282	0.053
			0.000			1/2"	1.864	1.428	0.070
			0.000			Ice	2.035	1.580	0.090
						1" Ice	2.398	1.908	0.138
						2" Ice			
PCS 1900MHZ 4X45W-65MHZ	A	From Leg	4.000	0.000	150.000	No Ice	2.322	2.238	0.060
			0.000			1/2"	2.527	2.441	0.083
			0.000			Ice	2.739	2.651	0.110
						1" Ice	3.185	3.093	0.173
						2" Ice			
PCS 1900MHZ 4X45W-65MHZ	B	From Leg	4.000	0.000	150.000	No Ice	2.322	2.238	0.060
			0.000			1/2"	2.527	2.441	0.083
			0.000			Ice	2.739	2.651	0.110
						1" Ice	3.185	3.093	0.173
						2" Ice			
PCS 1900MHZ 4X45W-65MHZ	C	From Leg	4.000	0.000	150.000	No Ice	2.322	2.238	0.060
			0.000			1/2"	2.527	2.441	0.083
			0.000			Ice	2.739	2.651	0.110
						1" Ice	3.185	3.093	0.173
						2" Ice			
12.5' x 2.375" Horizontal Mount Pipe	A	From Leg	4.000	0.000	150.000	No Ice	2.980	0.010	0.046
			0.000			1/2"	4.250	0.050	0.068
			0.000			Ice	5.550	0.100	0.981
						1" Ice	8.060	0.240	0.183
						2" Ice			
12.5' x 2.375" Horizontal Mount Pipe	B	From Leg	4.000	0.000	150.000	No Ice	2.980	0.010	0.046
			0.000			1/2"	4.250	0.050	0.068
			0.000			Ice	5.550	0.100	0.981
						1" Ice	8.060	0.240	0.183
						2" Ice			
12.5' x 2.375" Horizontal Mount Pipe	C	From Leg	4.000	0.000	150.000	No Ice	2.980	0.010	0.046
			0.000			1/2"	4.250	0.050	0.068
			0.000			Ice	5.550	0.100	0.981
						1" Ice	8.060	0.240	0.183
						2" Ice			
6' x 2" Mount Pipe	A	From Leg	4.000	0.000	150.000	No Ice	1.425	1.425	0.022
			0.000			1/2"	1.925	1.925	0.033
			0.000			Ice	2.294	2.294	0.048
						1" Ice	3.060	3.060	0.090
						2" Ice			
6' x 2" Mount Pipe	B	From Leg	4.000	0.000	150.000	No Ice	1.425	1.425	0.022
			0.000			1/2"	1.925	1.925	0.033

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
			0.000			Ice	2.294	2.294	0.048
						1" Ice	3.060	3.060	0.090
						2" Ice			
6' x 2" Mount Pipe	C	From Leg	4.000	0.000	150.000	No Ice	1.425	1.425	0.022
			0.000			1/2"	1.925	1.925	0.033
			0.000			Ice	2.294	2.294	0.048
						1" Ice	3.060	3.060	0.090
						2" Ice			
Sector Mount [SM 502-3]	C	None		0.000	150.000	No Ice	29.820	29.820	1.673
						1/2"	42.210	42.210	2.266
						Ice	54.430	54.430	3.052
						1" Ice	78.490	78.490	5.180
						2" Ice			
*** 140 P ***									
MX08FRO665-20 w/ Mount Pipe	A	From Leg	4.000	0.000	140.000	No Ice	8.010	4.230	0.098
			0.000			1/2"	8.520	4.690	0.184
			0.000			Ice	9.040	5.160	0.281
						1" Ice	10.110	6.120	0.512
						2" Ice			
MX08FRO665-20 w/ Mount Pipe	B	From Leg	4.000	0.000	140.000	No Ice	8.010	4.230	0.098
			0.000			1/2"	8.520	4.690	0.184
			0.000			Ice	9.040	5.160	0.281
						1" Ice	10.110	6.120	0.512
						2" Ice			
MX08FRO665-20 w/ Mount Pipe	C	From Leg	4.000	0.000	140.000	No Ice	8.010	4.230	0.098
			0.000			1/2"	8.520	4.690	0.184
			0.000			Ice	9.040	5.160	0.281
						1" Ice	10.110	6.120	0.512
						2" Ice			
TA08025-B604	A	From Leg	4.000	0.000	140.000	No Ice	1.964	0.981	0.064
			0.000			1/2"	2.138	1.112	0.081
			0.000			Ice	2.320	1.250	0.100
						1" Ice	2.705	1.548	0.148
						2" Ice			
TA08025-B604	B	From Leg	4.000	0.000	140.000	No Ice	1.964	0.981	0.064
			0.000			1/2"	2.138	1.112	0.081
			0.000			Ice	2.320	1.250	0.100
						1" Ice	2.705	1.548	0.148
						2" Ice			
TA08025-B604	C	From Leg	4.000	0.000	140.000	No Ice	1.964	0.981	0.064
			0.000			1/2"	2.138	1.112	0.081
			0.000			Ice	2.320	1.250	0.100
						1" Ice	2.705	1.548	0.148
						2" Ice			
TA08025-B605	A	From Leg	4.000	0.000	140.000	No Ice	1.964	1.129	0.075
			0.000			1/2"	2.138	1.267	0.093
			0.000			Ice	2.320	1.411	0.114
						1" Ice	2.705	1.723	0.164
						2" Ice			
TA08025-B605	B	From Leg	4.000	0.000	140.000	No Ice	1.964	1.129	0.075
			0.000			1/2"	2.138	1.267	0.093
			0.000			Ice	2.320	1.411	0.114
						1" Ice	2.705	1.723	0.164
						2" Ice			
TA08025-B605	C	From Leg	4.000	0.000	140.000	No Ice	1.964	1.129	0.075
			0.000			1/2"	2.138	1.267	0.093
			0.000			Ice	2.320	1.411	0.114
						1" Ice	2.705	1.723	0.164
						2" Ice			
RDIDC-9181-PF-48	A	From Leg	4.000	0.000	140.000	No Ice	2.312	1.293	0.022
			0.000			1/2"	2.502	1.448	0.041
			0.000			Ice	2.700	1.610	0.063
						1" Ice	3.118	1.957	0.117
						2" Ice			
(2) 8' x 2" Mount Pipe	A	From Leg	4.000	0.000	140.000	No Ice	1.900	1.900	0.029

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
			0.000 0.000			1/2" Ice	2.728 3.401	2.728 3.401	0.044 0.063
						1" Ice	4.396	4.396	0.119
						2" Ice			
(2) 8' x 2" Mount Pipe	B	From Leg	4.000 0.000 0.000	0.000	140.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.900 2.728 3.401 4.396	1.900 2.728 3.401 4.396	0.029 0.044 0.063 0.119
(2) 8' x 2" Mount Pipe	C	From Leg	4.000 0.000 0.000	0.000	140.000	No Ice 1/2" Ice 1" Ice 2" Ice	1.900 2.728 3.401 4.396	1.900 2.728 3.401 4.396	0.029 0.044 0.063 0.119
Commscope MTC3975083 (3)	C	None		0.000	140.000	No Ice 1/2" Ice 1" Ice 2" Ice	23.850 34.120 44.390 64.930	23.850 34.120 44.390 64.930	1.260 1.803 2.345 3.431
****** *									
GPS_A	C	From Leg	3.000 0.000 0.000	0.000	50.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.255 0.320 0.393 0.561	0.255 0.320 0.393 0.561	0.001 0.005 0.010 0.025
Side Arm Mount [SO 305-1]	C	From Leg	1.500 0.000 0.000	0.000	50.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.530 0.780 1.060 1.730	1.520 2.070 2.660 3.910	0.030 0.044 0.064 0.125
*									
(4) L2x2x1/4 (RD)	A	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.944 1.273 1.610 2.305	0.005 0.021 0.044 0.113	0.016 0.022 0.032 0.065
(4) L2x2x1/4 (RD)	B	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.944 1.273 1.610 2.305	0.005 0.021 0.044 0.113	0.016 0.022 0.032 0.065
(4) L2x2x1/4 (RD)	C	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.944 1.273 1.610 2.305	0.005 0.021 0.044 0.113	0.016 0.022 0.032 0.065
(4) L2x2x1/4 (RH)	A	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.825 1.115 1.412 2.029	0.005 0.021 0.044 0.113	0.014 0.019 0.028 0.057
(4) L2x2x1/4 (RH)	B	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.825 1.115 1.412 2.029	0.005 0.021 0.044 0.113	0.014 0.019 0.028 0.057
(4) L2x2x1/4 (RH)	C	From Leg	0.500 0.000 0.000	0.000	126.667 - 120.000	No Ice 1/2" Ice 1" Ice 2" Ice	0.825 1.115 1.412 2.029	0.005 0.021 0.044 0.113	0.014 0.019 0.028 0.057
****** ***									

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
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 Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
T1	180 - 160	Leg	Max Tension	7	17.692	0.127	0.017
			Max. Compression	10	-26.206	-0.103	0.025
			Max. Mx	22	-1.389	1.081	-0.039

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. My	20	-1.718	0.006	1.119
			Max. Vy	6	1.199	-0.495	0.006
			Max. Vx	8	-1.235	-0.012	0.519
		Diagonal	Max Tension	25	5.105	0.000	0.000
			Max. Compression	24	-5.294	0.000	0.000
			Max. Mx	31	0.839	0.043	0.000
			Max. My	24	-2.522	-0.001	-0.005
			Max. Vy	31	-0.031	0.043	0.000
			Max. Vx	24	0.001	0.000	0.000
		Top Girt	Max Tension	14	0.167	0.000	0.000
			Max. Compression	11	-0.100	0.000	0.000
			Max. Mx	26	0.100	-0.053	0.000
			Max. My	26	0.092	0.000	0.000
			Max. Vy	26	0.033	0.000	0.000
			Max. Vx	26	-0.000	0.000	0.000
T2	160 - 155	Leg	Max Tension	15	26.217	0.126	0.011
			Max. Compression	10	-35.350	0.089	0.034
			Max. Mx	22	24.525	0.131	-0.026
			Max. My	8	-4.503	-0.014	0.198
			Max. Vy	14	0.077	-0.109	0.013
			Max. Vx	8	-0.141	-0.014	0.198
		Diagonal	Max Tension	25	4.451	0.000	0.000
			Max. Compression	24	-4.592	0.000	0.000
			Max. Mx	31	0.568	0.021	0.003
			Max. My	37	-1.164	0.017	-0.003
			Max. Vy	29	0.021	0.018	0.002
			Max. Vx	37	0.001	0.000	0.000
T3	155 - 150	Leg	Max Tension	15	33.727	-0.106	0.012
			Max. Compression	10	-43.741	0.126	0.037
			Max. Mx	10	-43.741	0.126	0.037
			Max. My	8	-4.787	-0.014	0.198
			Max. Vy	18	-0.038	0.126	-0.025
			Max. Vx	8	0.110	-0.014	0.198
		Diagonal	Max Tension	24	4.585	0.000	0.000
			Max. Compression	25	-4.502	0.000	0.000
			Max. Mx	31	0.806	0.025	0.003
			Max. My	31	0.740	0.021	0.003
			Max. Vy	29	0.023	0.021	0.003
			Max. Vx	31	-0.001	0.000	0.000
T4	150 - 145	Leg	Max Tension	15	41.112	-0.107	0.019
			Max. Compression	10	-53.793	-0.038	0.027
			Max. Mx	10	-53.684	0.126	0.037
			Max. My	8	-6.308	-0.024	0.237
			Max. Vy	18	0.063	0.126	-0.025
			Max. Vx	8	-0.110	-0.024	0.237
		Diagonal	Max Tension	25	5.445	0.000	0.000
			Max. Compression	24	-5.640	0.000	0.000
			Max. Mx	27	0.894	0.037	0.003
			Max. My	24	-5.594	-0.006	-0.005
			Max. Vy	27	-0.031	0.037	0.003
			Max. Vx	31	-0.002	0.000	0.000
T5	145 - 140	Leg	Max Tension	7	49.954	-0.088	0.024
			Max. Compression	10	-63.708	0.070	0.042
			Max. Mx	10	-63.653	0.304	-0.007
			Max. My	8	-6.687	-0.024	0.237
			Max. Vy	10	-0.154	0.304	-0.007
			Max. Vx	8	0.162	-0.024	0.237
		Diagonal	Max Tension	24	5.570	0.000	0.000
			Max. Compression	24	-5.539	0.000	0.000
			Max. Mx	27	1.104	-0.048	0.008
			Max. My	10	3.848	-0.040	-0.010
			Max. Vy	27	0.040	-0.048	0.008
			Max. Vx	31	0.003	0.000	0.000
		Secondary Horizontal	Max Tension	6	0.219	0.011	-0.003
			Max. Compression	11	-0.178	0.004	0.004
			Max. Mx	36	0.101	0.026	0.001
			Max. My	6	-0.096	0.010	0.007
			Max. Vy	36	0.031	0.026	0.001

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. Vx	6	-0.002	0.000	0.000
T6	140 - 133.333	Leg	Max Tension	7	59.490	0.015	0.031
			Max. Compression	10	-75.455	-0.074	0.051
			Max. Mx	27	-38.177	-0.114	-0.002
			Max. My	8	-8.014	-0.040	0.384
			Max. Vy	18	0.069	0.075	-0.025
			Max. Vx	8	-0.140	-0.040	0.384
		Diagonal	Max Tension	25	6.740	0.000	0.000
			Max. Compression	24	-6.930	0.000	0.000
			Max. Mx	27	0.913	-0.066	0.006
			Max. My	24	-6.909	0.012	0.017
			Max. Vy	29	-0.049	-0.056	-0.006
			Max. Vx	24	-0.004	0.000	0.000
T7	133.333 - 126.667	Leg	Max Tension	7	71.706	-0.664	0.002
			Max. Compression	10	-89.011	-1.085	-0.002
			Max. Mx	10	-89.011	-1.085	-0.002
			Max. My	8	-8.660	-0.143	0.404
			Max. Vy	10	0.584	0.858	0.004
			Max. Vx	8	0.219	-0.040	0.384
		Diagonal	Max Tension	25	7.007	-0.043	0.006
			Max. Compression	24	-7.063	0.000	0.000
			Max. Mx	27	1.582	-0.076	-0.011
			Max. My	10	4.611	-0.062	-0.016
			Max. Vy	27	0.052	-0.076	-0.011
			Max. Vx	31	0.004	0.000	0.000
		Secondary Horizontal	Max Tension	8	0.627	0.012	-0.008
			Max. Compression	9	-0.516	0.009	0.008
			Max. Mx	31	0.160	0.036	0.001
			Max. My	11	0.541	0.007	-0.009
			Max. Vy	31	-0.035	0.036	0.001
			Max. Vx	10	-0.002	0.010	-0.009
T8	126.667 - 120	Leg	Max Tension	7	82.277	0.419	0.001
			Max. Compression	10	-100.685	1.142	-0.054
			Max. Mx	10	-100.230	1.555	0.041
			Max. My	8	-9.202	-0.181	0.762
			Max. Vy	10	-1.601	1.555	0.041
			Max. Vx	8	-0.637	-0.181	0.762
		Diagonal	Max Tension	25	7.044	-0.039	-0.001
			Max. Compression	10	-7.697	0.000	0.000
			Max. Mx	10	4.728	-0.096	0.001
			Max. My	27	-0.336	-0.009	0.004
			Max. Vy	10	-0.040	-0.096	0.001
			Max. Vx	27	0.002	0.000	0.000
		Horizontal	Max Tension	8	0.436	0.019	0.010
			Max. Compression	9	-0.373	0.012	0.007
			Max. Mx	29	0.171	0.048	0.026
			Max. My	29	0.171	0.048	0.026
			Max. Vy	29	0.046	0.048	0.026
			Max. Vx	29	0.006	0.000	0.000
		Redund Horz 1 Bracing	Max Tension	10	1.733	0.000	0.000
			Max. Compression	23	-1.411	0.000	0.000
			Max. Mx	26	0.468	-0.010	0.000
			Max. My	26	0.339	0.000	0.000
			Max. Vy	26	-0.015	0.000	0.000
			Max. Vx	26	-0.000	0.000	0.000
		Redund Diag 1 Bracing	Max Tension	23	0.894	0.000	0.000
			Max. Compression	10	-1.158	0.000	0.000
			Max. Mx	26	-0.338	-0.012	0.000
			Max. My	26	-0.295	0.000	0.000
			Max. Vy	26	0.016	0.000	0.000
			Max. Vx	26	-0.001	0.000	0.000
T9	120 - 113.333	Leg	Max Tension	7	93.893	-0.991	-0.002

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
			Max. Compression	10	-114.070	-0.822	0.020
			Max. Mx	10	-114.035	1.276	-0.004
			Max. My	8	-9.820	-0.181	0.762
			Max. Vy	10	-0.758	1.276	-0.004
			Max. Vx	8	0.372	-0.181	0.762
		Diagonal	Max Tension	25	7.210	-0.071	0.015
			Max. Compression	24	-7.370	0.000	0.000
			Max. Mx	27	1.554	-0.113	-0.014
			Max. My	10	-6.863	0.029	-0.027
			Max. Vy	27	0.071	-0.113	-0.014
			Max. Vx	31	-0.005	0.000	0.000
		Secondary Horizontal	Max Tension	8	0.991	0.015	-0.011
			Max. Compression	9	-0.811	0.018	0.012
			Max. Mx	32	0.197	0.053	0.003
			Max. My	6	-0.594	0.023	0.012
			Max. Vy	32	-0.048	0.053	0.003
			Max. Vx	6	-0.003	0.000	0.000
T10	113.333 - 106.667	Leg	Max Tension	7	104.374	-0.900	-0.001
			Max. Compression	10	-125.783	-0.534	0.038
			Max. Mx	10	-125.734	1.146	-0.002
			Max. My	8	-10.344	-0.140	0.721
			Max. Vy	10	-0.629	1.146	-0.002
			Max. Vx	8	0.315	-0.140	0.721
		Diagonal	Max Tension	25	7.248	-0.076	0.003
			Max. Compression	24	-7.624	0.000	0.000
			Max. Mx	27	1.234	-0.125	-0.017
			Max. My	10	4.093	-0.107	-0.025
			Max. Vy	27	0.076	-0.125	-0.017
			Max. Vx	31	0.005	0.000	0.000
		Secondary Horizontal	Max Tension	8	0.774	0.024	-0.010
			Max. Compression	9	-0.625	0.015	0.012
			Max. Mx	30	0.304	0.062	0.001
			Max. My	8	-0.605	0.020	0.012
			Max. Vy	30	-0.051	0.062	0.001
			Max. Vx	8	-0.002	0.000	0.000
T11	106.667 - 100	Leg	Max Tension	7	115.076	0.319	0.023
			Max. Compression	10	-138.334	4.126	0.063
			Max. Mx	10	-138.334	4.126	0.063
			Max. My	8	-11.121	-0.119	0.364
			Max. Vy	10	-0.740	4.126	0.063
			Max. Vx	8	0.131	-0.119	0.364
		Diagonal	Max Tension	24	7.111	0.000	0.000
			Max. Compression	24	-7.043	0.000	0.000
			Max. Mx	27	1.746	-0.120	-0.014
			Max. My	30	1.140	-0.115	-0.018
			Max. Vy	29	-0.079	-0.116	0.014
			Max. Vx	30	0.005	0.000	0.000
T12	100 - 80	Leg	Max Tension	7	144.095	-3.007	0.026
			Max. Compression	10	-172.302	3.034	0.078
			Max. Mx	10	-149.250	4.126	0.063
			Max. My	8	-13.664	-0.032	0.438
			Max. Vy	18	0.343	4.057	-0.036
			Max. Vx	8	-0.146	-0.032	0.438
		Diagonal	Max Tension	24	7.901	0.000	0.000
			Max. Compression	24	-7.813	0.000	0.000
			Max. Mx	27	1.579	-0.176	0.021
			Max. My	37	-1.964	-0.152	0.028
			Max. Vy	29	-0.106	-0.173	-0.022
			Max. Vx	37	-0.006	0.000	0.000
T13	80 - 60	Leg	Max Tension	7	170.020	-3.339	0.067
			Max. Compression	10	-202.914	1.432	0.103
			Max. Mx	11	-182.151	3.381	0.112
			Max. My	8	-15.844	-0.250	0.748
			Max. Vy	18	0.271	3.323	-0.067
			Max. Vx	8	-0.176	-0.054	0.611

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial K	Major Axis Moment kip-ft	Minor Axis Moment kip-ft
		Diagonal	Max Tension	24	9.375	0.000	0.000
			Max. Compression	24	-9.370	0.000	0.000
			Max. Mx	29	1.724	-0.232	0.028
			Max. My	30	1.451	-0.231	-0.033
			Max. Vy	29	-0.116	-0.232	0.028
			Max. Vx	30	0.007	0.000	0.000
T14	60 - 40	Leg	Max Tension	7	195.407	2.581	0.027
			Max. Compression	10	-233.537	1.569	0.083
			Max. Mx	10	-233.503	9.992	-0.009
			Max. My	8	-17.825	-0.740	0.945
			Max. Vy	10	-2.899	9.992	-0.009
			Max. Vx	8	0.313	-0.740	0.945
		Diagonal	Max Tension	13	10.102	-0.153	0.003
			Max. Compression	10	-10.986	0.000	0.000
			Max. Mx	29	1.101	-0.310	-0.045
			Max. My	31	-3.433	-0.279	-0.050
			Max. Vy	29	-0.145	-0.310	-0.045
			Max. Vx	31	-0.009	0.000	0.000
		Secondary Horizontal	Max Tension	10	2.674	0.060	-0.001
			Max. Compression	7	-2.082	0.046	0.011
			Max. Mx	32	0.464	0.157	0.012
			Max. My	30	0.263	0.157	0.014
			Max. Vy	32	-0.087	0.157	0.012
			Max. Vx	30	-0.004	0.000	0.000
T15	40 - 30	Leg	Max Tension	7	209.149	-2.244	0.049
			Max. Compression	10	-250.927	1.171	0.066
			Max. Mx	37	12.264	-2.591	-0.045
			Max. My	8	-19.922	-0.183	1.034
			Max. Vy	33	-0.388	-2.570	0.023
			Max. Vx	8	-0.166	-0.183	1.034
		Diagonal	Max Tension	12	10.074	0.000	0.000
			Max. Compression	12	-10.168	0.000	0.000
			Max. Mx	29	0.622	-0.402	-0.049
			Max. My	37	-3.203	-0.364	0.053
			Max. Vy	29	-0.174	-0.402	-0.049
			Max. Vx	37	-0.009	0.000	0.000
T16	30 - 20	Leg	Max Tension	7	220.628	-1.425	0.041
			Max. Compression	10	-265.219	-0.607	-0.036
			Max. Mx	10	-265.135	10.887	-0.003
			Max. My	8	-20.754	-0.183	1.034
			Max. Vy	27	2.474	-7.096	0.015
			Max. Vx	8	0.283	-0.183	1.034
		Diagonal	Max Tension	13	10.939	-0.229	0.015
			Max. Compression	10	-11.889	0.000	0.000
			Max. Mx	27	2.387	-0.403	-0.058
			Max. My	30	2.118	-0.396	-0.064
			Max. Vy	29	-0.177	-0.402	0.055
			Max. Vx	30	0.010	0.000	0.000
		Secondary Horizontal	Max Tension	10	2.529	0.092	-0.001
			Max. Compression	7	-1.997	0.070	0.014
			Max. Mx	30	1.363	0.208	0.014
			Max. My	30	0.747	0.205	0.017
			Max. Vy	30	-0.105	0.208	0.014
			Max. Vx	30	-0.004	0.000	0.000
T17	20 - 0	Leg	Max Tension	7	246.501	-3.959	0.068
			Max. Compression	10	-297.529	0.000	-0.000
			Max. Mx	27	-120.483	9.548	0.000
			Max. My	8	-23.498	-0.214	1.477
			Max. Vy	27	-1.682	-7.096	0.015
			Max. Vx	8	-0.287	-0.214	1.477
		Diagonal	Max Tension	13	10.925	0.000	0.000
			Max. Compression	12	-11.317	0.000	0.000
			Max. Mx	29	-1.066	0.329	0.035
			Max. My	30	5.045	0.241	0.043
			Max. Vy	29	0.124	0.329	0.035
			Max. Vx	30	-0.007	0.000	0.000

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Leg C	Max. Vert	18	302.108	27.747	-16.941
	Max. H_x	18	302.108	27.747	-16.941
	Max. H_z	7	-252.611	-23.442	14.453
	Min. Vert	7	-252.611	-23.442	14.453
	Min. H_x	7	-252.611	-23.442	14.453
	Min. H_z	18	302.108	27.747	-16.941
Leg B	Max. Vert	10	305.116	-27.297	-17.433
	Max. H_x	23	-248.879	22.928	14.835
	Max. H_z	23	-248.879	22.928	14.835
	Min. Vert	23	-248.879	22.928	14.835
	Min. H_x	10	305.116	-27.297	-17.433
	Min. H_z	10	305.116	-27.297	-17.433
Leg A	Max. Vert	2	301.326	0.792	31.824
	Max. H_x	20	25.442	5.634	1.948
	Max. H_z	2	301.326	0.792	31.824
	Min. Vert	15	-244.909	-0.729	-26.739
	Min. H_x	9	18.323	-5.571	1.400
	Min. H_z	15	-244.909	-0.729	-26.739

Tower Mast Reaction Summary

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
Dead Only	59.140	0.000	-0.000	-22.315	-36.697	0.000
1.2 Dead+1.0 Wind 0 deg - No Ice	70.969	-0.055	-50.989	-5498.226	-35.455	29.851
0.9 Dead+1.0 Wind 0 deg - No Ice	53.226	-0.055	-50.989	-5491.531	-24.446	29.851
1.2 Dead+1.0 Wind 30 deg - No Ice	70.969	24.124	-41.903	-4559.927	-2650.953	15.485
0.9 Dead+1.0 Wind 30 deg - No Ice	53.226	24.124	-41.903	-4553.232	-2639.945	15.485
1.2 Dead+1.0 Wind 60 deg - No Ice	70.969	42.651	-24.630	-2684.425	-4646.543	-31.525
0.9 Dead+1.0 Wind 60 deg - No Ice	53.226	42.651	-24.630	-2677.731	-4635.534	-31.525
1.2 Dead+1.0 Wind 90 deg - No Ice	70.969	49.517	0.055	-18.197	-5383.932	-65.543
0.9 Dead+1.0 Wind 90 deg - No Ice	53.226	49.517	0.055	-11.502	-5372.924	-65.543
1.2 Dead+1.0 Wind 120 deg - No Ice	70.969	44.945	26.018	2755.211	-4844.746	-55.813
0.9 Dead+1.0 Wind 120 deg - No Ice	53.226	44.945	26.018	2761.905	-4833.737	-55.813
1.2 Dead+1.0 Wind 150 deg - No Ice	70.969	24.891	43.120	4644.530	-2740.628	-45.089
0.9 Dead+1.0 Wind 150 deg - No Ice	53.226	24.891	43.120	4651.224	-2729.619	-45.089
1.2 Dead+1.0 Wind 180 deg - No Ice	70.969	0.055	47.919	5194.140	-52.617	-29.851
0.9 Dead+1.0 Wind 180 deg - No Ice	53.226	0.055	47.919	5200.834	-41.608	-29.851
1.2 Dead+1.0 Wind 210 deg - No Ice	70.969	-24.124	41.903	4506.371	2562.882	-15.485
0.9 Dead+1.0 Wind 210 deg - No Ice	53.226	-24.124	41.903	4513.066	2573.891	-15.485
1.2 Dead+1.0 Wind 240 deg - No Ice	70.969	-45.310	26.165	2756.135	4775.437	31.525
0.9 Dead+1.0 Wind 240 deg	53.226	-45.310	26.165	2762.830	4786.446	31.525

Load Combination	Vertical K	$Shear_x$ K	$Shear_z$ K	Overturning Moment, M_x kip-ft	Overturning Moment, M_z kip-ft	Torque kip-ft
- No Ice 1.2 Dead+1.0 Wind 270 deg - No Ice	70.969	-49.517	-0.055	-35.359	5295.861	65.543
0.9 Dead+1.0 Wind 270 deg - No Ice	53.226	-49.517	-0.055	-28.664	5306.870	65.543
1.2 Dead+1.0 Wind 300 deg - No Ice	70.969	-42.287	-24.483	-2683.501	4539.709	55.813
0.9 Dead+1.0 Wind 300 deg - No Ice	53.226	-42.287	-24.483	-2676.807	4550.718	55.813
1.2 Dead+1.0 Wind 330 deg - No Ice	70.969	-24.891	-43.120	-4698.085	2652.556	45.089
0.9 Dead+1.0 Wind 330 deg - No Ice	53.226	-24.891	-43.120	-4691.391	2663.565	45.089
1.2 Dead+1.0 Ice+1.0 Temp	164.818	0.000	-0.000	-124.201	-92.873	-0.000
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	164.818	-0.010	-12.643	-1498.052	-91.421	8.687
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	164.818	6.060	-10.517	-1274.400	-755.222	1.815
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	164.818	10.518	-6.073	-788.488	-1243.380	-10.090
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	164.818	12.560	0.010	-122.749	-1461.441	-19.165
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	164.818	11.309	6.542	584.659	-1317.678	-18.559
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	164.818	6.331	10.968	1073.432	-784.285	-13.106
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	164.818	0.010	12.249	1218.629	-94.326	-8.687
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	164.818	-6.060	10.517	1025.998	569.476	-1.815
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	164.818	-10.858	6.270	555.596	1084.498	10.090
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	164.818	-12.560	-0.010	-125.654	1275.694	19.165
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	164.818	-10.968	-6.345	-817.551	1105.067	18.559
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	164.818	-6.331	-10.968	-1321.834	598.539	13.106
Dead+Wind 0 deg - Service	59.140	-0.012	-11.550	-1256.590	-34.772	6.736
Dead+Wind 30 deg - Service	59.140	5.468	-9.497	-1045.203	-624.952	3.521
Dead+Wind 60 deg - Service	59.140	9.664	-5.581	-621.946	-1075.137	-7.026
Dead+Wind 90 deg - Service	59.140	11.220	0.012	-20.391	-1241.475	-14.672
Dead+Wind 120 deg - Service	59.140	10.179	5.892	605.197	-1119.579	-12.515
Dead+Wind 150 deg - Service	59.140	5.639	9.770	1031.552	-645.060	-10.135
Dead+Wind 180 deg - Service	59.140	0.012	10.861	1155.785	-38.621	-6.736
Dead+Wind 210 deg - Service	59.140	-5.468	9.497	1000.573	551.559	-3.521
Dead+Wind 240 deg - Service	59.140	-10.261	5.925	605.404	1050.394	7.026
Dead+Wind 270 deg - Service	59.140	-11.220	-0.012	-24.239	1168.081	14.672
Dead+Wind 300 deg - Service	59.140	-9.583	-5.548	-621.738	997.536	12.515
Dead+Wind 330 deg - Service	59.140	-5.639	-9.770	-1076.182	571.667	10.135

Solution Summary

	Sum of Applied Forces			Sum of Reactions			
Load Comb.	PX K	PY K	PZ K	PX K	PY K	PZ K	% Error
1	0.000	-59.140	0.000	-0.000	59.140	0.000	0.000%
2	-0.055	-70.969	-50.989	0.055	70.969	50.989	0.000%

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
3	-0.055	-53.226	-50.989	0.055	53.226	50.989	0.000%
4	24.124	-70.969	-41.903	-24.124	70.969	41.903	0.000%
5	24.124	-53.226	-41.903	-24.124	53.226	41.903	0.000%
6	42.651	-70.969	-24.630	-42.651	70.969	24.630	0.000%
7	42.651	-53.226	-24.630	-42.651	53.226	24.630	0.000%
8	49.517	-70.969	0.055	-49.517	70.969	-0.055	0.000%
9	49.517	-53.226	0.055	-49.517	53.226	-0.055	0.000%
10	44.945	-70.969	26.018	-44.945	70.969	-26.018	0.000%
11	44.945	-53.226	26.018	-44.945	53.226	-26.018	0.000%
12	24.891	-70.969	43.120	-24.891	70.969	-43.120	0.000%
13	24.891	-53.226	43.120	-24.891	53.226	-43.120	0.000%
14	0.055	-70.969	47.919	-0.055	70.969	-47.919	0.000%
15	0.055	-53.226	47.919	-0.055	53.226	-47.919	0.000%
16	-24.124	-70.969	41.903	24.124	70.969	-41.903	0.000%
17	-24.124	-53.226	41.903	24.124	53.226	-41.903	0.000%
18	-45.310	-70.969	26.165	45.310	70.969	-26.165	0.000%
19	-45.310	-53.226	26.165	45.310	53.226	-26.165	0.000%
20	-49.517	-70.969	-0.055	49.517	70.969	0.055	0.000%
21	-49.517	-53.226	-0.055	49.517	53.226	0.055	0.000%
22	-42.287	-70.969	-24.483	42.287	70.969	24.483	0.000%
23	-42.287	-53.226	-24.483	42.287	53.226	24.483	0.000%
24	-24.891	-70.969	-43.120	24.891	70.969	43.120	0.000%
25	-24.891	-53.226	-43.120	24.891	53.226	43.120	0.000%
26	0.000	-164.818	0.000	-0.000	164.818	0.000	0.000%
27	-0.010	-164.818	-12.643	0.010	164.818	12.643	0.000%
28	6.060	-164.818	-10.517	-6.060	164.818	10.517	0.000%
29	10.518	-164.818	-6.073	-10.518	164.818	6.073	0.000%
30	12.560	-164.818	0.010	-12.560	164.818	-0.010	0.000%
31	11.309	-164.818	6.542	-11.309	164.818	-6.542	0.000%
32	6.331	-164.818	10.968	-6.331	164.818	-10.968	0.000%
33	0.010	-164.818	12.249	-0.010	164.818	-12.249	0.000%
34	-6.060	-164.818	10.517	6.060	164.818	-10.517	0.000%
35	-10.858	-164.818	6.270	10.858	164.818	-6.270	0.000%
36	-12.560	-164.818	-0.010	12.560	164.818	0.010	0.000%
37	-10.968	-164.818	-6.345	10.968	164.818	6.345	0.000%
38	-6.331	-164.818	-10.968	6.331	164.818	10.968	0.000%
39	-0.012	-59.140	-11.550	0.012	59.140	11.550	0.000%
40	5.468	-59.140	-9.497	-5.468	59.140	9.497	0.000%
41	9.664	-59.140	-5.581	-9.664	59.140	5.581	0.000%
42	11.220	-59.140	0.012	-11.220	59.140	-0.012	0.000%
43	10.179	-59.140	5.892	-10.179	59.140	-5.892	0.000%
44	5.639	-59.140	9.770	-5.639	59.140	-9.770	0.000%
45	0.012	-59.140	10.861	-0.012	59.140	-10.861	0.000%
46	-5.468	-59.140	9.497	5.468	59.140	-9.497	0.000%
47	-10.261	-59.140	5.925	10.261	59.140	-5.925	0.000%
48	-11.220	-59.140	-0.012	11.220	59.140	0.012	0.000%
49	-9.583	-59.140	-5.548	9.583	59.140	5.548	0.000%
50	-5.639	-59.140	-9.770	5.639	59.140	9.770	0.000%

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	180 - 160	3.962	43	0.237	0.027
T2	160 - 155	2.991	43	0.212	0.026
T3	155 - 150	2.767	43	0.204	0.024
T4	150 - 145	2.552	43	0.195	0.023
T5	145 - 140	2.348	43	0.184	0.022
T6	140 - 133.333	2.157	43	0.173	0.021
T7	133.333 - 126.667	1.919	43	0.160	0.020
T8	126.667 - 120	1.701	43	0.145	0.018
T9	120 - 113.333	1.503	43	0.130	0.017
T10	113.333 -	1.326	43	0.117	0.016

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
	106.667				
T11	106.667 - 100	1.168	43	0.103	0.015
T12	100 - 80	1.025	43	0.095	0.014
T13	80 - 60	0.657	43	0.073	0.010
T14	60 - 40	0.375	43	0.054	0.008
T15	40 - 30	0.175	43	0.035	0.005
T16	30 - 20	0.106	43	0.025	0.004
T17	20 - 0	0.057	43	0.016	0.003

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
182.000	19" Accelerator	43	3.962	0.237	0.027	116507
180.000	Lightning Rod 5/8" x 6'	43	3.962	0.237	0.027	116507
178.000	(2) LPA-80080/6CF	43	3.862	0.235	0.027	116507
165.000	7770.00 w/ Mount Pipe	43	3.225	0.219	0.026	38836
150.000	APXVTM14-ALU-I20 w/ Mount Pipe	43	2.552	0.195	0.023	29518
140.000	MX08FRO665-20 w/ Mount Pipe	43	2.157	0.173	0.021	28752
126.667	(4) L2x2x1/4 (RD)	43	1.701	0.145	0.018	26463
123.333	(4) L2x2x1/4 (RD)	43	1.599	0.137	0.018	26336
120.000	(4) L2x2x1/4 (RD)	43	1.503	0.130	0.017	25997
50.000	GPS_A	43	0.265	0.045	0.006	58721

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	180 - 160	17.288	10	1.019	0.120
T2	160 - 155	13.090	10	0.920	0.116
T3	155 - 150	12.114	10	0.887	0.110
T4	150 - 145	11.178	10	0.849	0.103
T5	145 - 140	10.285	10	0.804	0.098
T6	140 - 133.333	9.452	10	0.753	0.094
T7	133.333 - 126.667	8.411	10	0.697	0.088
T8	126.667 - 120	7.457	10	0.635	0.082
T9	120 - 113.333	6.591	10	0.569	0.076
T10	113.333 - 106.667	5.814	10	0.511	0.071
T11	106.667 - 100	5.123	10	0.450	0.066
T12	100 - 80	4.497	10	0.416	0.061
T13	80 - 60	2.885	10	0.320	0.047
T14	60 - 40	1.645	10	0.238	0.034
T15	40 - 30	0.771	10	0.152	0.024
T16	30 - 20	0.467	10	0.111	0.019
T17	20 - 0	0.253	19	0.070	0.015

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
182.000	19" Accelerator	10	17.288	1.019	0.120	29911

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
180.000	Lightning Rod 5/8" x 6'	10	17.288	1.019	0.120	29911
178.000	(2) LPA-80080/6CF	10	16.858	1.010	0.120	29911
165.000	7770.00 w/ Mount Pipe	10	14.104	0.948	0.119	9970
150.000	APXVTM14-ALU-I20 w/ Mount Pipe	10	11.178	0.849	0.103	6905
140.000	MX08FRO665-20 w/ Mount Pipe	10	9.452	0.753	0.094	6683
126.667	(4) L2x2x1/4 (RD)	10	7.457	0.635	0.082	6095
123.333	(4) L2x2x1/4 (RD)	10	7.013	0.601	0.079	6050
120.000	(4) L2x2x1/4 (RD)	10	6.591	0.569	0.076	5956
50.000	GPS_A	10	1.163	0.195	0.028	13391

Bolt Design Data

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt K	Allowable Load per Bolt K	Ratio Load / Allowable	Allowable Ratio	Criteria
T1	180	Leg	A325N	0.625	4	4.423	20.340	0.217	1.05	Bolt Tension
		Diagonal	A325X	0.500	1	5.105	7.504	0.680	1.05	Gusset Bearing
		Top Girt	A325N	0.500	1	0.167	4.133	0.040	1.05	Member Bearing
T2	160	Diagonal	A325N	0.500	1	4.451	6.199	0.718	1.05	Member Bearing
T3	155	Diagonal	A325N	0.500	1	4.585	6.199	0.740	1.05	Member Bearing
T4	150	Diagonal	A325X	0.500	1	5.445	7.504	0.726	1.05	Gusset Bearing
T5	145	Leg	A325N	0.750	4	12.489	30.101	0.415	1.05	Bolt Tension
		Diagonal	A325N	0.500	1	5.570	7.504	0.742	1.05	Gusset Bearing
T6	140	Diagonal	A325N	0.500	2	3.370	11.011	0.306	1.05	Member Block Shear
T7	133.333	Diagonal	A325N	0.500	2	3.504	11.011	0.318	1.05	Member Block Shear
T8	126.667	Leg	A325N	0.875	4	20.538	41.556	0.494	1.05	Bolt Tension
		Diagonal	A325N	0.500	2	3.522	11.011	0.320	1.05	Member Block Shear
		Redund Horz 1 Bracing	A325N	0.625	1	1.746	9.108	0.192	1.05	Member Block Shear
		Redund Diag 1 Bracing	A325N	0.625	1	1.064	9.108	0.117	1.05	Member Block Shear
T9	120	Diagonal	A325N	0.500	2	3.605	13.050	0.276	1.05	Member Block Shear
T10	113.333	Diagonal	A325N	0.500	2	3.624	13.050	0.278	1.05	Member Block Shear
T11	106.667	Leg	A325N	0.875	4	28.769	41.556	0.692	1.05	Bolt Tension
		Diagonal	A325N	0.500	2	3.555	13.050	0.272	1.05	Member Block Shear
T12	100	Leg	A325N	1.000	4	36.024	54.517	0.661	1.05	Bolt Tension
		Diagonal	A325N	0.500	2	3.950	14.070	0.281	1.05	Member Block Shear
T13	80	Leg	A325N	1.000	4	42.505	54.517	0.780	1.05	Bolt Tension
		Diagonal	A325N	0.625	1	9.375	13.920	0.673	1.05	Gusset Bearing
T14	60	Leg	A325N	1.000	6	32.514	54.517	0.596	1.05	Bolt Tension
		Diagonal	A325N	0.625	1	10.102	13.920	0.726	1.05	Gusset Bearing
T15	40	Diagonal	A325N	0.625	1	10.074	13.920	0.724	1.05	Gusset Bearing
T16	30	Leg	A325N	1.000	6	36.721	54.517	0.674	1.05	Bolt Tension
		Diagonal	A325N	0.625	1	10.939	13.920	0.786	1.05	Gusset Bearing
T17	20	Diagonal	A325N	0.625	2	5.462	13.025	0.419	1.05	Member Block Shear

Compression Checks

Leg Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	ROHN 2 STD	20.000	4.000	61.0 K=1.00	1.075	-26.206	36.842	0.711 [1]
T2	160 - 155	ROHN 2.5 EH	5.009	5.009	65.0 K=1.00	2.254	-35.350	74.429	0.475 [1]
T3	155 - 150	ROHN 2.5 EH	5.009	5.009	65.0 K=1.00	2.254	-43.741	74.427	0.588 [1]
T4	150 - 145	ROHN 2.5 EH	5.009	5.009	65.0 K=1.00	2.254	-53.793	74.427	0.723 [1]
T5	145 - 140	ROHN 2.5 EH	5.009	2.581	33.5 K=1.00	2.254	-63.708	93.410	0.682 [1]
T6	140 - 133.333	ROHN 3 EH	6.678	6.678	70.5 K=1.00	3.016	-75.455	94.342	0.800 [1]
T7	133.333 - 126.667	ROHN 3 EH	6.678	3.457	36.5 K=1.00	3.016	-89.011	123.118	0.723 [1]
T8	126.667 - 120	ROHN 3 EH	6.678	1.670	8.8 K=0.50	3.016	-100.685	134.948	0.746 [1]
T9	120 - 113.333	ROHN 3.5 EH	6.678	3.443	31.6 K=1.00	3.678	-114.070	153.863	0.741 [1]
T10	113.333 - 106.667	ROHN 3.5 EH	6.678	3.437	31.6 K=1.00	3.678	-125.783	153.899	0.817 [1]
T11	106.667 - 100	BT100140- Rohn 3.5EH w/ 2" SR	6.678	6.678	61.4 K=0.78	6.820	-138.334	232.935	0.594 [1]
T12	100 - 80	BT100140- Rohn 4EH w/ 2" SR	20.037	6.679	54.6 K=0.80	7.549	-172.302	273.092	0.631 [1]
T13	80 - 60	BT100140- Rohn 5EH w/ 2" SR (60-80)	20.033	10.017	65.5 K=0.83	9.253	-202.914	304.198	0.667 [1]
T14	60 - 40	BT100140- Rohn 5EH w/ 2" SR (40-60)	20.036	5.151	34.5 K=0.85	9.253	-233.537	381.660	0.612 [1]
T15	40 - 30	BT100140- Rohn 6EHS w/ 2" SR (30-40)	10.017	10.017	55.0 K=0.85	9.855	-250.927	355.524	0.706 [1]
T16	30 - 20	BT100140- Rohn 6EHS w/ 2" SR (20-30)	10.017	5.132	28.2 K=0.85	9.855	-265.219	418.472	0.634 [1]
T17	20 - 0	BT100140- Rohn 6EH w/ 2" SR	20.033	10.017	55.0 K=0.87	11.547	-297.529	416.534	0.714 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L2x2x1/4	7.682	3.623	113.4 K=1.02	0.938	-5.294	20.877	0.254 [1]
T2	160 - 155	L1 3/4x1 3/4x3/16	8.454	4.131	144.3 K=1.00	0.621	-4.592	8.534	0.538 [1]
T3	155 - 150	L1 3/4x1 3/4x3/16	8.869	4.341	151.7 K=1.00	0.621	-4.502	7.728	0.582 [1]
T4	150 - 145	L2x2x1/4	9.296	4.553	139.7 K=1.00	0.938	-5.640	13.748	0.410 [1]
T5	145 - 140	2L1 3/4x1 3/4x3/16x3/16	9.732	4.876	185.2 K=1.00	1.242	-5.539	10.250	0.540 [1]
T6	140 - 133.333	2L 'a' > 28.068 in - 70 2L2x2x3/16x1/2	11.156	5.441	105.8 K=1.00	1.430	-6.930	32.698	0.212 [1]
T7	133.333 - 126.667	2L 'a' > 31.235 in - 82 2L2x2x3/16x1/2 2L 'a' > 33.766 in - 91	11.706	5.881	114.3 K=1.00	1.430	-7.063	29.769	0.237 [1]

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T8	126.667 - 120	2L2x2x3/16x1/2	6.277	6.105	86.0 K=1.00	1.430	-7.697	38.221	0.201 [1]
T9	120 - 113.333	2L2 1/2x2 1/2x3/16x1/2	12.843	6.425	100.2 K=1.00	1.805	-7.370	41.764	0.176 [1]
T10	113.333 - 106.667	2L 'a' > 36.772 in - 145 2L2 1/2x2 1/2x3/16x1/2	13.430	6.719	104.8 K=1.00	1.805	-7.624	39.969	0.191 [1]
T11	106.667 - 100	2L 'a' > 38.454 in - 157 2L2 1/2x2 1/2x3/16x1/2	14.025	6.849	106.8 K=1.00	1.805	-7.043	39.141	0.180 [1]
T12	100 - 80	2L 'a' > 39.199 in - 169 2L3x3x3/16x1/2	15.889	7.764	101.9 K=1.00	2.180	-7.813	46.595	0.168 [1]
T13	80 - 60	2L 'a' > 44.357 in - 178 2L3x3x3/16x1/4	19.100	9.452	127.6 K=1.00	2.180	-9.370	34.378	0.273 [1]
T14	60 - 40	2L 'a' > 54.001 in - 199 2L3x3x1/4x1/4	20.885	10.475	141.5 K=1.00	2.875	-10.539	39.600	0.266 [1]
T15	40 - 30	2L 'a' > 60.029 in - 213 2L3 1/2x3 1/2x1/4x1/4	21.789	10.747	125.0 K=1.00	3.375	-10.168	57.513	0.177 [1]
T16	30 - 20	2L 'a' > 61.473 in - 234 2L3 1/2x3 1/2x1/4x1/4	22.687	11.316	131.6 K=1.00	3.375	-11.889	52.338	0.227 [1]
T17	20 - 0	2L 'a' > 64.727 in - 243 L4x4x1/4	24.500	12.024	166.9 K=0.92	1.940	-11.317	19.935	0.568 [1]

[1] P_u / ϕP_n controls

Horizontal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T8	126.667 - 120	L2 1/2x2 1/2x1/4	10.297	5.003	156.1 K=1.00	1.190	-1.746	13.973	0.125 [1]

[1] P_u / ϕP_n controls

Secondary Horizontal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T5	145 - 140	L2x2x1/4	8.340	8.100	159.6 K=1.00	0.938	-1.105	10.539	0.105 [1]
T7	133.333 - 126.667	L2x2x1/4	9.608	9.316	183.6 K=1.00	0.938	-1.544	7.967	0.194 [1]
T9	120 - 113.333	L2 1/2x2 1/2x1/4	10.965	10.631	165.9 K=1.00	1.190	-1.978	12.375	0.160 [1]
T10	113.333 - 106.667	L2 1/2x2 1/2x1/4	11.646	11.313	176.5 K=1.00	1.190	-2.181	10.929	0.200 [1]
T14	60 - 40	L3x3x1/4	18.319	17.855	230.4 K=1.00	1.440	-4.050	7.765	0.522 [1]
T16	30 - 20	L3 1/2x3 1/2x1/4	20.350	19.798	218.0 K=1.00	1.690	-4.600	10.182	0.452 [1]

[1] P_u / ϕP_n controls

Top Girt Design Data (Compression)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T1	180 - 160	L2x2x1/8	6.521	6.115	184.6 K=1.00	0.484	-0.100	4.070	0.025 [1]

[1] P_u / ϕP_n controls

Redundant Horizontal (1) Design Data (Compression)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T8	126.667 - 120	L2x2x1/4	2.574	2.428	74.5 K=1.00	0.938	-1.746	27.870	0.063 [1]

[1] P_u / ϕP_n controls

Redundant Diagonal (1) Design Data (Compression)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T8	126.667 - 120	L2x2x1/4	3.138	2.963	90.9 K=1.00	0.938	-1.158	24.988	0.046 [1]

[1] P_u / ϕP_n controls

Tension Checks

Leg Design Data (Tension)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T1	180 - 160	ROHN 2 STD	20.000	4.000	61.0	1.075	17.692	48.354	0.366 [1]
T2	160 - 155	ROHN 2.5 EH	5.009	5.009	65.0	2.254	26.217	101.409	0.259 [1]
T3	155 - 150	ROHN 2.5 EH	5.009	5.009	65.0	2.254	33.727	101.409	0.333 [1]
T4	150 - 145	ROHN 2.5 EH	5.009	5.009	65.0	2.254	41.112	101.409	0.405 [1]
T5	145 - 140	ROHN 2.5 EH	5.009	2.581	33.5	2.254	49.954	101.409	0.493 [1]
T6	140 - 133.333	ROHN 3 EH	6.678	6.678	70.5	3.016	59.490	135.717	0.438 [1]
T7	133.333 - 126.667	ROHN 3 EH	6.678	3.222	34.0	3.016	71.706	135.717	0.528 [1]
T8	126.667 - 120	ROHN 3 EH	6.678	1.670	17.6	3.016	82.277	135.717	0.606 [1]
T9	120 - 113.333	ROHN 3.5 EH	6.678	3.236	29.7	3.678	93.893	165.529	0.567 [1]
T10	113.333 - 106.667	ROHN 3.5 EH	6.678	3.241	29.8	3.678	104.374	165.529	0.631 [1]
T11	106.667 - 100	BT100140- Rohn 3.5EH	6.678	6.678	78.7	6.820	115.076	306.900	0.375 [1]

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
		w/ 2" SR							
T12	100 - 80	BT100140- Rohn 4EH w/ 2" SR	20.037	6.679	68.3	7.549	144.095	339.705	0.424 [1]
T13	80 - 60	BT100140- Rohn 5EH w/ 2" SR (60-80)	20.033	10.017	78.9	9.253	170.020	416.385	0.408 [1]
T14	60 - 40	BT100140- Rohn 5EH w/ 2" SR (40-60)	20.036	4.867	38.4	9.253	195.377	416.385	0.469 [1]
T15	40 - 30	BT100140- Rohn 6EHS w/ 2" SR (30-40)	10.017	10.017	64.7	9.855	209.149	443.471	0.472 [1]
T16	30 - 20	BT100140- Rohn 6EHS w/ 2" SR (20-30)	10.017	4.885	31.5	9.855	220.628	443.471	0.498 [1]
T17	20 - 0	BT100140- Rohn 6EH w/ 2" SR	20.033	10.017	63.6	11.547	246.501	519.615	0.474 [1]

[1] P_u / ϕP_n controls

Diagonal Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T1	180 - 160	L2x2x1/4	7.682	3.623	73.4	0.586	5.105	28.583	0.179 [1]
T2	160 - 155	L1 3/4x1 3/4x3/16	8.454	4.131	94.6	0.378	4.451	16.440	0.271 [1]
T3	155 - 150	L1 3/4x1 3/4x3/16	8.869	4.341	99.3	0.378	4.585	16.440	0.279 [1]
T4	150 - 145	L2x2x1/4	9.296	4.553	91.8	0.586	5.445	28.583	0.190 [1]
T5	145 - 140	2L1 3/4x1 3/4x3/16x3/16 2L 'a' > 28.068 in - 69	9.732	4.876	109.0	0.756	5.570	32.880	0.169 [1]
T6	140 - 133.333	2L2x2x3/16x1/2 2L 'a' > 31.235 in - 81	11.156	5.441	109.0	0.896	6.740	38.997	0.173 [1]
T7	133.333 - 126.667	2L2x2x3/16x1/2 2L 'a' > 33.766 in - 90	11.706	5.881	114.3	0.896	7.007	38.997	0.180 [1]
T8	126.667 - 120	2L2x2x3/16x1/2	6.277	6.105	71.4	0.896	7.044	38.997	0.181 [1]
T9	120 - 113.333	2L2 1/2x2 1/2x3/16x1/2 2L 'a' > 36.772 in - 144	12.843	6.425	99.1	1.178	7.210	51.231	0.141 [1]
T10	113.333 - 106.667	2L2 1/2x2 1/2x3/16x1/2 2L 'a' > 38.454 in - 156	13.430	6.719	103.6	1.178	7.248	51.231	0.141 [1]
T11	106.667 - 100	2L2 1/2x2 1/2x3/16x1/2 2L 'a' > 39.199 in - 168	14.025	6.849	108.2	1.178	7.111	51.231	0.139 [1]
T12	100 - 80	2L3x3x3/16x1/2 2L 'a' > 44.357 in - 177	15.889	7.764	101.3	1.459	7.901	63.466	0.124 [1]
T13	80 - 60	2L3x3x3/16x1/4 2L 'a' > 54.001 in - 198	19.100	9.452	122.3	1.424	9.375	61.937	0.151 [1]
T14	60 - 40	2L3x3x1/4x1/4 2L 'a' > 57.451 in - 223	19.977	10.025	129.3	1.875	10.102	91.406	0.111 [1]
T15	40 - 30	2L3 1/2x3 1/2x1/4x1/4 2L 'a' > 61.473 in - 235	21.789	10.747	119.5	2.250	10.074	109.688	0.092 [1]
T16	30 - 20	2L3 1/2x3 1/2x1/4x1/4 2L 'a' > 64.727 in - 244	22.687	11.316	124.4	2.250	10.939	109.688	0.100 [1]
T17	20 - 0	L4x4x1/4	24.500	12.024	117.3	1.314	10.925	64.076	0.170 [1]

[1] P_u / ϕP_n controls

Horizontal Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
T8	126.667 - 120	L2 1/2x2 1/2x1/4	10.297	5.003	117.1	1.190	1.746	38.556	0.045 [1]

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	

[1] P_u / ϕP_n controls

Secondary Horizontal Design Data (Tension)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T5	145 - 140	L2x2x1/4	8.340	8.100	159.6	0.704	1.105	34.296	0.032 [1]
T7	133.333 - 126.667	L2x2x1/4	9.608	9.316	183.6	0.704	1.544	34.296	0.045 [1]
T9	120 - 113.333	L2 1/2x2 1/2x1/4	10.965	10.631	165.9	1.190	1.978	38.556	0.051 [1]
T10	113.333 - 106.667	L2 1/2x2 1/2x1/4	11.646	11.313	176.5	1.190	2.181	38.556	0.057 [1]
T14	60 - 40	L3x3x1/4	17.276	16.812	216.9	1.440	4.050	46.656	0.087 [1]
T16	30 - 20	L3 1/2x3 1/2x1/4	20.350	19.798	218.0	1.690	4.600	54.756	0.084 [1]

[1] P_u / ϕP_n controls

Top Girt Design Data (Tension)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T1	180 - 160	L2x2x1/8	6.521	6.115	121.2	0.305	0.167	13.254	0.013 [1]

[1] P_u / ϕP_n controls

Redundant Horizontal (1) Design Data (Tension)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T8	126.667 - 120	L2x2x1/4	2.574	2.428	47.8	0.563	1.746	24.485	0.071 [1]

[1] P_u / ϕP_n controls

Redundant Diagonal (1) Design Data (Tension)

Section No.	Elevation	Size	L	L_u	Kl/r	A	P_u	ϕP_n	Ratio $\frac{P_u}{\phi P_n}$
	ft		ft	ft		in^2	K	K	
T8	126.667 - 120	L2x2x1/4	3.138	2.963	58.4	0.563	1.064	24.485	0.043 [1]

[1] P_u / ϕP_n controls

Section Capacity Table

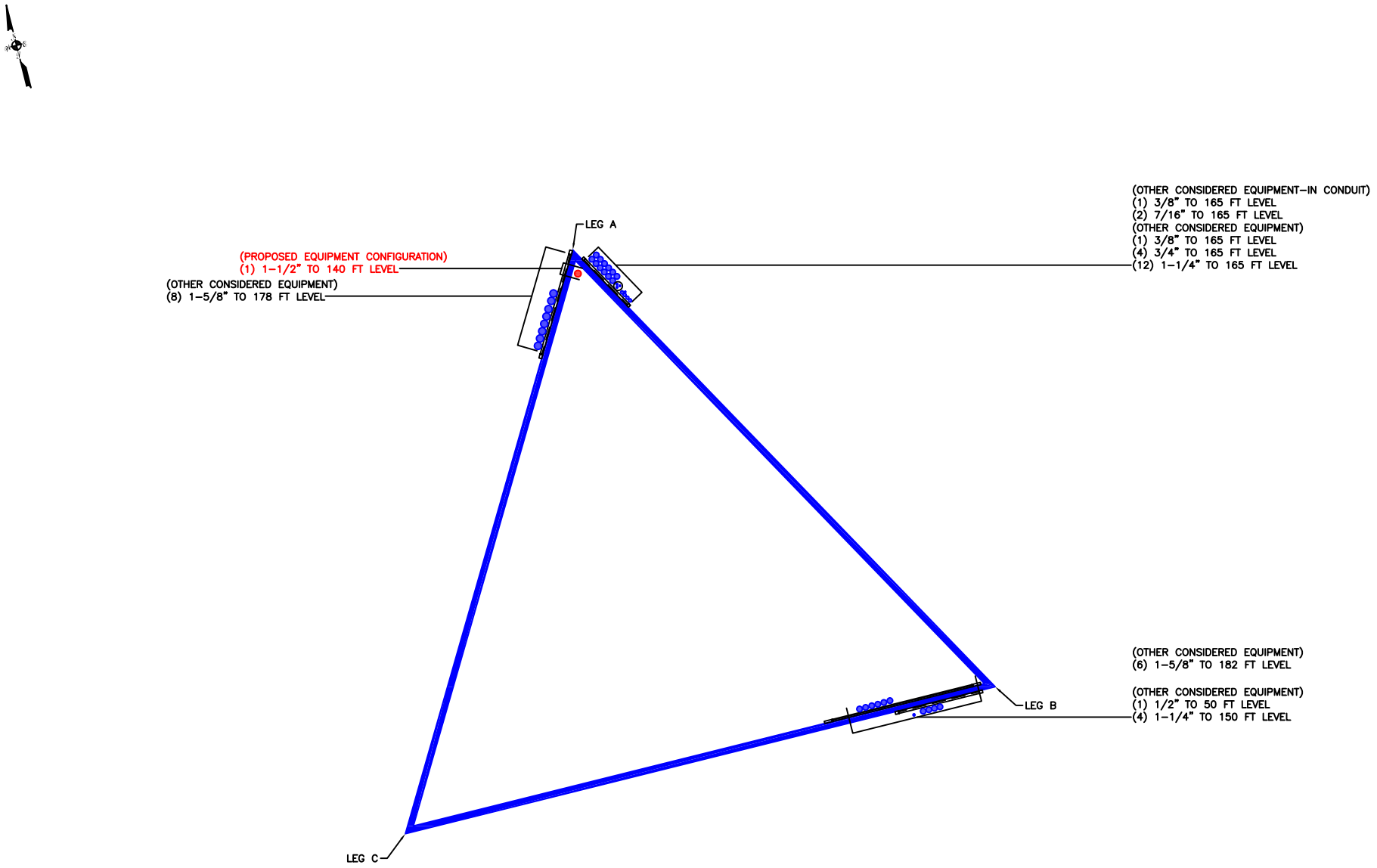
Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
T1	180 - 160	Leg	ROHN 2 STD	2	-26.206	38.684	67.7	Pass
T2	160 - 155	Leg	ROHN 2.5 EH	38	-35.350	78.151	45.2	Pass
T3	155 - 150	Leg	ROHN 2.5 EH	47	-43.741	78.148	56.0	Pass
T4	150 - 145	Leg	ROHN 2.5 EH	56	-53.793	78.149	68.8	Pass
T5	145 - 140	Leg	ROHN 2.5 EH	65	-63.708	98.081	65.0	Pass
T6	140 - 133.333	Leg	ROHN 3 EH	77	-75.455	99.059	76.2	Pass
T7	133.333 - 126.667	Leg	ROHN 3 EH	86	-89.011	129.274	68.9	Pass
T8	126.667 - 120	Leg	ROHN 3 EH	98	-100.685	141.695	71.1	Pass
T9	120 - 113.333	Leg	ROHN 3.5 EH	140	-114.070	161.556	70.6	Pass
T10	113.333 - 106.667	Leg	ROHN 3.5 EH	152	-125.783	161.594	77.8	Pass
T11	106.667 - 100	Leg	BT100140- Rohn 3.5EH w/ 2" SR	164	-138.334	244.582	56.6	Pass
T12	100 - 80	Leg	BT100140- Rohn 4EH w/ 2" SR	173	-172.302	286.747	60.1	Pass
T13	80 - 60	Leg	BT100140- Rohn 5EH w/ 2" SR (60-80)	194	-202.914	319.408	63.5	Pass
T14	60 - 40	Leg	BT100140- Rohn 5EH w/ 2" SR (40-60)	209	-233.537	400.743	58.3	Pass
T15	40 - 30	Leg	BT100140- Rohn 6EHS w/ 2" SR (30-40)	230	-250.927	373.300	67.2	Pass
T16	30 - 20	Leg	BT100140- Rohn 6EHS w/ 2" SR (20-30)	239	-265.219	439.396	60.4	Pass
T17	20 - 0	Leg	BT100140- Rohn 6EH w/ 2" SR	251	-297.529	437.361	68.0	Pass
T1	180 - 160	Diagonal	L2x2x1/4	10	-5.294	21.921	24.2	Pass
T2	160 - 155	Diagonal	L1 3/4x1 3/4x3/16	43	-4.592	8.960	51.2	Pass
T3	155 - 150	Diagonal	L1 3/4x1 3/4x3/16	52	-4.502	8.115	55.5	Pass
T4	150 - 145	Diagonal	L2x2x1/4	61	-5.640	14.435	39.1	Pass
T5	145 - 140	Diagonal	2L1 3/4x1 3/4x3/16x3/16	70	-5.539	10.763	51.5	Pass
T6	140 - 133.333	Diagonal	2L2x2x3/16x1/2	82	-6.930	34.333	20.2	Pass
T7	133.333 - 126.667	Diagonal	2L2x2x3/16x1/2	91	-7.063	31.258	22.6	Pass
T8	126.667 - 120	Diagonal	2L2x2x3/16x1/2	108	-7.697	40.133	19.2	Pass
T9	120 - 113.333	Diagonal	2L2 1/2x2 1/2x3/16x1/2	145	-7.370	43.852	16.8	Pass
T10	113.333 - 106.667	Diagonal	2L2 1/2x2 1/2x3/16x1/2	157	-7.624	41.968	18.2	Pass
T11	106.667 - 100	Diagonal	2L2 1/2x2 1/2x3/16x1/2	169	-7.043	41.098	17.1	Pass
T12	100 - 80	Diagonal	2L3x3x3/16x1/2	178	-7.813	48.925	16.0	Pass
T13	80 - 60	Diagonal	2L3x3x3/16x1/4	199	-9.370	36.097	26.0	Pass
T14	60 - 40	Diagonal	2L3x3x1/4x1/4	213	-10.539	41.581	25.3	Pass
T15	40 - 30	Diagonal	2L3 1/2x3 1/2x1/4x1/4	234	-10.168	60.389	16.8	Pass
T16	30 - 20	Diagonal	2L3 1/2x3 1/2x1/4x1/4	243	-11.889	54.955	21.6	Pass
T17	20 - 0	Diagonal	L4x4x1/4	255	-11.317	20.932	54.1	Pass
T8	126.667 - 120	Horizontal	L2 1/2x2 1/2x1/4	100	-1.746	14.671	11.9	Pass
T5	145 - 140	Secondary Horizontal	L2x2x1/4	73	-1.105	11.066	10.0	Pass
T7	133.333 - 126.667	Secondary Horizontal	L2x2x1/4	94	-1.544	8.365	18.5	Pass
T9	120 - 113.333	Secondary Horizontal	L2 1/2x2 1/2x1/4	148	-1.978	12.994	15.2	Pass
T10	113.333 - 106.667	Secondary Horizontal	L2 1/2x2 1/2x1/4	160	-2.181	11.476	19.0	Pass
T14	60 - 40	Secondary Horizontal	L3x3x1/4	217	-4.050	8.153	49.7	Pass
T16	30 - 20	Secondary Horizontal	L3 1/2x3 1/2x1/4	247	-4.600	10.692	43.0	Pass
T1	180 - 160	Top Girt	L2x2x1/8	6	-0.100	4.273	2.3	Pass
T8	126.667 - 120	Redund Horz 1 Bracing	L2x2x1/4	105	1.746	25.709	6.8	Pass
T8	126.667 - 120	Redund Diag 1 Bracing	L2x2x1/4	129	-1.158	26.237	4.4	Pass
							Summary	
						Leg (T10)	77.8	Pass
						Diagonal (T3)	55.5	Pass

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
						Horizontal (T8)	11.9	Pass
						Secondary Horizontal (T14)	49.7	Pass
						Top Girt (T1)	2.3	Pass
						Redund Horz 1 Bracing (T8)	6.8	Pass
						Redund Diag 1 Bracing (T8)	4.4	Pass
						Bolt Checks	74.8	Pass
						RATING =	**77.8**	**Pass**

***NOTE: Above stress ratios for reinforced sections are approximate. More exact calculations are presented in Appendix C.**

APPENDIX B

BASE LEVEL DRAWING


(OTHER CONSIDERED EQUIPMENT–IN CONDUIT)
(1) 3/8" TO 165 FT LEVEL
(2) 7/16" TO 165 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(1) 3/8" TO 165 FT LEVEL
(4) 3/4" TO 165 FT LEVEL
(12) 1–1/4" TO 165 FT LEVEL
LEG A
(PROPOSED EQUIPMENT CONFIGURATION)
(1) 1–1/2" TO 140 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(8) 1–5/8" TO 178 FT LEVEL
(OTHER CONSIDERED EQUIPMENT)
(6) 1–5/8" TO 182 FT LEVEL
LEG B
(OTHER CONSIDERED EQUIPMENT)
(1) 1/2" TO 50 FT LEVEL
(4) 1–1/4" TO 150 FT LEVEL
LEG C

APPENDIX C

ADDITIONAL CALCULATIONS

Pipe with SR on Heel 100' to 110'

LOADS

Compression: $C_u := 115.076kip$

Tension: $T_u := 144.095kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 4in$

Nominal Thickness: $T_L := 0.318in$

Yield Strength: $F_{y\_L} := 50ksi$

Ultimate Strength: $F_{u\_L} := 65ksi$

Unbraced Length: $L_{u\_L} := 80.1in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2in$

Yield Strength: $F_{y\_R} := 105ksi$

Ultimate Strength: $F_{u\_R} := 125ksi$

Intermediate Spacing: $L_{u\_R} := 36in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 12.58$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 3.36 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 3.68 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 6.28 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 1.31 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 2 \cdot in$

$y_L := 0.5 D_{L\_out} = 2 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 6.28 \cdot in^4$

$I_{yy} := I_L = 6.28 \cdot in^4$

$r_{xL} := r_L = 1.31 \cdot in$

$r_{yL} := r_L = 1.31 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 3.14 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia:

$$I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$$

Section Modulus:

$$S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$$

Radius of Gyration:

$$r_R := \frac{D_R}{4} = 0.5 \cdot in$$

Gap:

$$g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$$

$$g = 7 \cdot in$$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area:

$$A_T := A_L + A_R = 6.82 \cdot in^2$$

Centroid:

$$x_{bar1} := x_{bar\_L} + D_R = 4 \cdot in$$

$$x_{bar2} := x_{bar\_R} + g = 8 \cdot in$$

$$A_L \cdot x_{bar1} = 14.71 \cdot in^3$$

$$A_R \cdot x_{bar2} = 25.13 \cdot in^3$$

$$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 39.85 \cdot in^3$$

$$x_0 := \frac{Ax_{total}}{A_T} = 5.84 \cdot in$$

Moments of Inertia:

$$I_x := I_{xx} + I_R = 7.07 \cdot in^4$$

$$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 18.77 \cdot in^4$$

$$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 15.41 \cdot in^4$$

$$I_y := I_{bar\_yL} + I_{bar\_yR} = 34.18 \cdot in^4$$

Radii of Gyration:

$$r_x := \sqrt{\frac{I_x}{A_T}} = 1.02 \cdot in$$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 2.24 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 3.68 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 6.28 \cdot in^4$$

$$I_{yL} := I_{yy} = 6.28 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 1.307 \cdot in$$

$$r_{yL} = 1.31 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 6.82 \cdot in^2$$

Moment of Inertias:

$$I_x = 7.07 \cdot in^4$$

$$I_y = 34.18 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.018 \cdot in$$

$$r_y = 2.239 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 3.53 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 3.53 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 3.8 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 5.85 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 12.58$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} & \text{if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} & \text{if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} & \text{if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 61.3$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate = "Bolted"} \\ 0.8 & \text{if Intermediate = "Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

BUILT-UP MEMBER (TIA-222-H Section 4.5.3):

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 78.7$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^{\,2} + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 100.14$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^{\,2} + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 106.66$$

Spacing Requirement Verification:

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 160.2$$

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 160.2$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^{\,2}} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 76.16 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 37.99 \cdot ksi$$

$A_L = 3.68 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 125.76 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 39.58 \cdot \% \qquad C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 49.35 \cdot \%$$

$Compressive_{Strength} := \max(C_{reinf}, C_{Leg}) = 49.35 \cdot \%$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \quad = 47.0 \cdot \% \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases}$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \quad = \text{"N/A"} \cdot kip \\ \text{"N/A"} & \text{otherwise} \end{cases}$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \quad = 0 \cdot \% \\ 0\% & \text{otherwise} \end{cases}$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \quad = 0.0 \cdot \% \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases}$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \quad = 0 \cdot \% \\ 0\% & \text{otherwise} \end{cases}$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 165.53 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}} \right) & \text{otherwise} \end{cases} = 46.95 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 44.7 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 3.68 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 179.32 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}} \right) & \text{otherwise} \end{cases} = 43.34 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 41.3 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 47 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 44.72 \cdot \%$$

$$Tension_{Rupture} = 41.28 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 47 \cdot \%$$

Pipe with SR on Heel 80' to 100'

LOADS

Compression: $C_u := 172.302kip$

Tension: $T_u := 144.095kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 4.5in$

Nominal Thickness: $T_L := 0.337in$

Yield Strength: $F_{y\_L} := 50ksi$

Ultimate Strength: $F_{u\_L} := 65ksi$

Unbraced Length: $L_{u\_L} := 80.2in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2in$

Yield Strength: $F_{y\_R} := 105ksi$

Ultimate Strength: $F_{u\_R} := 125ksi$

Intermediate Spacing: $L_{u\_R} := 36in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 13.35$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 3.83 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 4.41 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 9.61 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 1.48 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 2.25 \cdot in$

$y_L := 0.5 D_{L\_out} = 2.25 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 9.61 \cdot in^4$

$I_{yy} := I_L = 9.61 \cdot in^4$

$r_{xL} := r_L = 1.48 \cdot in$

$r_{yL} := r_L = 1.48 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 4.27 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 6.75 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 7.55 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 4.25 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 7.75 \cdot in$

$A_L \cdot x_{bar1} = 18.73 \cdot in^3$

$A_R \cdot x_{bar2} = 24.35 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 43.08 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.71 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 10.4 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 18.96 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 13.9 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 32.86 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.17 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 2.09 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 4.41 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 9.61 \cdot in^4$$

$$I_{yL} := I_{yy} = 9.61 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 1.477 \cdot in$$

$$r_{yL} = 1.48 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 7.55 \cdot in^2$$

Moment of Inertias:

$$I_x = 10.4 \cdot in^4$$

$$I_y = 32.86 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.174 \cdot in$$

$$r_y = 2.087 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 4.62 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 4.62 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 3.76 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 5.76 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 13.35$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} \text{ if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} \text{ if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} \text{ if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} \quad \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 54.31$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate = "Bolted"} \\ 0.8 & \text{if Intermediate = "Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

BUILT-UP MEMBER (TIA-222-H Section 4.5.3):

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 68.34$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^2 + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 92.22$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^2 + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 99.27$$

Spacing Requirement Verification:

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 160.4$$

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 160.4$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^2} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 97.03 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 40.3 \cdot ksi$$

$A_L = 4.41 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 159.86 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 53.54 \cdot \% \qquad C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 62.93 \cdot \%$$

$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 62.93 \cdot \%$

$$Compressive_{Strength\_Allowable} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 59.9 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength\_Allowable} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 198.33 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}} \right) & \text{otherwise} \end{cases} = 42.42 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 40.4 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 4.41 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 214.86 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}} \right) & \text{otherwise} \end{cases} = 39.15 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 37.3 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 59.93 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 40.4 \cdot \%$$

$$Tension_{Rupture} = 37.29 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 59.93 \cdot \%$$

Pipe with SR on Heel 60' to 80'

LOADS

Compression: $C_u := 202.914\,kip$

Tension: $T_u := 170.020\,kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 5.563\,in$

Nominal Thickness: $T_L := 0.375\,in$

Yield Strength: $F_{y\_L} := 50\,ksi$

Ultimate Strength: $F_{u\_L} := 65\,ksi$

Unbraced Length: $L_{u\_L} := 120.2\,in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2\,in$

Yield Strength: $F_{y\_R} := 105\,ksi$

Ultimate Strength: $F_{u\_R} := 125\,ksi$

Intermediate Spacing: $L_{u\_R} := 36\,in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 14.83$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 4.81 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 6.11 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 20.67 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 1.84 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 2.78 \cdot in$

$y_L := 0.5 D_{L\_out} = 2.78 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 20.67 \cdot in^4$

$I_{yy} := I_L = 20.67 \cdot in^4$

$r_{xL} := r_L = 1.84 \cdot in$

$r_{yL} := r_L = 1.84 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 7.43 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 6.22 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 9.25 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 4.78 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 7.22 \cdot in$

$A_L \cdot x_{bar1} = 29.22 \cdot in^3$

$A_R \cdot x_{bar2} = 22.68 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 51.9 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.61 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 21.46 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 24.85 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 8.93 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 33.78 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.52 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 1.91 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 6.11 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 20.67 \cdot in^4$$

$$I_{yL} := I_{yy} = 20.67 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 1.839 \cdot in$$

$$r_{yL} = 1.84 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 9.25 \cdot in^2$$

Moment of Inertias:

$$I_x = 21.46 \cdot in^4$$

$$I_y = 33.78 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.523 \cdot in$$

$$r_y = 1.911 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 7.71 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 7.71 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 4.11 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 6.02 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 14.83$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} \text{ if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} \text{ if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} \text{ if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} \quad \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 65.36$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate = "Bolted"} \\ 0.8 & \text{if Intermediate = "Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

BUILT-UP MEMBER (TIA-222-H Section 4.5.3):

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 78.94$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^2 + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 100.33$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^2 + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 106.84$$

Spacing Requirement Verification:

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 240.4$$

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 240.4$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^2} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 67 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 36.59 \cdot ksi$$

$A_L = 6.11 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 201.25 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 51.44 \cdot \%$$

$$C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 66.6 \cdot \%$$

$$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 66.6 \cdot \%$$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 63.4 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 275.04 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}}\right) & \text{otherwise} \end{cases} = 40.83 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 38.9 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 6.11 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 297.96 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}}\right) & \text{otherwise} \end{cases} = 37.69 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 35.9 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 63.42 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 38.89 \cdot \%$$

$$Tension_{Rupture} = 35.89 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 63.42 \cdot \%$$

Pipe with SR on Heel 40' to 60'

LOADS

Compression: $C_u := 233.537kip$

Tension: $T_u := 195.377kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 5.563in$

Nominal Thickness: $T_L := 0.375in$

Yield Strength: $F_{y\_L} := 50ksi$

Ultimate Strength: $F_{u\_L} := 65ksi$

Unbraced Length: $L_{u\_L} := 61.8in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2in$

Yield Strength: $F_{y\_R} := 105ksi$

Ultimate Strength: $F_{u\_R} := 125ksi$

Intermediate Spacing: $L_{u\_R} := 36in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 14.83$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 4.81 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 6.11 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 20.67 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 1.84 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 2.78 \cdot in$

$y_L := 0.5 D_{L\_out} = 2.78 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 20.67 \cdot in^4$

$I_{yy} := I_L = 20.67 \cdot in^4$

$r_{xL} := r_L = 1.84 \cdot in$

$r_{yL} := r_L = 1.84 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 7.43 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 6.22 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 9.25 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 4.78 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 7.22 \cdot in$

$A_L \cdot x_{bar1} = 29.22 \cdot in^3$

$A_R \cdot x_{bar2} = 22.68 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 51.9 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.61 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 21.46 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 24.85 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 8.93 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 33.78 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.52 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 1.91 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 6.11 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 20.67 \cdot in^4$$

$$I_{yL} := I_{yy} = 20.67 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 1.839 \cdot in$$

$$r_{yL} = 1.84 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 9.25 \cdot in^2$$

Moment of Inertias:

$$I_x = 21.46 \cdot in^4$$

$$I_y = 33.78 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.523 \cdot in$$

$$r_y = 1.911 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 7.71 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 7.71 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 4.11 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 6.02 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 14.83$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} \text{ if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} \text{ if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} \text{ if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} \quad \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 33.6$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate = "Bolted"} \\ 0.8 & \text{if Intermediate = "Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

BUILT-UP MEMBER (TIA-222-H Section 4.5.3):

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 40.59$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^2 + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 74.04$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^2 + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 82.65$$

Spacing Requirement Verification:

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 123.6$$

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 123.6$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^2} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 253.45 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 46.04 \cdot ksi$$

$A_L = 6.11 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 253.24 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 59.2 \cdot \%$$

$$C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 60.91 \cdot \%$$

$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 60.91 \cdot \%$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 58.0 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 275.04 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}}\right) & \text{otherwise} \end{cases} = 46.92 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 44.7 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 6.11 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 297.96 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}}\right) & \text{otherwise} \end{cases} = 43.31 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 41.2 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 58.01 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 44.69 \cdot \%$$

$$Tension_{Rupture} = 41.25 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 58.01 \cdot \%$$

Pipe with SR on Heel 30' to 40'

LOADS

Compression: $C_u := 250.927kip$

Tension: $T_u := 209.149kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 6.625in$

Nominal Thickness: $T_L := 0.432in$

Yield Strength: $F_{y\_L} := 50ksi$

Ultimate Strength: $F_{u\_L} := 65ksi$

Unbraced Length: $L_{u\_L} := 120.2in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2in$

Yield Strength: $F_{y\_R} := 105ksi$

Ultimate Strength: $F_{u\_R} := 125ksi$

Intermediate Spacing: $L_{u\_R} := 36in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 5.76 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 8.4 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 40.49 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 2.19 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 3.31 \cdot in$

$y_L := 0.5 D_{L\_out} = 3.31 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 40.49 \cdot in^4$

$I_{yy} := I_L = 40.49 \cdot in^4$

$r_{xL} := r_L = 2.19 \cdot in$

$r_{yL} := r_L = 2.19 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 12.22 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 5.69 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 11.55 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 5.31 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 6.69 \cdot in$

$A_L \cdot x_{bar1} = 44.65 \cdot in^3$

$A_R \cdot x_{bar2} = 21.01 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 65.66 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.69 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 41.28 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 41.67 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 3.93 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 45.6 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.89 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 1.99 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 8.4 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 40.49 \cdot in^4$$

$$I_{yL} := I_{yy} = 40.49 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 2.195 \cdot in$$

$$r_{yL} = 2.19 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 11.55 \cdot in^2$$

Moment of Inertias:

$$I_x = 41.28 \cdot in^4$$

$$I_y = 45.6 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.891 \cdot in$$

$$r_y = 1.987 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 5.93 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 8.02 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} & \text{if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} & \text{if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} & \text{if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 54.76$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate} = \text{"Bolted"} \\ 0.8 & \text{if Intermediate} = \text{"Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

<u>BUILT-UP MEMBER (TIA-222-H Section 4.5.3):</u>

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 63.57$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^2 + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 88.75$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^2 + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate = "Bolted"} \\ KL_{rw} & \text{if Intermediate = "Welded"} \end{cases} = 96.05$$

Spacing Requirement Verification:

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 240.4$$

$$KL\_r_m := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 240.4$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^2} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 95.44 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 40.15 \cdot ksi$$

$A_L = 8.4 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 303.75 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 50.97 \cdot \%$$

$$C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 60.13 \cdot \%$$

$$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 60.13 \cdot \%$$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 57.3 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 378.22 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}}\right) & \text{otherwise} \end{cases} = 40.25 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 38.3 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 8.4 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 409.74 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}}\right) & \text{otherwise} \end{cases} = 37.16 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 35.4 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 57.27 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 38.34 \cdot \%$$

$$Tension_{Rupture} = 35.39 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 57.27 \cdot \%$$

Pipe with SR on Heel 20' to 30'

LOADS

Compression: $C_u := 265.219kip$

Tension: $T_u := 220.628kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 6.625in$

Nominal Thickness: $T_L := 0.432in$

Yield Strength: $F_{y\_L} := 50ksi$

Ultimate Strength: $F_{u\_L} := 65ksi$

Unbraced Length: $L_{u\_L} := 61.6in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2in$

Yield Strength: $F_{y\_R} := 105ksi$

Ultimate Strength: $F_{u\_R} := 125ksi$

Intermediate Spacing: $L_{u\_R} := 36in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 5.76 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 8.4 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 40.49 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 2.19 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 3.31 \cdot in$

$y_L := 0.5 D_{L\_out} = 3.31 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 40.49 \cdot in^4$

$I_{yy} := I_L = 40.49 \cdot in^4$

$r_{xL} := r_L = 2.19 \cdot in$

$r_{yL} := r_L = 2.19 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 12.22 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 5.69 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 11.55 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 5.31 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 6.69 \cdot in$

$A_L \cdot x_{bar1} = 44.65 \cdot in^3$

$A_R \cdot x_{bar2} = 21.01 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 65.66 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.69 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 41.28 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 41.67 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 3.93 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 45.6 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.89 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 1.99 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 8.4 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 40.49 \cdot in^4$$

$$I_{yL} := I_{yy} = 40.49 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 2.195 \cdot in$$

$$r_{yL} = 2.19 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 11.55 \cdot in^2$$

Moment of Inertias:

$$I_x = 41.28 \cdot in^4$$

$$I_y = 45.6 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.891 \cdot in$$

$$r_y = 1.987 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 5.93 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 8.02 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} & \text{if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} & \text{if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} & \text{if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 28.07$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} & \text{if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} & \text{if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} & \text{if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 & \text{if Intermediate} = \text{"Bolted"} \\ 0.8 & \text{if Intermediate} = \text{"Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

<u>BUILT-UP MEMBER (TIA-222-H Section 4.5.3):</u>

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 32.58$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^2 + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 69.97$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^2 + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 79.03$$

Spacing Requirement Verification:

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 123.2$$

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 123.2$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^2} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 363.38 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 47.2 \cdot ksi$$

$A_L = 8.4 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 357.06 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 53.88 \cdot \%$$

$$C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 54.07 \cdot \%$$

$$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 54.07 \cdot \%$$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 51.5 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 378.22 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}} \right) & \text{otherwise} \end{cases} = 42.46 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 40.4 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 8.4 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 409.74 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}} \right) & \text{otherwise} \end{cases} = 39.2 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 37.3 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$Compressive_{Strength} = 51.49 \cdot \%$$

$$Crushing_{Strength} = 0 \cdot \%$$

$$Tension_{Yielding} = 40.44 \cdot \%$$

$$Tension_{Rupture} = 37.33 \cdot \%$$

$$RATING := \max\left(Compressive_{Strength}, Crushing_{Strength}, Tension_{Yielding}, Tension_{Rupture}\right)$$

$$RATING = 51.49 \cdot \%$$

Pipe with SR on Heel 0' to 20'

LOADS

Compression: $C_u := 297.529\,kip$

Tension: $T_u := 246.501\,kip$

Apply TIA-222-H Section 15.5? No / Yes

EXISTING PIPE LEG INPUTS

Outside Diameter: $D_{L\_out} := 6.625\,in$

Nominal Thickness: $T_L := 0.432\,in$

Yield Strength: $F_{y\_L} := 50\,ksi$

Ultimate Strength: $F_{u\_L} := 65\,ksi$

Unbraced Length: $L_{u\_L} := 120.204\,in$

REINFORCEMENT INPUTS

Diameter: $D_R := 2\,in$

Yield Strength: $F_{y\_R} := 105\,ksi$

Ultimate Strength: $F_{u\_R} := 125\,ksi$

Intermediate Spacing: $L_{u\_R} := 36\,in$ (0.001in if Fully Welded)

End Connection Type: Fixed / Free

Intermediate Connection Type: Bolted / Welded (Fully tightened bolted connections are considered the same as welded)

Leg Crushing Check: Yes / No

Consider Reinforcement for Tension?: Yes / No

Consider Components as Composite?: Yes / No

EXISTING PIPE LEG PROPERTIES

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Inside Diameter: $D_{L\_in} := D_{L\_out} - 2 \cdot T_L = 5.76 \cdot in$

Area: $A_L := \frac{\pi}{4} \cdot \left(D_{L\_out}^{2} - D_{L\_in}^{2} \right) = 8.4 \cdot in^2$

Moment of Inertia: $I_L := \frac{\pi}{64} \cdot \left(D_{L\_out}^{4} - D_{L\_in}^{4} \right) = 40.49 \cdot in^4$

Radius of Gyration: $r_L := \frac{\sqrt{D_{L\_out}^{2} + D_{L\_in}^{2}}}{4} = 2.19 \cdot in$

Centroid Coordinates: $x_L := 0.5 D_{L\_out} = 3.31 \cdot in$

$y_L := 0.5 D_{L\_out} = 3.31 \cdot in$

Location of Centroid of Cross-Section

Distance of Centroid of Cross-Section from Reference Axis: $x_{bar\_L} := x_L$

Pipe Properties

$I_{xx} := I_L = 40.49 \cdot in^4$

$I_{yy} := I_L = 40.49 \cdot in^4$

$r_{xL} := r_L = 2.19 \cdot in$

$r_{yL} := r_L = 2.19 \cdot in$

Section Moduli

$S_L := \frac{I_L}{x_{bar\_L}} = 12.22 \cdot in^3$

SOLID ROUND REINFORCEMENT PROPERTIES

Centroid: $x_{bar\_R} := 0.5 D_R = 1 \cdot in$

$y_{bar\_R} := 0.5 D_R = 1 \cdot in$

Area: $A_R := \frac{\pi D_R^{2}}{4} = 3.14 \cdot in^2$

Moment of Inertia: $I_R := \frac{\pi D_R^4}{64} = 0.79 \cdot in^4$

Section Modulus: $S_R := \frac{\pi D_R^3}{32} = 0.79 \cdot in^3$

Radius of Gyration: $r_R := \frac{D_R}{4} = 0.5 \cdot in$

Gap: $g := 10in - \left(\frac{D_R}{2}\right) - \left(\frac{D_{L\_out}}{2}\right)$

$g = 5.69 \cdot in$

COMPOSITE SECTION PROPERTIES (Parallel Axis Theorem)

Area: $A_T := A_L + A_R = 11.55 \cdot in^2$

Centroid: $x_{bar1} := x_{bar\_L} + D_R = 5.31 \cdot in$

$x_{bar2} := x_{bar\_R} + g = 6.69 \cdot in$

$A_L \cdot x_{bar1} = 44.65 \cdot in^3$

$A_R \cdot x_{bar2} = 21.01 \cdot in^3$

$Ax_{total} := A_L \cdot x_{bar1} + A_R \cdot x_{bar2} = 65.66 \cdot in^3$

$x_0 := \frac{Ax_{total}}{A_T} = 5.69 \cdot in$

Moments of Inertia: $I_x := I_{xx} + I_R = 41.28 \cdot in^4$

$I_{bar\_yL} := I_{yy} + A_L \cdot \left(x_0 - x_{bar1}\right)^2 = 41.67 \cdot in^4$

$I_{bar\_yR} := I_R + A_R \cdot \left(x_0 - x_{bar2}\right)^2 = 3.93 \cdot in^4$

$I_y := I_{bar\_yL} + I_{bar\_yR} = 45.6 \cdot in^4$

Radii of Gyration: $r_x := \sqrt{\frac{I_x}{A_T}} = 1.89 \cdot in$

$$r_y := \sqrt{\frac{I_y}{A_T}} = 1.99 \cdot in$$

PROPERTIES SUMMARY

EXISTING LEG

Area:

$$A_L = 8.4 \cdot in^2$$

Moment of Inertias:

$$I_{xL} := I_{xx} = 40.49 \cdot in^4$$

$$I_{yL} := I_{yy} = 40.49 \cdot in^4$$

Radii of Gyration:

$$r_{xL} = 2.195 \cdot in$$

$$r_{yL} = 2.19 \cdot in$$

SOLID ROD RIENFORCEMENT

Area:

$$A_R = 3.14 \cdot in^2$$

Moment of Inertias:

$$I_{xR} := I_R = 0.79 \cdot in^4$$

$$I_{yR} := I_R = 0.79 \cdot in^4$$

Radii of Gyration:

$$r_{xR} := r_R = 0.5 \cdot in$$

$$r_{yR} := r_R = 0.5 \cdot in$$

COMPOSITE SECTION

Area:

$$A_T = 11.55 \cdot in^2$$

Moment of Inertias:

$$I_x = 41.28 \cdot in^4$$

$$I_y = 45.6 \cdot in^4$$

Radii of Gyration:

$$r_x = 1.891 \cdot in$$

$$r_y = 1.987 \cdot in$$

Elastic Section Moduli:

$$S_{x\_top} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{x\_bot} := \frac{I_x}{\max\left(0.5D_{L\_out}, 0.5 \cdot D_R\right)} = 12.46 \cdot in^3$$

$$S_{y\_right} := \frac{I_y}{0.5D_{L\_out} + g + D_R - x_{bar\_L}} = 5.93 \cdot in^3$$

$$S_{y\_left} := \frac{I_y}{x_0} = 8.02 \cdot in^3$$

BUILT-UP SECTION ANALYSIS

LEG DATA

Steel Modulus of Elasticity: $E := 29000ksi$

Diameter to Thickness Ratio: $\frac{D_{L\_out}}{T_L} = 15.34$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_L := \begin{cases} F_{y\_L} & \text{if } \frac{D_{L\_out}}{T_L} \le 0.114\frac{E}{F_{y\_L}} \\ \left(\frac{0.0379E}{\frac{D_{L\_out}}{T_L}\cdot F_{y\_L}} + \frac{2}{3}\right)\cdot F_{y\_L} & \text{if } 0.114\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 0.448\frac{E}{F_{y\_L}} \\ \frac{0.337E}{\frac{D_{L\_out}}{T_L}} & \text{if } 0.448\frac{E}{F_{y\_L}} < \frac{D_{L\_out}}{T_L} \le 300 \\ \text{"REDESIGN"} & \text{otherwise} \end{cases} = 50\cdot ksi$$

Effective Length Factor: $K_L := 1.0$

Effective Slenderness Ratio: $KL\_r_L := \frac{K_L\cdot L_{u\_L}}{r_L} = 54.77$

REINFORCEMENT DATA

$$\frac{D_R}{0.5\cdot D_R} = 2$$

Effective Yield Stress (TIA-222-H Section 4.5.4.1):

$$F'y\_R := \begin{cases} F_{y\_R} \text{ if } \frac{D_R}{0.5 \cdot D_R} \le 0.114 \frac{E}{F_{y\_R}} \\ \left(\frac{0.0379E}{\frac{D_R}{0.5 \cdot D_R} \cdot F_{y\_R}} + \frac{2}{3} \right) \cdot F_{y\_L} \text{ if } 0.114 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 0.448 \frac{E}{F_{y\_R}} \\ \frac{0.337E}{\frac{D_R}{0.5 \cdot D_R}} \text{ if } 0.448 \frac{E}{F_{y\_R}} < \frac{D_R}{0.5 \cdot D_R} \le 300 \\ \text{"REDESIGN" otherwise} \end{cases} = 105 \cdot ksi$$

Effective Length Factor:

$$K_R := \begin{cases} 1.0 \text{ if Intermediate} = \text{"Bolted"} \\ 0.8 \text{ if Intermediate} = \text{"Welded"} \end{cases}$$

Effective Slenderness Ratio:

$$KL\_r_R := \frac{K_R \cdot L_{u\_R}}{\min(r_{xR}, r_{yR})} = 72$$

<u>BUILT-UP MEMBER (TIA-222-H Section 4.5.3):</u>

Minimum Radius of Gyration of Individual Component:

$$r_i := \min(r_{xL}, r_{yL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Radius of Gyration of Indivdual Component About its Centroidal Axis Parallel to the Axis of Buckling under consideration for the Built-Up Member:

$$r_{ib} := \min(r_{xL}, r_{xR}, r_{yR}) = 0.5 \cdot in$$

Distance between Connectors:

$$a_i := L_{u\_R} = 36 \cdot in$$

Effective Length Factor for Individual Members:

$$K_i := 0.86$$

Effective Slenderness Ratio of Built-up Member Acting as a Unit:

$$KL\_r_o := \frac{1.0 \cdot \max(L_{u\_L}, L_{u\_R})}{\min(r_x, r_y)} = 63.58$$

Modified Effective Slenderness Ratio:

$$KL_{rw} := \begin{cases} KL\_r_o & \text{if } \frac{a_i}{r_i} \le 40 \\ \sqrt{KL\_r_o^{\,2} + \left(\frac{K_i \cdot a_i}{r_{ib}}\right)^2} & \text{if } \frac{a_i}{r_i} > 40 \end{cases} = 88.75$$

$$KL\_r_m := \begin{cases} \sqrt{KL\_r_o^{\,2} + \left(\frac{a_i}{r_i}\right)^2} & \text{if Intermediate} = \text{"Bolted"} \\ KL_{rw} & \text{if Intermediate} = \text{"Welded"} \end{cases} = 96.05$$

Spacing Requirement Verification:

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le 0.75 \cdot KL\_r_o \\ \frac{\max\left(K_L \cdot L_{u\_L}, K_R \cdot L_{u\_R}\right)}{r_{ib}} & \text{otherwise} \end{cases} = 240.41$$

$$KL\_r_{rm} := \begin{cases} KL\_r_m & \text{if } \frac{a_i}{r_i} \le KL\_r_m \\ \text{"Design Rqmts Not Met"} & \text{otherwise} \end{cases} = 240.41$$

COMPRESSIVE STRENGTH (REINFORCEMENT) [AISC 15th Ed. Section E3]

$$F'y := \min(F'y\_R) = 105 \cdot ksi$$

$$F_e := \frac{\pi^2 \cdot E}{KL\_r_R^{\,2}} = 55.21 \cdot ksi$$

$$F_{cr} := \begin{cases} 0.658^{\left(\frac{F'y}{F_e}\right)} \cdot F'y & \text{if } \frac{F'y}{F_e} \le 2.25 \\ 0.877 \cdot F_e & \text{otherwise} \end{cases} = 47.37 \cdot ksi$$

$$A := A_R$$

Reduction Factor:

$$\phi_c := 0.9$$

Design Compressive Strength (Reinforcement):

$$\phi C_{n\_R} := \phi_c \cdot A \cdot F_{cr} = 133.93 \cdot kip$$

COMPRESSIVE STRENGTH (ORIGINAL LEG) [TIA-222-H Section 4.5.4.2]

$F'y\_L = 50 \cdot ksi$

$$F_{e\_L} := \frac{\pi^2 \cdot E}{KL\_r_L^{\,2}} = 95.43 \cdot ksi$$

$$F_{cr\_L} := \begin{cases} 0.658^{\left(\frac{F'y\_L}{F_{e\_L}}\right)} \cdot F'y\_L & \text{if } KL\_r_L \le 4.71\sqrt{\frac{E}{F'y\_L}} \\ 0.877 \cdot F_{e\_L} & \text{otherwise} \end{cases} = 40.15 \cdot ksi$$

$A_L = 8.4 \cdot in^2$

Reduction Factor (Original Leg):

$\phi_{c\_L} := 0.9$

Design Compressive Strength (Original Leg):

$\phi C_{n\_L} := \phi_{c\_L} \cdot A_L \cdot F_{cr\_L} = 303.74 \cdot kip$

$$C_{reinf} := \frac{A_R}{A_T}\frac{C_u}{\phi C_{n\_R}} = 60.44 \cdot \%$$

$$C_{Leg} := \frac{A_L}{A_T}\frac{C_u}{\phi C_{n\_L}} = 71.3 \cdot \%$$

$Compressive_{Strength} := \max\left(C_{reinf}, C_{Leg}\right) = 71.3 \cdot \%$

$$Compressive_{Strength} := \begin{cases} Compressive_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Compressive_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 67.9 \cdot \%$$

Crushing Strength:

$$\phi C_{u\_Crushing} := \begin{cases} \phi_c \cdot F_{y\_L} \cdot A_L & \text{if Crushing} = \text{"Yes"} \\ \text{"N/A"} & \text{otherwise} \end{cases} = \text{"N/A"} \cdot kip$$

$$Crushing_{Strength} := \begin{cases} \frac{C_u}{\phi C_{u\_Crushing}} & \text{if Crushing} = \text{"Yes"} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

$$Crushing_{Strength} := \begin{cases} Crushing_{Strength} & \text{if S15Allowable} = \text{"No"} \\ \frac{Crushing_{Strength}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 0.0 \cdot \%$$

Flexural-Torsional Buckling:

$$Flexural\_Torsional := \begin{cases} \text{"Redesign"} & \text{if } L_{u\_L} \le L_{u\_R} \\ 0\% & \text{otherwise} \end{cases} = 0 \cdot \%$$

TENSION YIELDING STRENGTH (TIA-222-H Section 4.6.3)

Reduction Factor: $\phi_{ty} := 0.9$

Design Strengths: $\phi T_{yn\_L} := \phi_{ty} \cdot A_L \cdot F_{y\_L} = 378.22 \cdot kip$

$\phi T_{yn\_R} := \phi_{ty} \cdot A_R \cdot F_{y\_R} = 296.88 \cdot kip$

$$Tension_{Yielding} := \begin{cases} \dfrac{T_u}{\phi T_{yn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{yn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{yn\_R}} \right) & \text{otherwise} \end{cases} = 47.44 \cdot \%$$

$$Tension_{Yielding} := \begin{cases} Tension_{Yielding} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Yielding}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 45.2 \cdot \%$$

TENSION RUPTURE STRENGTH (TIA-222-H Section 4.6.3 and 4.6.3.2)

Reduction Factor: $\phi_{tr} := 0.75$

Net Areas: $U := 1.0$

$A_{n\_L} := A_L \cdot U = 8.4 \cdot in^2$

$A_{n\_R} := A_R \cdot U = 3.14 \cdot in^2$

Design Strengths: $\phi T_{rn\_L} := \phi_{tr} \cdot A_{n\_L} \cdot F_{u\_L} = 409.74 \cdot kip$

$\phi T_{rn\_R} := \phi_{tr} \cdot A_{n\_R} \cdot F_{u\_R} = 294.52 \cdot kip$

$$Tension_{Rupture} := \begin{cases} \dfrac{T_u}{\phi T_{rn\_L}} & \text{if Tension} = \text{"No"} \\ \max\left(\dfrac{T_u \dfrac{A_L}{A_T}}{\phi T_{rn\_L}}, \dfrac{T_u \dfrac{A_R}{A_T}}{\phi T_{rn\_R}} \right) & \text{otherwise} \end{cases} = 43.79 \cdot \%$$

$$Tension_{Rupture} := \begin{cases} Tension_{Rupture} & \text{if S15Allowable} = \text{"No"} \\ \dfrac{Tension_{Rupture}}{1.05} & \text{if S15Allowable} = \text{"Yes"} \end{cases} = 41.7 \cdot \%$$

ANALYSIS / DESIGN SUMMARY

$$\text{Compressive}_{\text{Strength}} = 67.91 \cdot \%$$

$$\text{Crushing}_{\text{Strength}} = 0 \cdot \%$$

$$\text{Tension}_{\text{Yielding}} = 45.18 \cdot \%$$

$$\text{Tension}_{\text{Rupture}} = 41.71 \cdot \%$$

$$\text{RATING} := \max\left(\text{Compressive}_{\text{Strength}}, \text{Crushing}_{\text{Strength}}, \text{Tension}_{\text{Yielding}}, \text{Tension}_{\text{Rupture}}\right)$$

$$\text{RATING} = 67.91 \cdot \%$$

Self Support Anchor Rod Capacity

Site Info	
BU #	806478
Site Name	HRT 080 953381
Order #	553396 Rev. 0

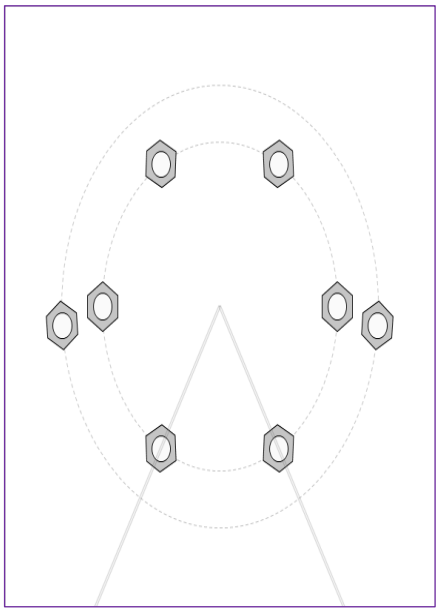
Analysis Considerations	
TIA-222 Revision	H
Grout Considered:	See Custom Sheet
l_{ar} (in)	See Custom Sheet

Applied Loads		
	Comp.	Uplift
Axial Force (kips)	305.12	252.61
Shear Force (kips)	32.39	27.54

**TIA-222-H Section 15.5 Applied*

Considered Eccentricity	
Leg Mod Eccentricity (in)	0.000
Anchor Rod N.A Shift (in)	-0.185
Total Eccentricity (in)	-0.185

**Anchor Rod Eccentricity Applied*



Connection Properties

Anchor Rod Data

GROUP 1: (6) 1" ø bolts (A449 N; Fy=92 ksi, Fu=120 ksi) on 12.625" BC
l_{ar} (in): 0

GROUP 2: (2) 1" ø bolts (A193 Gr. B7 N; Fy=105 ksi, Fu=125 ksi) on 17" BC
pos. (deg): 355, 185
l_{ar} (in): 0

Analysis Results

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

GROUP 1:		
Pu_t = 33.77	ϕPn_t = 54.54	**Stress Rating**
Vu = 4.59	ϕVn = 35.34	**59.0%**
Mu = n/a	ϕMn = n/a	**Pass**
GROUP 2:		
Pu_t = 31.36	ϕPn_t = 56.81	**Stress Rating**
Vu = 0	ϕVn = 36.82	**52.6%**
Mu = n/a	ϕMn = n/a	**Pass**

Pier and Pad Foundation

BU # :	806478
Site Name:	HRT 080 953381
App. Number:	553396 Rev. 0

TIA-222 Revision:	H
Tower Type:	Self Support

Top & Bot. Pad Rein. Different?:	☐
Block Foundation?:	☐
Rectangular Pad?:	☐

Superstructure Analysis Reactions

Compression, P_{comp}:	305.12	kips
Compression Shear, Vu_comp:	32.39	kips
Uplift, P_{uplift}:	252.61	kips
Uplift Shear, V_{u_uplift}:	27.54	kips
Tower Height, **H**:	180	ft
Base Face Width, **BW**:	22.86	ft
BP Dist. Above Fdn, bp_{dist}:	2.5	in

Pier Properties

Pier Shape:	Square	
Pier Diameter, **dpier**:	5	ft
Ext. Above Grade, **E**:	0.3333333	ft
Pier Rebar Size, **Sc**:	8	
Pier Rebar Quantity, **mc**:	18	
Pier Tie/Spiral Size, **St**:	3	
Pier Tie/Spiral Quantity, **mt**:	7	
Pier Reinforcement Type:	Tie	
Pier Clear Cover, cc_{pier}:	3	in

Pad Properties

Depth, **D**:	9.6666667	ft
Pad Width, W_1:	7.3333333	ft
Pad Thickness, **T**:	2	ft
Pad Rebar Size (Bottom dir. 2), Sp_2:	9	
Pad Rebar Quantity (Bottom dir. 2), mp_2:	4	
Pad Clear Cover, cc_{pad}:	3	in

Material Properties

Rebar Grade, **Fy**:	60	ksi
Concrete Compressive Strength, **F'c**:	3	ksi
Dry Concrete Density, δ**c**:	150	pcf

Soil Properties

Total Soil Unit Weight, γ:	122	pcf
Ultimate Net Bearing, Qnet:	30.000	ksf
Cohesion, **Cu**:	0.000	ksf
Friction Angle, φ:	32	degrees
SPT Blow Count, N_{blows}:		
Base Friction, μ:	0.4	
Neglected Depth, **N**:	3.33	ft
Foundation Bearing on Rock?	Yes	
Groundwater Depth, **gw**:	N/A	ft

<--Toggle between Gross and Net

Foundation Analysis Checks

	Capacity	Demand	Rating*	Check
Uplift (kips)	250.12	252.61	**96.2%**	**Pass**
Lateral (Sliding) (kips)	73.36	27.54	**35.8%**	**Pass**
Bearing Pressure (ksf)	23.38	7.30	**29.7%**	**Pass**
*Pier Flexure (Comp.) (kip*ft)*	2060.10	259.12	**12.0%**	**Pass**
*Pier Flexure (Tension) (kip*ft)*	1155.70	220.32	**18.2%**	**Pass**
Pier Compression (kip)	8751.60	341.12	**3.7%**	**Pass**
*Pad Flexure (kip*ft)*	337.92	29.05	**8.2%**	**Pass**
Pad Shear - 1-way (kips)	139.60	0.00	**0.0%**	**Pass**
Pad Shear - 2-way (Comp) (ksi)	0.164	0.017	**9.8%**	**Pass**
*Flexural 2-way (Comp) (kip*ft)*	675.84	155.47	**21.9%**	**Pass**
Pad Shear - 2-way (Uplift) (ksi)	0.164	0.052	**30.0%**	**Pass**
*Flexural 2-way (Tension) (kip*ft)*	675.84	132.19	**18.6%**	**Pass**

**Rating per TIA-222-H Section 15.5*

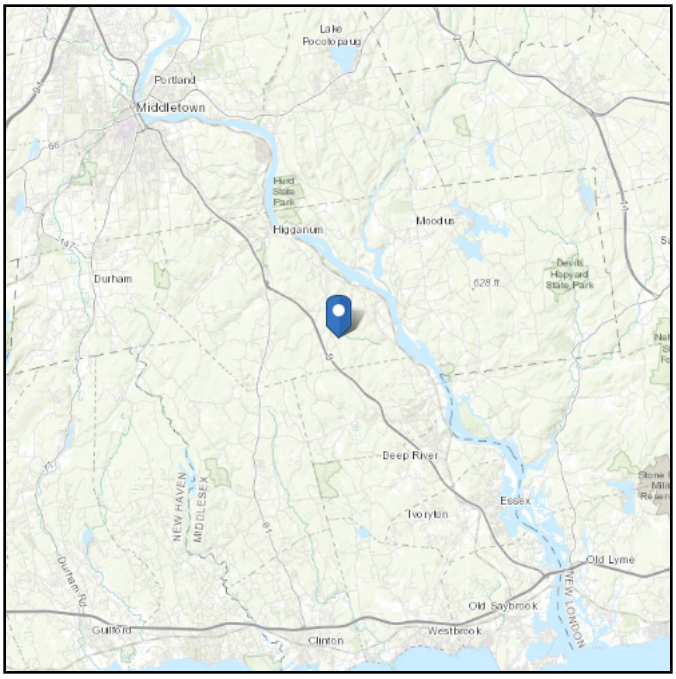
Soil Rating*:	**96.2%**
Structural Rating*:	**30.0%**

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-10
Risk Category: II
Soil Class: D - Stiff Soil

Elevation: 504.12 ft (NAVD 88)
Latitude: 41.443056
Longitude: -72.506222



Wind

Results:

Wind Speed:	130 Vmph per jurisdiction requirement
10-year MRI	78 Vmph
25-year MRI	88 Vmph
50-year MRI	96 Vmph
100-year MRI	105 Vmph

Data Source: ASCE/SEI 7-10, Fig. 26.5-1A and Figs. CC-1–CC-4, and Section 26.5.2, incorporating errata of March 12, 2014

Date Accessed: Wed Mar 31 2021

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 7-10 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

Site is in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2. Glazed openings need not be protected against wind-borne debris.

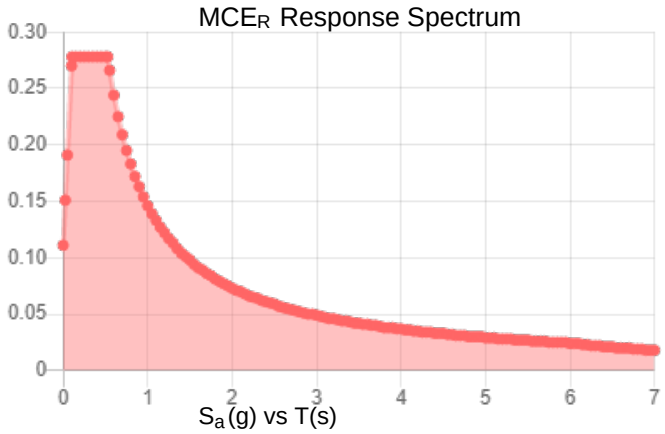
Seismic

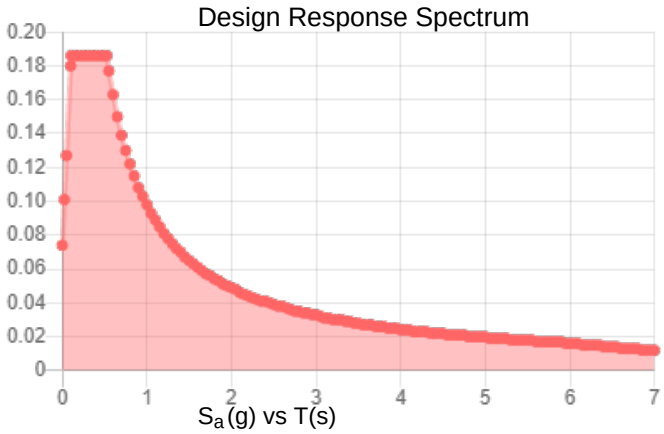
Site Soil Class: D - Stiff Soil

Results:

S_S :	0.174	S_{DS} :	0.186
S_1 :	0.061	S_{D1} :	0.098
F_a :	1.6	T_L :	6
F_v :	2.4	PGA :	0.088
S_{MS} :	0.278	PGA_M :	0.141
S_{M1} :	0.146	F_{PGA} :	1.6
		I_e :	1

Seismic Design Category B





Data Accessed: Wed Mar 31 2021

Date Source: USGS Seismic Design Maps based on ASCE/SEI 7-10, incorporating Supplement 1 and errata of March 31, 2013, and ASCE/SEI 7-10 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-10 Ch. 21 are available from USGS.

Ice

Results:

Ice Thickness:	0.75 in.
Concurrent Temperature:	15 F
Gust Speed:	50 mph
Data Source:	Standard ASCE/SEI 7-10, Figs. 10-2 through 10-8
Date Accessed:	Wed Mar 31 2021

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 50-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.