



## **Tower Analysis Report**

**Site Name:** South Brunswick 6  
**Site Location:** 136 Friendship Road  
Cranbury, New Jersey 08512  
**County:** Middlesex County  
**Block:** 37  
**Lot:** 18.04

### **Analysis Results**

**All Monopole Structural Members Pass**

#### **Prepared by:**

E 2 Project Management LLC  
87 Hibernia Avenue  
Rockaway, NJ 07866

#### **Prepared For:**

Verizon Wireless  
180 Washington Valley Road,  
Bedminster, New Jersey 07921

## Introduction

It is proposed that new antennas be added to the existing monopole. The purpose of this report is to summarize the analysis results of the structural analysis of the changes to the existing monopole.

## Analysis Criteria

Basic Wind Speed: 115 mph  
Basic Wind Speed with Ice: 50 mph  
Ice Thickness: 1”  
Standard/Code: ANSI/TIA-222-H  
2018 IBC, New Jersey  
Exposure Category: C  
Risk Category: II  
Site Soil Class: D-Default  
S<sub>s</sub>: 0.241  
S<sub>1</sub>: 0.054  
T<sub>L</sub>: 6

## Appurtenance Loading Table

Carrier	Elevation (ft.)	Description
Verizon	126.7	(3) L-SUB6-MT6407-77A
	125.0	(6) HEX656CW0000G
		(3) B2+B66 Macro RU
		(3) B13+B5 Macro RU
		(2) 3315-PF-48 OVP
	125	Platform
	125 -0	(12) 1 5/8" Coax
125-0	(2) hybrid trunk lines	
Other	125	(1) lighting Rod

## Analysis Assumptions

1. All existing structural members were inspected and are in good condition with no physical damage or deterioration associated with corrosion.
2. The monopole section dimensions are the same as shown on the original construction drawings.

## **Analysis Summary**

The analysis was performed using Bentley OpenTower Designer program. The monopole rating is 18% and the anchor roads 18% of the total capacity. This is less than the allowable 100%, Therefore the monopole is adequate for the anticipated loading.

## **Attachments**

1. Photos
2. ASCE 7-16 Hazard Report
3. Pages from Original Construction Drawings
4. Pages from Current Construction Drawings
5. Open Tower Mount Analysis Reports

**Attachment 1**  
Photos



Photo 1: Existing Monopole

## **Attachment 2**

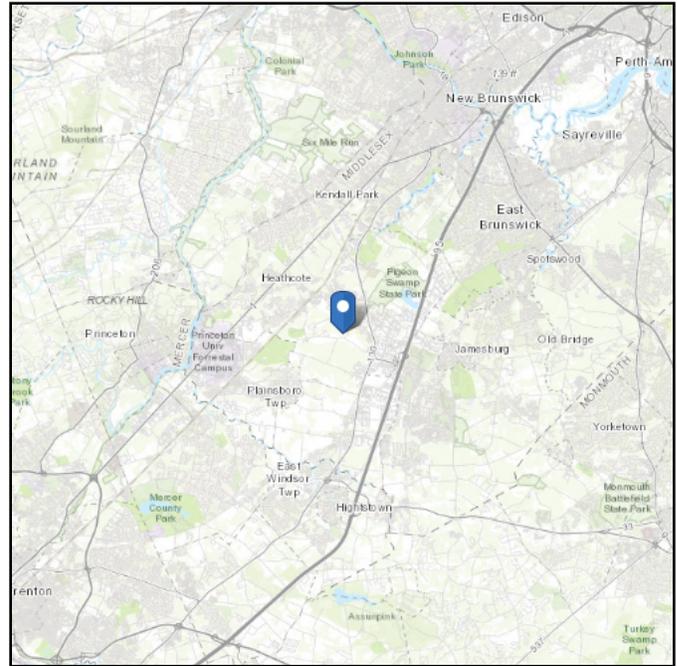
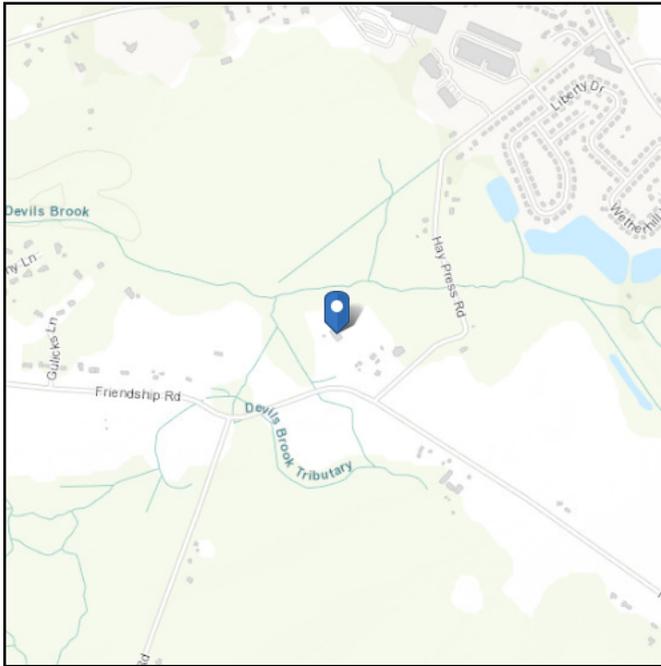
ASCE 7-16 Hazzard Report

# ASCE 7 Hazards Report

**Address:**  
136 Friendship Rd  
Cranbury, New Jersey  
08512

**Standard:** ASCE/SEI 7-16  
**Risk Category:** II  
**Soil Class:** D - Default (see Section 11.4.3)

**Elevation:** 93.3 ft (NAVD 88)  
**Latitude:** 40.361727  
**Longitude:** -74.518256



## Wind

### Results:

Wind Speed	115 Vmph
10-year MRI	75 Vmph
25-year MRI	84 Vmph
50-year MRI	90 Vmph
100-year MRI	95 Vmph

Data Source: ASCE/SEI 7-16, Fig. 26.5-1B and Figs. CC.2-1–CC.2-4, and Section 26.5.2  
Date Accessed: Wed Dec 15 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 7-16 Standard. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (annual exceedance probability = 0.00143, MRI = 700 years).

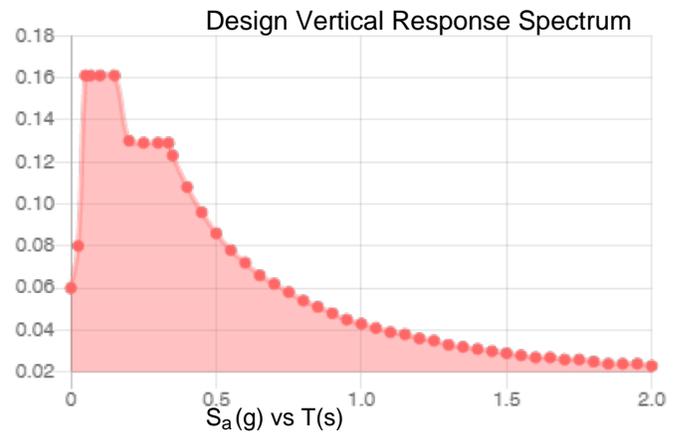
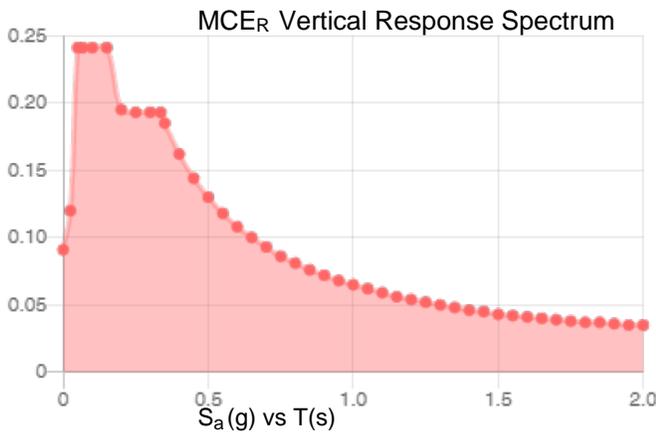
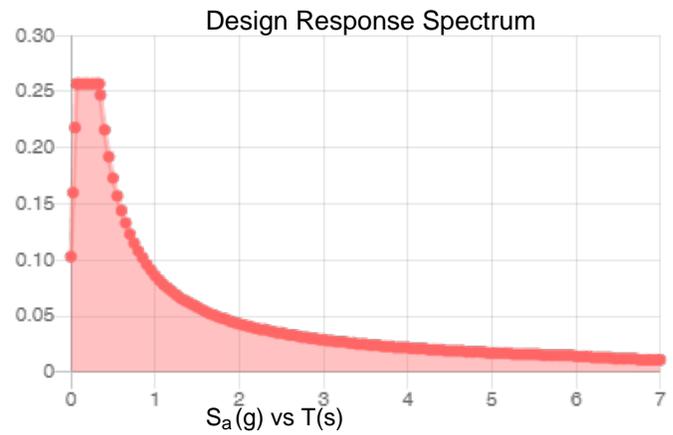
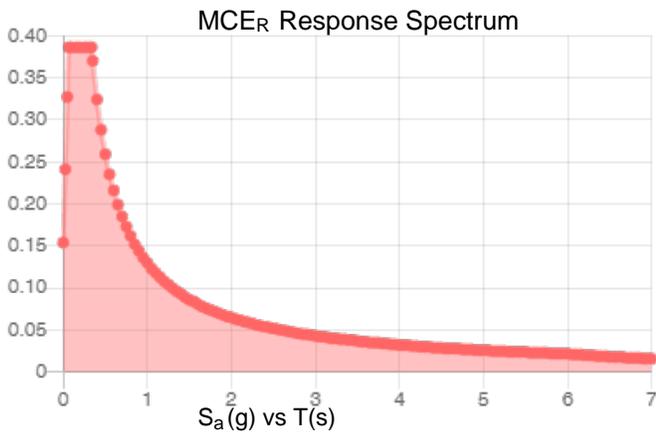
Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

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

**Results:**

$S_s$ :	0.241	$S_{D1}$ :	0.086
$S_1$ :	0.054	$T_L$ :	6
$F_a$ :	1.6	PGA :	0.143
$F_v$ :	2.4	PGA <sub>M</sub> :	0.217
$S_{MS}$ :	0.386	$F_{PGA}$ :	1.514
$S_{M1}$ :	0.13	$I_e$ :	1
$S_{DS}$ :	0.257	$C_v$ :	0.782

**Seismic Design Category** B



**Data Accessed:** Wed Dec 15 2021

**Date Source:**

**USGS Seismic Design Maps based on ASCE/SEI 7-16 and ASCE/SEI 7-16 Table 1.5-2. Additional data for site-specific ground motion procedures in accordance with ASCE/SEI 7-16 Ch. 21 are available from USGS.**

## Ice

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**Results:**

Ice Thickness: 1.00 in.  
Concurrent Temperature: 15 F  
Gust Speed 40 mph

**Data Source:** Standard ASCE/SEI 7-16, Figs. 10-2 through 10-8

**Date Accessed:** Wed Dec 15 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 500-year mean recurrence interval, and temperatures concurrent with ice thicknesses due to freezing rain. Thicknesses for ice accretions caused by other sources shall be obtained from local meteorological studies. Ice thicknesses in exposed locations at elevations higher than the surrounding terrain and in valleys and gorges may exceed the mapped values.

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## **Attachment 3**

Pages from Original Construction Drawings



# TransAmerican Power Products, Inc.

2427 Kelly Lane  
Houston, Texas 77068

PH: 281-444-8277 / FX: 281-444-7270

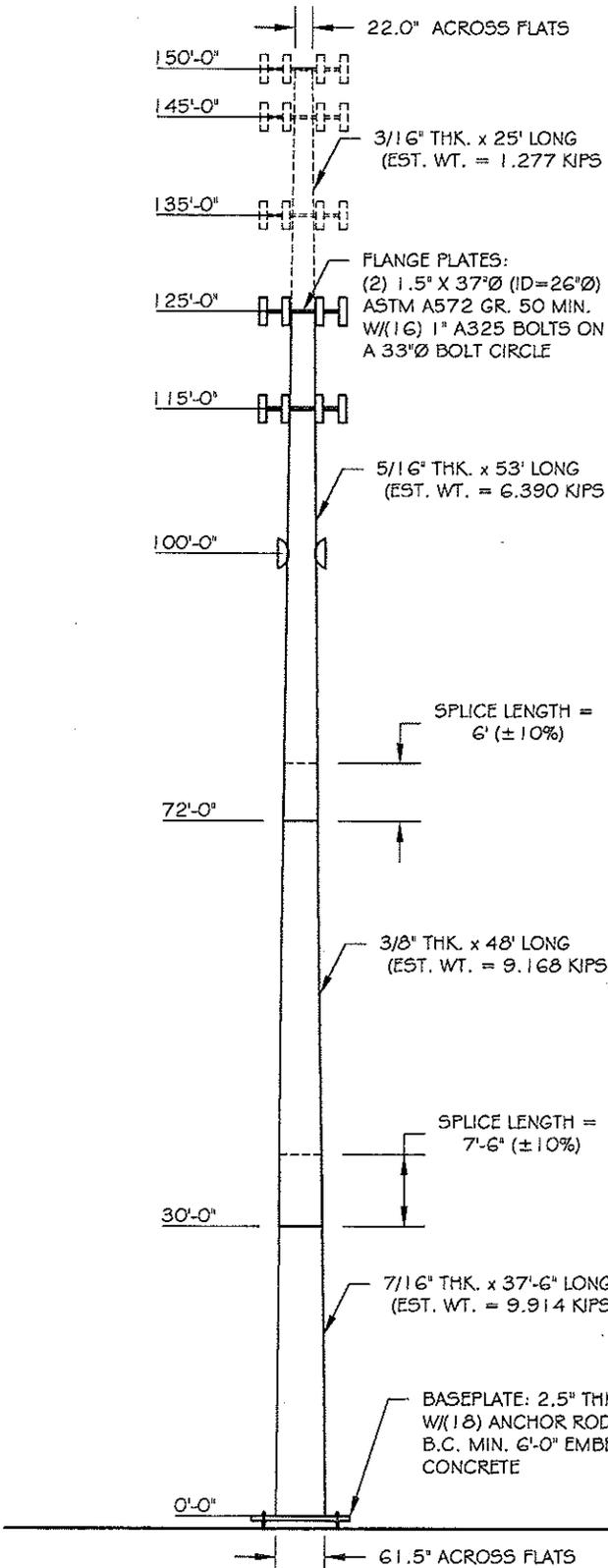
Page 1 of 2	Job Number: 23513-0090
Eng: MFP	Customer Ref: TP-11319
	Date: 4/2/2013
Structure:	125-FT POLE (FUT. 150-FT)
Site:	SOUTH BRUNSWICK 6
Location:	MIDDLESEX CO., NJ / 40°21'42.2", -74°31'7.5"
Owner:	VERIZON
Revision No.:	Revision Date:

DESIGN			
Building Code: 2006+ INTERNATIONAL BUILDING CODE			
Design Standard: ANSI/TIA-222-G-2			
Wind Speed Load Cases: 3-SEC. GUSTED WIND SPEED			
Load Case #1: 100 MPH Design Wind Speed			
Load Case #2: 50 MPH Wind with 1" Ice Accumulation			
Load Case #3: 60 MPH Service Wind Speed			
Structure Class	Exposure Cat.	Topography Cat.	Crest Height
II	C	I	

EQUIPMENT LIST	
Elev.	Description
150	(12) ANTEL BXA-80040/GCF PANEL
150	12-FT LOW PROFILE PLATFORM
145	(12) ANTEL BXA-80040/GCF PANEL
145	12-FT LOW PROFILE PLATFORM
135	(12) ANTEL BXA-80040/GCF PANEL
135	12-FT LOW PROFILE PLATFORM
125	(12) ANTEL BXA-80040/GCF PANEL
125	12-FT LOW PROFILE PLATFORM
115	(12) ANTEL BXA-80040/GCF PANEL
115	12-FT LOW PROFILE PLATFORM
100	(2) 4-FT STD. MICROWAVE DISH
100	DUAL MICROWAVE MOUNT

ANTENNA FEED LINES ROUTED ON THE INSIDE OF THE POLE

STRUCTURE PROPERTIES					
Cross-Section: 18-SIDED			Taper: 0.27250 in/ft		
Shaft Steel: ASTM A572 GR 65			Baseplate Steel: ASTM A572 GR 50		
Anchor Rods: 2.25 in. A615 GR. 75 X 7'-0" LONG					
Sect.	Length (ft)	Thickness (in)	Splice (ft)	Top Dia. (in)	Bot Dia. (in)
1	25.00	0.1875	0.00	22.00	28.81
2	53.00	0.3125	6.00	28.81	43.26
3	48.00	0.3750	7.50	41.00	54.08
4	37.50	0.4375		51.28	61.50



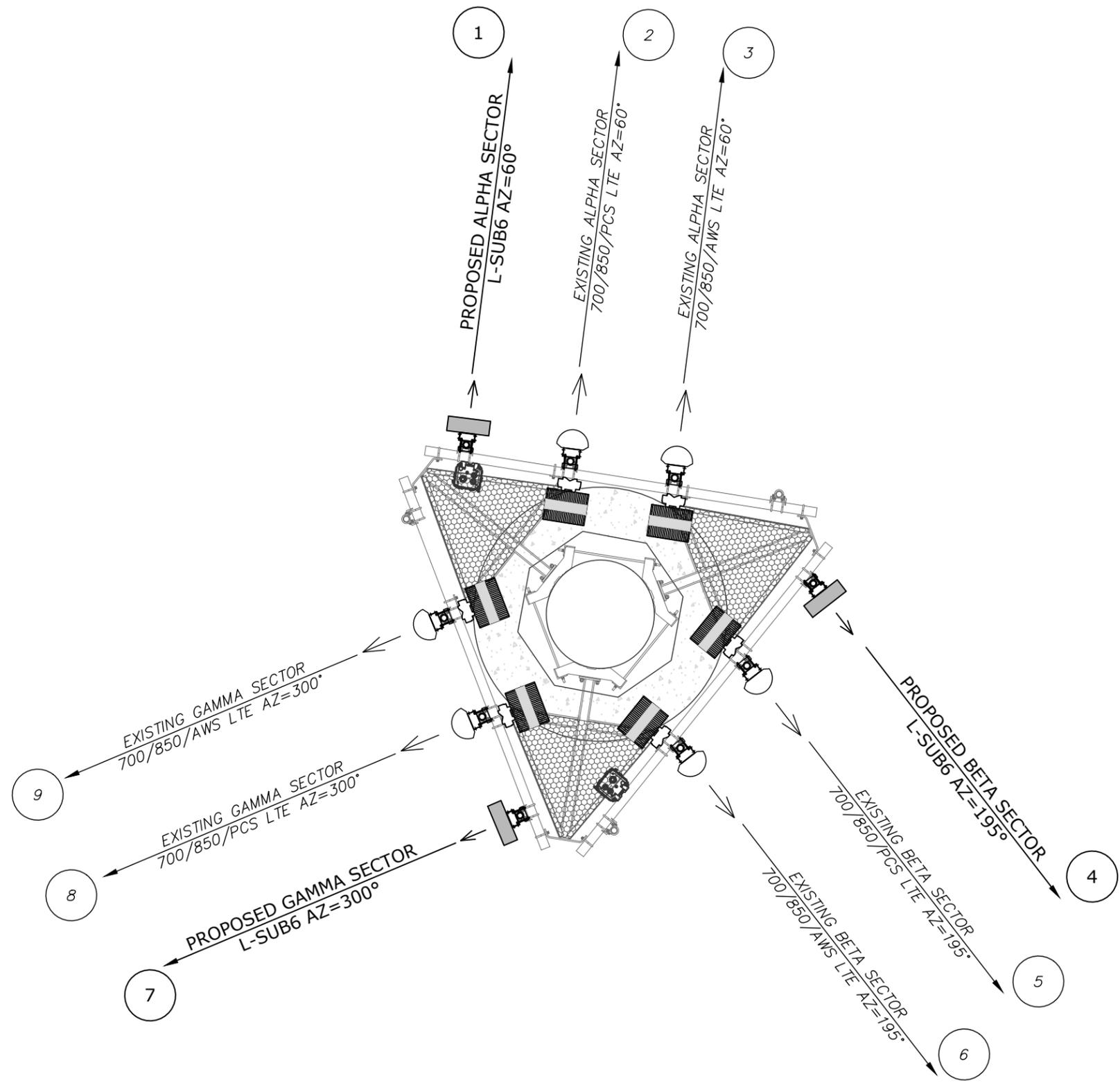
NICHOLAS P. PLAVINSKI, P.E., No. GE47130  
614-398-6250 / npl@fpp.com

### BASE REACTIONS FOR FOUNDATION DESIGN

Moment: 6250 ft-kip  
Shear: 54 kip  
Axial: 57 kip

## **Attachment 4**

Pages from Current Construction Drawings



**PROPOSED ANTENNA SCHEDULE**

	DESIGNATION	No. OF ANTENNAS	AZIMUTH (AZ)	ANTENNA CENTERLINE	ANTENNA
1	ALPHA	1 NEW	60°	126.7'± AGL.	<b>L-SUB6 - MT6407-77A</b>
2		1 EXISTING	60°	125.0'± AGL.	700/850/PCS LTE - HEX656CW0000G
3		1 EXISTING	60°	125.0'± AGL.	700/850/AWS LTE - HEX656CW0000G
4	BETA	1 NEW	195°	126.7'± AGL.	<b>L-SUB6 - MT6407-77A</b>
5		1 EXISTING	195°	125.0'± AGL.	700/850/PCS LTE - HEX656CW0000G
6		1 EXISTING	195°	125.0'± AGL.	700/850/AWS LTE - HEX656CW0000G
7	GAMMA	1 NEW	300°	126.7'± AGL.	<b>L-SUB6 - MT6407-77A</b>
8		1 EXISTING	300°	125.0'± AGL.	700/850/PCS LTE - HEX656CW0000G
9		1 EXISTING	300°	125.0'± AGL.	700/850/AWS LTE - HEX656CW0000G

**PROPOSED ANTENNA PLAN**

N.T.S

SCHEDULE OF REVISIONS					
REV. NO.	DATE	DESCRIPTION OF CHANGES	DRAWN BY	CHK. BY	
B	11/18/21	REVISED PER RF COMMENTS	AF	JS	
A	11/15/21	ISSUED FOR PRELIMINARY REVIEW/INTERNAL APPROVALS	AF	JS	

NEW YORK SMSA  
LIMITED PARTNERSHIP  
d/b/a **verizon wireless**  
180 WASHINGTON VALLEY ROAD,  
BEDMINSTER, NEW JERSEY 07921

N.J. ENGINEERING CERTIFICATE OF AUTHORIZATION No. 24GA28118200  
**E 2 PROJECT MANAGEMENT LLC**  
87 HIBERNIA AVENUE  
ROCKAWAY, N.J. 07866  
PHONE: (973) 299-5200  
FAX: (973) 299-5059  
www.E2PM.com



THIS DRAWING DOES NOT INCLUDE NECESSARY COMPONENTS FOR CONSTRUCTION SAFETY. ALL CONSTRUCTION MUST BE DONE IN COMPLIANCE WITH THE OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970 AND ALL RULES AND REGULATIONS THEREBY APPURTENANT. THIS DRAWING AND THE DESIGN FEATURES OR CONSTRUCTION DISCLOSED ARE PROPRIETARY TO E2 PROJECT MANAGEMENT LLC AND SHALL NOT BE REPRODUCED, ALTERED OR COPIED WITHOUT WRITTEN PERMISSION. SHALL NOT BE USED IN ANY MANNER DETRIMENTAL TO ITS INTEREST AND SHALL BE RETURNED UPON REQUEST.

I CERTIFY THAT THESE PLANS HAVE BEEN PREPARED UNDER MY SUPERVISION  
  
JAMES C. MURAWSKI P.E. NJ24GE04738200  
REGISTERED PROFESSIONAL ENGINEER

**PROPOSED ANTENNA PLAN**  
CELL SITE NAME:  
SOUTH BRUNSWICK 6  
  
136 FRIENDSHIP ROAD, CRANBURY,  
MIDDLESEX COUNTY, NEW JERSEY 08512  
BLOCK: 37 LOT: 18.04

DRAWING ISSUE STATUS CURRENTLY -		<b>B</b>
A- ISSUED FOR PRELIMINARY REVIEW		
B- (SPECIFY)		
C- (SPECIFY)		
D- (SPECIFY)		
FIRST ISSUE: 11/15/21	DRAWING NO.	<b>A-2</b>
DRAWN BY: AF	CHECKED BY: JS	
SCALE: AS SHOWN	SHEET NO: 7 OF 10	
PROJECT #: P-21-01-166	PRINT DATE: 11/18/21	
FILE: \\SOUTH BRUNSWICK 6-L-SUB6-01-RFP-01.dwg		

## **Attachment 5**

OpenTower Tower analysis

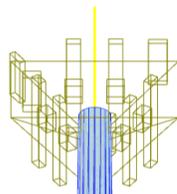
**TOWER DESIGN NOTES**

1. Tower is located in , ,
2. Tower is designed for exposure C, structure class II and topographic category 1 with crest height 0 ft.
3. Tower is designed for 115 mph basic wind in accordance with the TIA-222-H (ASCE 7-16) Standard.
4. Tower is also designed for 50 mph basic wind with 1 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon 60 mph service wind speed.
6. Tower structural rating : 17.66%.
7. Tower Weight : 25.41 kip.

**SECTION DETAILS**

Index	Section	Material	Top Elevation (ft)	Bottom Elevation (ft)	Section Length (ft)	Connection	Socket Length (ft)	Section Type	Top Dia (in)	Bottom Dia (in)	Thickness (in)	Tapered Factor	Reqd. Lap Splice(ft)
1	TT28.81x43.26x0.31x18	A572 Gr.65	125.0000	72.0000	53.0000	LapSplice	6.0000	18	28.8100	43.2600	0.3125	0.2726	5.3294
2	TT41x54.08x0.38x18	A572 Gr.65	78.0000	30.0000	48.0000	LapSplice	7.5000	18	41.0000	54.0800	0.3750	0.2725	6.6663
3	TT51.28x61.5x0.44x18	A572 Gr.65	37.5000	0.0000	37.5000	BasePlate	0.0000	18	51.2800	61.5000	0.4375	0.2725	0.0000

Top Elev. 125.00 ft



Top Elev. 78.00 ft

Top Elev. 37.50 ft

Base Elev. 0.00 ft



**LOADING DETAILS**

Mount Level(ft)	CL. Elevation(ft)	No. of Antennas	Antenna Manufacturer	Antenna Model	No. of FeedLines	FeedLine size(in)
125	126.7	3	UPT:Samsung	UPT:L-SUB6	14	1-5/8
125	125	6	AMPHENOL	HEX656CW0000G		
125	125	3	UPT:Samsung	UPT:B13+B5		
125	125	3	UPT:Samsung	UPT:B2+B66		
125	125	2	RAYCAP	RRDC-3315-PF-48		
125	125	1	MOUNTS	LP 101-C		

**TOWER SUMMARY REACTION**

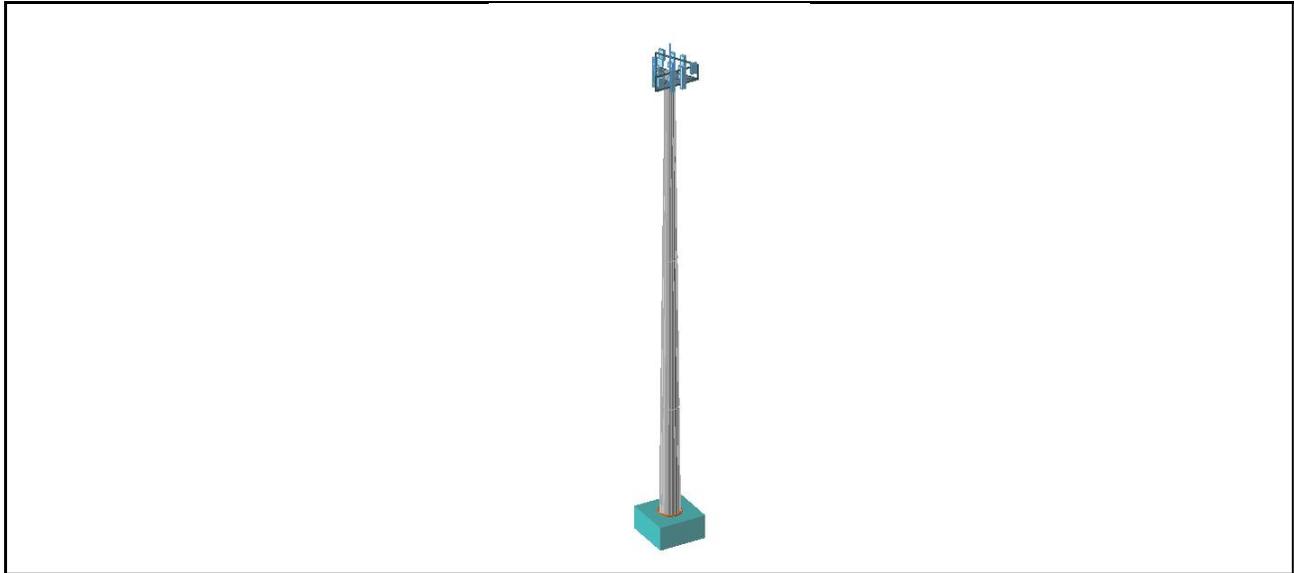
Max Reaction	Load Combination	Moment(kip-ft)	Axial(kips)	Shear(kips)
Total Overturning Moment (1.2D)	LC -PDELTA 20 1.2D + 1.0Wo-210°	1274.947	35.01	16.07
Total Overturning Moment (0.9D)	LC -PDELTA 32 0.9D + 1.0Wo-210°	1271.753	26.257	16.07
Total Overturning Moment (1.0D)	LC -PDELTA 44 1.0D + 1.0Ws-210°	346.519	29.175	4.375
Total Compression	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	386.3348	45.002	5.099
Total Shear	LC -PDELTA 32 0.9D + 1.0Wo-210°	1271.7533	26.257	16.07



Phone:

Job :			
Project :			
Client:	Drawn By:	App'd:	
Code: TIA-222-H (ASCE 7-16)	Date: 12/15/2021 12:00:00 AM	Scale: NTS	
Path:	Dwg No:		

## Tower Profile



### Summary Tower Reaction

<i>Maximum Reaction</i>	<i>Load Combination</i>	<i>Moment (kip-ft)</i>	<i>Axial (kip)</i>	<i>Shear (kip)</i>
Total Overturning Moment (1.2D)	LC -PDELTA 20 1.2D + 1.0Wo-210°	1274.947	35.01	16.07
Total Overturning Moment (0.9D)	LC -PDELTA 32 0.9D + 1.0Wo-210°	1271.753	26.257	16.07
Total Overturning Moment (1.0D)	LC -PDELTA 44 1.0D + 1.0Ws-210°	346.519	29.175	4.375
Total Compression	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	386.3348	45.002	5.099
Total Shear	LC -PDELTA 32 0.9D + 1.0Wo-210°	1271.7533	26.257	16.07

## Tower Summary

Tower Type	Monopole
Tower Height (ft)	125
Base Elevation(ft)	0
Bearing Angle with respect to North	0 deg
State	
County	
Latitude	
Longitude	
Active Scenario	Scenario1

## Wind Load Parameters

Design Standard	TIA-222-H (ASCE 7-16)-Annex S
Structure Class	II
Wind Speed (mph)	115
Service Wind Speed (mph)	60
Ice Wind Speed (mph)	50
Ice Thickness (in)	1
Ground EL above Sea Level (ft)	94

## Seismic Load Parameters

Design Standard	TIA-222-H (ASCE 7-16)
Method	Equivalent Lateral Force Procedure
Risk Category	II
Importance Factor	1
Response Modification Factor	1.5
Site Class	StiffSoilDefault
$S_s$	.241
$S_1$	.054
$T_L$	6
Fundamental Period of Tower, $T_T$	1.02052 seconds
Seismic Design Category	B

## Analysis Parameters

Type of Analysis	Non-Linear
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## Site Parameters

Wind Direction From True North (deg)	Structure Class	Exposure Category	Topographic Category
All	II	C	1

## Tower Geometry

Section ID	Section Range (ft)	Section Length (ft)	Connection	Design Lap Splice (ft)	Section Type	Section Profile	Taper Factor (in/ft)	Top Dia (in)	Bottom Dia (in)	Thickness (in)	Material	Required Lap Splice (ft)
1	125-72	53	LapSplice	6	18	TT28.81x4 3.26x0.31x 18	0.67	28.81	43.26	0.3125	A572 Gr.65	5.3294
2	78-30	48	LapSplice	7.5	18	TT41x54.0 8x0.38x18	0.76	41	54.08	0.375	A572 Gr.65	6.6662
3	37.5-0	37.5	BasePlate	0	18	TT51.28x6 1.5x0.44x1 8	0.83	51.28	61.5	0.4375	A572 Gr.65	0

## Discrete Appurtenances

Mt CL (ft)	Mount Type	Ant CL (ft)	Mfg	Model Number	Location	Horiz. Offset (ft)	Lat. Offset (ft)	Vert. Offset (ft)	Front Area (no ice) (ft2)	Side Area (no ice) (ft2)	Weight (no ice) (lbs)	Ka	Ks (fr)	Ks (Si)	Rel. Azi (deg)
125	LP 101-C	126.7	UPT:Samsung	UPT:L-SUB6	FaceA	0	-4.5	1.7	4.692	1.84	82	1	1	1	0
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceA	0	-1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsung	UPT:B13 +B5	FaceA	0	-1.5	0	1.865	1.252	73	1	1	1	180
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceA	0	1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsung	UPT:B2+ B66	FaceA	0	1.5	0	1.865	1.252	75	1	1	1	180
125	LP 101-C	126.7	UPT:Samsung	UPT:L-SUB6	FaceB	0	-4.5	1.7	4.692	1.84	82	1	1	1	0
125	LP 101-C	125	RAYCAP	RRODC- 3315-PF- 48	FaceB	0	-4.5	0	3.792	2.514	32	1	1	1	180
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceB	0	-1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsung	UPT:B13 +B5	FaceB	0	-1.5	0	1.865	1.252	73	1	1	1	180
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceB	0	1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsung	UPT:B2+ B66	FaceB	0	1.5	0	1.865	1.252	75	1	1	1	180
125	LP 101-C	126.7	UPT:Samsung	UPT:L-SUB6	FaceC	0	-4.5	1.7	4.692	1.84	82	1	1	1	0
125	LP 101-C	125	RAYCAP	RRODC- 3315-PF- 48	FaceC	0	4.5	0	3.792	2.514	32	1	1	1	180
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceC	0	-1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsung	UPT:B13 +B5	FaceC	0	-1.5	0	1.865	1.252	73	1	1	1	180

### Discrete Appurtenances Cont...

Mt CL (ft)	Mount Type	Ant CL (ft)	Mfg	Model Number	Location	Horiz. Offset (ft)	Lat. Offset (ft)	Vert. Offset (ft)	Front Area (no ice) (ft2)	Side Area (no ice) (ft2)	Weight (no ice) (lbs)	Ka	Ks (fr)	Ks (Si)	Rel. Azi (deg)
125	LP 101-C	125	AMPHENOL	HEX656C W0000G	FaceC	0	1.5	0	7.13	4.03	50.6	1	1	1	0
125	LP 101-C	125	UPT:Samsun g	UPT:B2+ B66	FaceC	0	1.5	0	1.865	1.252	75	1	1	1	180

### Miscellaneous Appurtenances

Height	Mfg	Model Number	Location	Horiz. Offset (ft)	Lat. Offset (ft)	Vert. Offset (ft)	Front Area (no ice) (ft2)	Side Area (no ice) (ft2)	Weight (no ice) (lbs)	Ka	Ks (fr)	Ks (Si)	Rel. Azi (deg)
123	LIGHTNING ROD	10' x 2.0"	Centroid	0	0	5	1.667	1.667	26.892	1	1	1	0

### Linear Attachments

Attachment ID	Attachment model	Bottom Elevation (ft)	Top Elevation (ft)	Location	lateral Offset(of face)	lateral Offset(leg) (in)	Area (no ice) (ft2/ft)	Weight (No) (lbs/ft)
1	None	0	125	Face A	0.0000	0.0000	0.0000	0.0000

### Linear Appurtenances

Attachment	Qty	Size (in)	Bottom Elv. (ft)	Top Elv. (ft)	Manufacturer	Model	Weight (No ice) (lbs/ft)
1	14	1-5/8	0	125	ANDREW	AVA7-50	0.7

### Load Combinations

Combination no	Description
52	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°
53	LC -PDELTA 2 1.2D + 1.0Di + 1.0Wi-30°
54	LC -PDELTA 3 1.2D + 1.0Di + 1.0Wi-60°
55	LC -PDELTA 4 1.2D + 1.0Di + 1.0Wi-90°
56	LC -PDELTA 5 1.2D + 1.0Di + 1.0Wi-120°
57	LC -PDELTA 6 1.2D + 1.0Di + 1.0Wi-150°

### Load Combinations Cont...

<i>Combination no</i>	<i>Description</i>
58	LC -PDELTA 7 1.2D + 1.0Di + 1.0Wi-180°
59	LC -PDELTA 8 1.2D + 1.0Di + 1.0Wi-210°
60	LC -PDELTA 9 1.2D + 1.0Di + 1.0Wi-240°
61	LC -PDELTA 10 1.2D + 1.0Di + 1.0Wi-270°
62	LC -PDELTA 11 1.2D + 1.0Di + 1.0Wi-300°
63	LC -PDELTA 12 1.2D + 1.0Di + 1.0Wi-330°
64	LC -PDELTA 13 1.2D + 1.0Wo-0°
65	LC -PDELTA 14 1.2D + 1.0Wo-30°
66	LC -PDELTA 15 1.2D + 1.0Wo-60°
67	LC -PDELTA 16 1.2D + 1.0Wo-90°
68	LC -PDELTA 17 1.2D + 1.0Wo-120°
69	LC -PDELTA 18 1.2D + 1.0Wo-150°
70	LC -PDELTA 19 1.2D + 1.0Wo-180°
71	LC -PDELTA 20 1.2D + 1.0Wo-210°
72	LC -PDELTA 21 1.2D + 1.0Wo-240°
73	LC -PDELTA 22 1.2D + 1.0Wo-270°
74	LC -PDELTA 23 1.2D + 1.0Wo-300°
75	LC -PDELTA 24 1.2D + 1.0Wo-330°
76	LC -PDELTA 25 0.9D + 1.0Wo-0°
77	LC -PDELTA 26 0.9D + 1.0Wo-30°

### Load Combinations Cont...

<i>Combination no</i>	<i>Description</i>
78	LC -PDELTA 27 0.9D + 1.0W <sub>o</sub> -60°
79	LC -PDELTA 28 0.9D + 1.0W <sub>o</sub> -90°
80	LC -PDELTA 29 0.9D + 1.0W <sub>o</sub> -120°
81	LC -PDELTA 30 0.9D + 1.0W <sub>o</sub> -150°
82	LC -PDELTA 31 0.9D + 1.0W <sub>o</sub> -180°
83	LC -PDELTA 32 0.9D + 1.0W <sub>o</sub> -210°
84	LC -PDELTA 33 0.9D + 1.0W <sub>o</sub> -240°
85	LC -PDELTA 34 0.9D + 1.0W <sub>o</sub> -270°
86	LC -PDELTA 35 0.9D + 1.0W <sub>o</sub> -300°
87	LC -PDELTA 36 0.9D + 1.0W <sub>o</sub> -330°
88	LC -PDELTA 37 1.0D + 1.0W <sub>s</sub> -0°
89	LC -PDELTA 38 1.0D + 1.0W <sub>s</sub> -30°
90	LC -PDELTA 39 1.0D + 1.0W <sub>s</sub> -60°
91	LC -PDELTA 40 1.0D + 1.0W <sub>s</sub> -90°
92	LC -PDELTA 41 1.0D + 1.0W <sub>s</sub> -120°
93	LC -PDELTA 42 1.0D + 1.0W <sub>s</sub> -150°
94	LC -PDELTA 43 1.0D + 1.0W <sub>s</sub> -180°
95	LC -PDELTA 44 1.0D + 1.0W <sub>s</sub> -210°
96	LC -PDELTA 45 1.0D + 1.0W <sub>s</sub> -240°
97	LC -PDELTA 46 1.0D + 1.0W <sub>s</sub> -270°
98	LC -PDELTA 47 1.0D + 1.0W <sub>s</sub> -300°

### Load Combinations Cont...

Combination no	Description
99	LC -PDELTA 48 1.0D + 1.0Ws-330°

### Maximum Member Forces

Section ID	Panel Elevation (ft)	Member Class	Condition	Critical Load Combintion	Force (kip)	Major Axis Moment (kip-ft)	Minor Axis Moment (kip-ft)
1	125-72	Tapered	Max Compression	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	16.9263	0.161	-101.6713
1	125-72	Tapered	Max Vy	LC -PDELTA 16 1.2D + 1.0Wo-90°	11.8341	-358.275	-0.0924
1	125-72	Tapered	Max Vz	LC -PDELTA 13 1.2D + 1.0Wo-0°	11.8341	0.16	-360.1316
1	125-72	Tapered	Max Mz	LC -PDELTA 22 1.2D + 1.0Wo-270°	11.8341	358.595	-0.0924
1	125-72	Tapered	Max My	LC -PDELTA 13 1.2D + 1.0Wo-0°	11.8341	0.16	-360.1316
2	78-30	Tapered	Max Compression	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	30.805	0.1624	-246.7292
2	78-30	Tapered	Max Vy	LC -PDELTA 16 1.2D + 1.0Wo-90°	23.0571	-828.0172	-0.093
2	78-30	Tapered	Max Vz	LC -PDELTA 13 1.2D + 1.0Wo-0°	23.0571	0.1611	-831.1501
2	78-30	Tapered	Max Mz	LC -PDELTA 22 1.2D + 1.0Wo-270°	23.0571	828.3394	-0.093
2	78-30	Tapered	Max My	LC -PDELTA 13 1.2D + 1.0Wo-0°	23.0571	0.1611	-831.1501
3	37.5-0	Tapered	Max Compression	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	44.179	0.1629	-386.2645
3	37.5-0	Tapered	Max Vy	LC -PDELTA 16 1.2D + 1.0Wo-90°	34.2962	-1268.7775	-0.0932
3	37.5-0	Tapered	Max Vz	LC -PDELTA 13 1.2D + 1.0Wo-0°	34.2962	0.1614	-1272.8158

**Maximum Member Forces Cont...**

Section ID	Panel Elevation (ft)	Member Class	Condition	Critical Load Combintion	Force (kip)	Major Axis Moment (kip-ft)	Minor Axis Moment (kip-ft)
3	37.5-0	Tapered	Max Mz	LC -PDELTA 22 1.2D + 1.0Wo-270°	34.2962	1269.1004	-0.0932
3	37.5-0	Tapered	Max My	LC -PDELTA 13 1.2D + 1.0Wo-0°	34.2962	0.1614	-1272.8158

**Tower Reaction Summary**

Node Id	Load Combination	Vertical kip	Shear x kip	Shear z kip	Overturning Moment, Mx kip-ft	Overturning Moment, Mz kip-ft	Torque kip-ft
34	LC -PDELTA 1 1.2D + 1.0Di + 1.0Wi-0°	45.0021	0.0000	5.0993	386.3347	-0.1629	0.0700
34	LC -PDELTA 2 1.2D + 1.0Di + 1.0Wi-30°	45.0021	-2.5510	4.4178	334.8337	193.0880	-0.0934
34	LC -PDELTA 3 1.2D + 1.0Di + 1.0Wi-60°	45.0021	-4.4152	2.5495	193.1567	334.2436	0.2513
34	LC -PDELTA 4 1.2D + 1.0Di + 1.0Wi-90°	45.0021	-5.0933	0.0000	0.0940	385.3148	0.3716
34	LC -PDELTA 5 1.2D + 1.0Di + 1.0Wi-120°	45.0021	-4.4073	-2.5450	-192.3926	333.2453	-0.0906
34	LC -PDELTA 6 1.2D + 1.0Di + 1.0Wi-150°	45.0021	-2.5465	-4.4099	-333.6473	192.5119	-0.3716
34	LC -PDELTA 7 1.2D + 1.0Di + 1.0Wi-180°	45.0021	0.0000	-5.0993	-386.1466	-0.1629	-0.0700
34	LC -PDELTA 8 1.2D + 1.0Di + 1.0Wi-210°	45.0021	2.5510	-4.4178	-334.6456	-193.4138	0.0934
34	LC -PDELTA 9 1.2D + 1.0Di + 1.0Wi-240°	45.0021	4.4152	-2.5495	-192.9687	-334.5694	-0.2513
34	LC -PDELTA 10 1.2D + 1.0Di + 1.0Wi-270°	45.0021	5.0933	0.0000	0.0940	-385.6406	-0.3716
34	LC -PDELTA 11 1.2D + 1.0Di + 1.0Wi-300°	45.0021	4.4073	2.5450	192.5807	-333.5711	0.0906
34	LC -PDELTA 12 1.2D + 1.0Di + 1.0Wi-330°	45.0021	2.5465	4.4099	333.8354	-192.8377	0.3716

**Tower Reaction Summary Cont...**

<i>Node Id</i>	<i>Load Combination</i>	<i>Vertical</i> <i>kip</i>	<i>Shear x</i> <i>kip</i>	<i>Shear z</i> <i>kip</i>	<i>Overturing</i> <i>Moment, Mx</i> <i>kip-ft</i>	<i>Overturing</i> <i>Moment, Mz</i> <i>kip-ft</i>	<i>Torque</i> <i>kip-ft</i>
34	LC -PDELTA 13 1.2D + 1.0Wo-0°	35.0096	0.0000	16.0552	1.2730e+3	-0.1614	0.2966
34	LC -PDELTA 14 1.2D + 1.0Wo-30°	35.0096	-8.0359	13.9168	1.1042e+3	637.3485	-0.5463
34	LC -PDELTA 15 1.2D + 1.0Wo-60°	35.0096	-13.9038	8.0284	636.6569	1.1023e+3	1.1996
34	LC -PDELTA 16 1.2D + 1.0Wo-90°	35.0096	-16.0253	0.0000	0.0932	1.2690e+3	1.8420
34	LC -PDELTA 17 1.2D + 1.0Wo-120°	35.0096	-13.8650	-8.0060	-633.6343	1.0974e+3	-0.4515
34	LC -PDELTA 18 1.2D + 1.0Wo-150°	35.0096	-8.0135	-13.8779	-1.0991e+3	634.5123	-1.8420
34	LC -PDELTA 19 1.2D + 1.0Wo-180°	35.0096	0.0000	-16.0552	-1.2728e+3	-0.1614	-0.2966
34	LC -PDELTA 20 1.2D + 1.0Wo-210°	35.0096	8.0359	-13.9168	-1.1040e+3	-637.6714	0.5463
34	LC -PDELTA 21 1.2D + 1.0Wo-240°	35.0096	13.9038	-8.0284	-636.4705	-1.1026e+3	-1.1996
34	LC -PDELTA 22 1.2D + 1.0Wo-270°	35.0096	16.0253	0.0000	0.0932	-1.2693e+3	-1.8420
34	LC -PDELTA 23 1.2D + 1.0Wo-300°	35.0096	13.8650	8.0060	633.8207	-1.0977e+3	0.4515
34	LC -PDELTA 24 1.2D + 1.0Wo-330°	35.0096	8.0135	13.8779	1.0993e+3	-634.8351	1.8420
34	LC -PDELTA 25 0.9D + 1.0Wo-0°	26.2572	0.0000	16.0552	1.2698e+3	-0.1205	0.2966
34	LC -PDELTA 26 0.9D + 1.0Wo-30°	26.2572	-8.0359	13.9168	1.1014e+3	635.7923	-0.5463
34	LC -PDELTA 27 0.9D + 1.0Wo-60°	26.2572	-13.9038	8.0284	635.0389	1.0996e+3	1.1996

**Tower Reaction Summary Cont...**

<i>Node Id</i>	<i>Load Combination</i>	<i>Vertical</i> <i>kip</i>	<i>Shear x</i> <i>kip</i>	<i>Shear z</i> <i>kip</i>	<i>Overturing</i> <i>Moment, Mx</i> <i>kip-ft</i>	<i>Overturing</i> <i>Moment, Mz</i> <i>kip-ft</i>	<i>Torque</i> <i>kip-ft</i>
34	LC -PDELTA 28 0.9D + 1.0Wo-90°	26.2572	-16.0253	0.0000	0.0696	1.2658e+3	1.8420
34	LC -PDELTA 29 0.9D + 1.0Wo-120°	26.2572	-13.8650	-8.0060	-632.0721	1.0947e+3	-0.4515
34	LC -PDELTA 30 0.9D + 1.0Wo-150°	26.2572	-8.0135	-13.8779	-1.0964e+3	632.9646	-1.8420
34	LC -PDELTA 31 0.9D + 1.0Wo-180°	26.2572	0.0000	-16.0552	-1.2697e+3	-0.1205	-0.2966
34	LC -PDELTA 32 0.9D + 1.0Wo-210°	26.2572	8.0359	-13.9168	-1.1013e+3	-636.0333	0.5463
34	LC -PDELTA 33 0.9D + 1.0Wo-240°	26.2572	13.9038	-8.0284	-634.8998	-1.0998e+3	-1.1996
34	LC -PDELTA 34 0.9D + 1.0Wo-270°	26.2572	16.0253	0.0000	0.0696	-1.2661e+3	-1.8420
34	LC -PDELTA 35 0.9D + 1.0Wo-300°	26.2572	13.8650	8.0060	632.2112	-1.0949e+3	0.4515
34	LC -PDELTA 36 0.9D + 1.0Wo-330°	26.2572	8.0135	13.8779	1.0965e+3	-633.2056	1.8420
34	LC -PDELTA 37 1.0D + 1.0Ws-0°	29.1747	0.0000	4.3698	345.9718	-0.1341	0.0807
34	LC -PDELTA 38 1.0D + 1.0Ws-30°	29.1747	-2.1880	3.7885	300.1438	173.1730	-0.1487
34	LC -PDELTA 39 1.0D + 1.0Ws-60°	29.1747	-3.7850	2.1859	173.1269	299.4879	0.3265
34	LC -PDELTA 40 1.0D + 1.0Ws-90°	29.1747	-4.3617	0.0000	0.0774	344.7314	0.5014
34	LC -PDELTA 41 1.0D + 1.0Ws-120°	29.1747	-3.7744	-2.1798	-172.2020	298.1535	-0.1229
34	LC -PDELTA 42 1.0D + 1.0Ws-150°	29.1747	-2.1819	-3.7779	-298.6545	172.4016	-0.5014

**Tower Reaction Summary Cont...**

<i>Node Id</i>	<i>Load Combination</i>	<i>Vertical</i> <i>kip</i>	<i>Shear x</i> <i>kip</i>	<i>Shear z</i> <i>kip</i>	<i>Overturning</i> <i>Moment, Mx</i> <i>kip-ft</i>	<i>Overturning</i> <i>Moment, Mz</i> <i>kip-ft</i>	<i>Torque</i> <i>kip-ft</i>
34	LC -PDELTA 43 1.0D + 1.0Ws-180°	29.1747	0.0000	-4.3698	-345.8170	-0.1341	-0.0807
34	LC -PDELTA 44 1.0D + 1.0Ws-210°	29.1747	2.1880	-3.7885	-299.9890	-173.4411	0.1487
34	LC -PDELTA 45 1.0D + 1.0Ws-240°	29.1747	3.7850	-2.1859	-172.9721	-299.7561	-0.3265
34	LC -PDELTA 46 1.0D + 1.0Ws-270°	29.1747	4.3617	0.0000	0.0774	-344.9995	-0.5014
34	LC -PDELTA 47 1.0D + 1.0Ws-300°	29.1747	3.7744	2.1798	172.3568	-298.4216	0.1229
34	LC -PDELTA 48 1.0D + 1.0Ws-330°	29.1747	2.1819	3.7779	298.8094	-172.6698	0.5014

Deflection Profile

**Critical Load Combination : LC -PDELTA 20 1.2D + 1.0Wo-210°**



**Design Summary: Whole Model [ TIA-222-H ]**

**Monopole Design Summary**

Section ID	Tower Elevation (ft)	$P_u$ (kips)	$\phi P_n$ (kips)	$V_u$ (kips)	$\phi V_n$ (kips)	$T_u$ (kip-ft)	$\phi T_n$ (kip-ft)	$M_u$ (kip-ft)	$\phi M_n$ (kip-ft)	Capacity Ratio (%)
1	125-72	10.3074	2395.3161	8.2069	718.5948	0.5463	2601.7117	307.1625	2385.9773	12.68
2	78-30	20.8277	3594.5857	12.2072	1078.3757	0.5463	4882.3076	735.8987	4410.0354	16.46
3	37.5-0	35.0096	4956.8881	15.8748	1487.0664	0.5463	7957.768	1274.7411	7152.2436	17.66

**Monopole Details**

Section ID	Tower Elevation (ft)	Member Description	Length (ft)	A (in <sup>2</sup> )	Z (in <sup>3</sup> )	F <sub>y</sub> (ksi)	F <sub>u</sub> (ksi)
1	125-72	TT28.81x43.26x0.31x18	53	40.946	0	65	80
2	78-30	TT41x54.08x0.38x18	48	61.446	0	65	80
3	37.5-0	TT51.28x61.5x0.44x18	37.5	84.733	0	65	80

**Anchor Rod Summary**

Anchor Rod Group ID	Elevation (ft)	Critical Load ID	$P_u$ (kips)	$P_n$ (kips)	$V_u$ (kips)	$V_n$ (kips)	$M_u$ (kips)	$M_n$ (kips)	Capacity Ratio
1	0	71	-51.1969	268.3853	0.8928	120.7734	0	0	18.1727