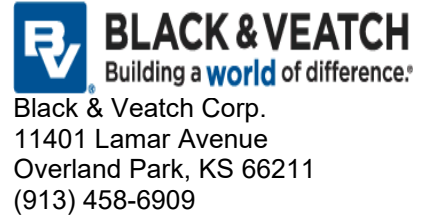


Date: **January 17, 2023**



Subject: **Structural Analysis Report**

Carrier Designation: **DISH Network Co-Locate**
Site Number: **DNDEN00109C**

Crown Castle Designation: **BU Number:** **877033**
Site Name: **2460 WAYNOKA PL**
JDE Job Number: **738698**
Work Order Number: **2195821**
Order Number: **642646 Rev. 2**

Engineering Firm Designation: **Black & Veatch Corp. Project Number:** **406642**

Site Data: **2427 Waynoka Road, Colorado Springs, El Paso County, CO 80915**
Latitude 38° 51' 59.97", Longitude -104° 43' 8.18"
55.5 Foot - Monopole Tower

Black & Veatch Corp. 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 2015 International Building Code and 2017 Edition of the Pikes Peak Regional Building Code. Applicable Standard references and design criteria are listed in Section 2 - Analysis Criteria.

Structural analysis prepared by: Danuwat Maoleethong / Khushal Patel

Respectfully submitted by:

Ping Jiang, P.E.
Professional Engineer



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1) INTRODUCTION

This tower is a 55.5 ft Monopole tower designed by Fort Worth Tower, Inc.

2) ANALYSIS CRITERIA

TIA-222 Revision:	TIA-222-H
Risk Category:	II
Wind Speed:	130 mph
Exposure Category:	C
Topographic Factor:	1
Seismic Ss:	0.175
Seismic S1:	0.060
Service Wind Speed:	60 mph
Seismic Loading:	Does not control per engineering judgment

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)
47.0	47.0	3	fujitsu	TA08025-B604	1	1 3/8
		3	fujitsu	TA08025-B605		
		3	jma wireless	MX08FRO665-21 w/ Mount Pipe		
		1	raycap	RDIDC-9181-PF-48_V2		
		1	tower mounts	Commscope MC-PK8-DSH		

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)
60.0	60.0	1	commscope	MC-PM12M-AP4 w/ MT-195-12HD, PVS-050B-U Platform Mount [LP 301-1_KCKR]	6	7/8
		3	andrew	HBXX-6517DS-A2M	3	1
		2	commscope	HCS 2.0 Part 1	1	1 1/4
		3	nokia	AEHC	2	1 1/2
		3	nokia	AHFIG_TMO		

3) ANALYSIS PROCEDURE

Table 3 - Documents Provided

Document	Reference	Source
4-GEOTECHNICAL REPORTS	1539571	CCISITES
4-TOWER FOUNDATION DRAWINGS/DESIGN/SPECS	1463322	CCISITES
4-TOWER MANUFACTURER DRAWINGS	1462026	CCISITES

3.1) Analysis Method

tnxTower (version 8.1.1.0), 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.

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. Black & Veatch Corp. should be notified to determine the effect on the structural integrity of the tower.

4) ANALYSIS RESULTS

Table 4 - Section Capacity (Summary) (Monopole Tower)

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
L1	55.5 - 42	Pole	TP15.448x12x0.1875	1	-6.40	539.18	31.1	Pass
L2	42 - 0	Pole	TP25.8x14.5622x0.1875	2	-9.43	936.28	66.2	Pass
							Summary	
						Pole (L2)	66.2	Pass
						Rating =	66.2	Pass

Table 5 - Tower Component Stresses vs. Capacity (Monopole Tower) - LC7

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	50.9	Pass
1	Base Plate	0	51.6	Pass
1	Base Foundation (Structure)	0	21.3	Pass
1	Base Foundation (Soil Interaction)	0	20.4	Pass

Structure Rating (max from all components) =	66.2%
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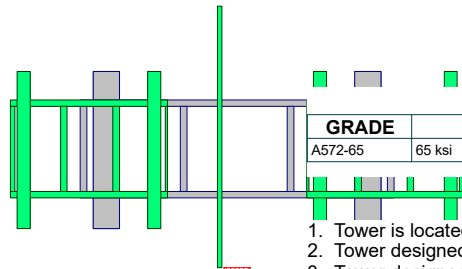
Note:

- 1) See additional documentation in "Appendix C – Additional Calculations" for calculations supporting the % capacity. Rating per TIA-222-H Section 15.5.

4.1) Recommendations

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

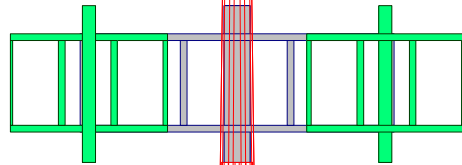
APPENDIX A
TNXTOWER OUTPUT



MATERIAL STRENGTH			MATERIAL STRENGTH		
GRADE	Fy	Fu	GRADE	Fy	Fu
A572-65	65 ksi	80 ksi			

TOWER DESIGN NOTES

1. Tower is located in El Paso County, Colorado.
2. Tower designed for Exposure C to the TIA-222-H Standard.
3. Tower designed for a 130 mph basic wind in accordance with the TIA-222-H Standard.
4. Deflections are based upon a 60 mph wind.
5. Tower Risk Category II.
6. Topographic Category 1 with Crest Height of 0.00 ft
7. TOWER RATING: 66.2%



55.5 ft

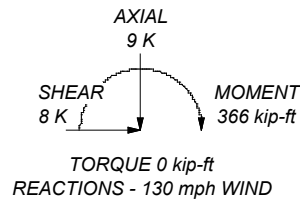
42.0 ft



0.0 ft

Section	1	2
Length (ft)	13.50	44.00
Number of Sides	18	18
Thickness (in)	0.1875	0.1875
Socket Length (ft)	2.00	14.5622
Top Dia (in)	12.0000	25.8000
Bot Dia (in)	15.4480	
Grade		A572-65
Weight (K)	0.4	1.8

ALL REACTIONS ARE FACTORED



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Black & Veatch Corp.
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Overland Park, KS 66211
Phone: (913) 458-6909
FAX: (913) 458-8136

Job: 2460 WAYNOKA PL (BU# 877033)		
Project: 406642 (877033.2195821)		
Client: Crown Castle	Drawn by: Khushal Patel	App'd:
Code: TIA-222-H	Date: 01/17/23	Scale: NTS
Path:		Dwg No. E-1

Tower Input Data

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

- Tower is located in El Paso County, Colorado.
- Tower base elevation above sea level: 6383.00 ft.
- Basic wind speed of 130 mph.
- Risk Category II.
- Exposure Category C.
- Simplified Topographic Factor Procedure for wind speed-up calculations is used.
- Topographic Category: 1.
- Crest Height: 0.00 ft.
- Deflections calculated using a wind speed of 60 mph.
- A non-linear (P-delta) analysis was used.
- Pressures are calculated at each section.
- Stress ratio used in pole design is 1.
- Tower analysis based on target reliabilities in accordance with Annex S.
- Load Modification Factors used: $K_{es}(F_w) = 0.95$.
- 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 Consider Moments - Horizontals Consider Moments - Diagonals Use Moment Magnification ✓ Use Code Stress Ratios ✓ Use Code Safety Factors - Guys Escalate Ice Always Use Max Kz Use Special Wind Profile Include Bolts In Member Capacity Leg Bolts Are At Top Of Section Secondary Horizontal Braces Leg Use Diamond Inner Bracing (4 Sided) SR Members Have Cut Ends SR Members Are Concentric	Distribute Leg Loads As Uniform Assume Legs Pinned ✓ Assume Rigid Index Plate ✓ Use Clear Spans For Wind Area Use Clear Spans For KL/r Retension Guys To Initial Tension ✓ Bypass Mast Stability Checks ✓ Use Azimuth Dish Coefficients ✓ Project Wind Area of Appurt. Autocalc Torque Arm Areas Add IBC .6D+W Combination Sort Capacity Reports By Component Triangulate Diamond Inner Bracing Treat Feed Line Bundles As Cylinder Ignore KL/ry For 60 Deg. Angle Legs	Use ASCE 10 X-Brace Ly Rules Calculate Redundant Bracing Forces Ignore Redundant Members in FEA SR Leg Bolts Resist Compression All Leg Panels Have Same Allowable Offset Girt At Foundation ✓ Consider Feed Line Torque Include Angle Block Shear Check Use TIA-222-H Bracing Resist. Exemption Use TIA-222-H Tension Splice Exemption <div style="text-align: center; background-color: #e0e0e0; padding: 2px;">Poles</div> ✓ Include Shear-Torsion Interaction Always Use Sub-Critical Flow Use Top Mounted Sockets Pole Without Linear Attachments Pole With Shroud Or No Appurtenances Outside and Inside Corner Radii Are Known
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Tapered Pole Section Geometry

Section	Elevation	Section Length	Splice Length	Number of Sides	Top Diameter	Bottom Diameter	Wall Thickness	Bend Radius	Pole Grade
	ft	ft	ft		in	in	in	in	
L1	55.50-42.00	13.50	2.00	18	12.0000	15.4480	0.1875	0.7500	A572-65 (65 ksi)
L2	42.00-0.00	44.00		18	14.5622	25.8000	0.1875	0.7500	A572-65 (65 ksi)

Tapered Pole Properties

Section	Tip Dia. in	Area in ²	I in ⁴	r in	C in	I/C in ³	J in ⁴	It/Q in ²	w in	w/t
L1	12.1562	7.0299	123.9285	4.1934	6.0960	20.3295	248.0200	3.5156	1.7820	9.504
	15.6574	9.0819	267.2095	5.4175	7.8476	34.0499	534.7707	4.5418	2.3888	12.741
L2	15.2766	8.5547	223.3267	5.1030	7.3976	30.1891	446.9473	4.2782	2.2329	11.909
	26.1691	15.2426	1263.2856	9.0924	13.1064	96.3869	2528.2335	7.6228	4.2108	22.458

Tower Elevation	Gusset Area (per face)	Gusset Thickness	Gusset Grade	Adjust. Factor A _r	Adjust. Factor A _r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals	Double Angle Stitch Bolt Spacing Horizontals	Double Angle Stitch Bolt Spacing Redundants
ft	ft ²	in					in	in	in
L1 55.50-42.00				1	1	1			
L2 42.00-0.00				1	1	1			

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	Sector	Exclude From Torque Calculation	Component Type	Placement ft	Total Number	Number Per Row	Start/End Position	Width or Diameter r in	Perimeter r in	Weight plf
Safety Line 3/8 ***	C	No	Surface Ar (CaAa)	55.50 - 9.50	1	1	0.100 0.120	0.3750		0.22
CU12PSM9P8XXX(1-3/8) ***	B	No	Surface Ar (CaAa)	47.00 - 0.00	1	1	-0.500 -0.432	1.4110		1.66

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Exclude From Torque Calculation	Component Type	Placement ft	Total Number	C _A A _A ft ² /ft	Weight plf

LDF5-50A(7/8)	C	No	No	Inside Pole	55.50 - 8.00	6	No Ice 0.00	0.33
LDF2-2R(1)	C	No	No	Inside Pole	55.50 - 0.00	3	No Ice 0.00	0.30
HCS 2.0 Part 3(1-1/2)	C	No	No	Inside Pole	55.50 - 8.00	2	No Ice 0.00	1.71
LDF6-50A(1-1/4) ***	C	No	No	Inside Pole	55.50 - 0.00	1	No Ice 0.00	0.60

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A _R ft ²	A _F ft ²	C _A A _A In Face ft ²	C _A A _A Out Face ft ²	Weight K
L1	55.50-42.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.706	0.000	0.01
		C	0.000	0.000	0.506	0.000	0.10
L2	42.00-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	5.926	0.000	0.07

Tower Section	Tower Elevation ft	Face	A_R ft ²	A_F ft ²	C_{AA} In Face ft ²	C_{AA} Out Face ft ²	Weight K
		C	0.000	0.000	1.219	0.000	0.25

Feed Line Center of Pressure

Section	Elevation ft	CP_x in	CP_z in	CP_x Ice in	CP_z Ice in
L1	55.50-42.00	-0.0323	-0.1767	-0.0204	-0.1117
L2	42.00-0.00	0.0313	-0.8811	0.0199	-0.5622

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

Shielding Factor K_a

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
L1	1	Safety Line 3/8	42.00 - 55.50	1.0000	1.0000
L1	8	CU12PSM9P8XXX(1-3/8)	42.00 - 47.00	1.0000	1.0000
L2	1	Safety Line 3/8	9.50 - 42.00	1.0000	1.0000
L2	8	CU12PSM9P8XXX(1-3/8)	0.00 - 42.00	1.0000	1.0000

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment t °	Placement ft	C_{AA} Front ft ²	C_{AA} Side ft ²	Weight K	
Lighting Rod 3/4" x 10'	C	From Leg	0.25 0.00 5.00	0.0000	55.50	No Ice	0.75	0.75	0.04

MC-PM12M-AP4 w/ MT-195-12HD, PVS-050B-U Platform Mount [LP 301-1_KCKR] AEHC	C	None		0.0000	60.00	No Ice	35.03	35.03	1.86
AEHC	A	From Leg	3.00 0.00 0.00	0.0000	60.00	No Ice	7.26	1.98	0.10
AEHC	B	From Leg	3.00 0.00 0.00	0.0000	60.00	No Ice	7.26	1.98	0.10
AEHC	C	From Leg	3.00 0.00 0.00	0.0000	60.00	No Ice	7.26	1.98	0.10
HBXX-6517DS-A2M	A	From Leg	3.00 0.00	0.0000	60.00	No Ice	8.02	4.37	0.05

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment t °	Placement ft		C _{AA} Front ft ²	C _{AA} Side ft ²	Weight K
HBXX-6517DS-A2M	B	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	8.02	4.37	0.05
HBXX-6517DS-A2M	C	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	8.02	4.37	0.05
AHFIG_TMO	A	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	3.08	1.47	0.07
AHFIG_TMO	B	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	3.08	1.47	0.07
AHFIG_TMO	C	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	3.08	1.47	0.07
HCS 2.0 Part 1	A	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	1.87	0.93	0.02
HCS 2.0 Part 1	B	From Leg	0.00 3.00 0.00	0.0000	60.00	No Ice	1.87	0.93	0.02

Commscope MC-PK8-DSH	C	None		0.0000	47.00	No Ice	34.24	34.24	1.75
(2) 8'x2" Mount Pipe	A	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.90	1.90	0.03
(2) 8'x2" Mount Pipe	B	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.90	1.90	0.03
(2) 8'x2" Mount Pipe	C	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.90	1.90	0.03
MX08FRO665-21 w/ Mount Pipe	A	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	8.01	4.23	0.11
MX08FRO665-21 w/ Mount Pipe	B	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	8.01	4.23	0.11
MX08FRO665-21 w/ Mount Pipe	C	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	8.01	4.23	0.11
TA08025-B605	A	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	1.13	0.08
TA08025-B605	B	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	1.13	0.08
TA08025-B605	C	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	1.13	0.08
TA08025-B604	A	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	0.98	0.06
TA08025-B604	B	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	0.98	0.06
TA08025-B604	C	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.96	0.98	0.06
RDIDC-9181-PF-48_V2	A	From Leg	0.00 3.00 0.00	0.0000	47.00	No Ice	1.87	1.07	0.02

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	Dead+Wind 0 deg - Service
27	Dead+Wind 30 deg - Service
28	Dead+Wind 60 deg - Service
29	Dead+Wind 90 deg - Service
30	Dead+Wind 120 deg - Service
31	Dead+Wind 150 deg - Service
32	Dead+Wind 180 deg - Service
33	Dead+Wind 210 deg - Service
34	Dead+Wind 240 deg - Service
35	Dead+Wind 270 deg - Service
36	Dead+Wind 300 deg - Service
37	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
L1	55.5 - 42	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-6.41	52.52	-30.28
			Max. Mx	8	-6.41	-60.90	-0.15
			Max. My	2	-6.40	0.22	61.35
			Max. Vy	8	6.26	-60.90	-0.15
			Max. Vx	2	-6.30	0.22	61.35
			Max. Torque	22			-0.19
L2	42 - 0	Pole	Max Tension	1	0.00	0.00	0.00
			Max. Compression	18	-9.43	313.86	-181.70
			Max. Mx	8	-9.43	-363.24	-0.83
			Max. My	2	-9.43	0.87	365.55
			Max. Vy	8	7.52	-363.24	-0.83
			Max. Vx	2	-7.56	0.87	365.55
			Max. Torque	22			-0.19

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	2	9.45	0.02	7.55
	Max. H _x	20	9.45	7.51	0.02
	Max. H _z	2	9.45	0.02	7.55
	Max. M _x	2	365.55	0.02	7.55
	Max. M _z	8	363.24	-7.51	-0.02
	Max. Torsion	10	0.19	-6.51	-3.79
	Min. Vert	19	7.08	6.49	-3.76
	Min. H _x	8	9.45	-7.51	-0.02
	Min. H _z	14	9.45	-0.02	-7.55
	Min. M _x	14	-365.25	-0.02	-7.55
	Min. M _z	20	-363.00	7.51	0.02
	Min. Torsion	22	-0.19	6.51	3.79

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	7.87	0.00	0.00	-0.12	-0.09	0.00
1.2 Dead+1.0 Wind 0 deg - No Ice	9.45	-0.02	-7.55	-365.55	0.87	0.09
0.9 Dead+1.0 Wind 0 deg - No Ice	7.08	-0.02	-7.55	-361.51	0.89	0.09
1.2 Dead+1.0 Wind 30 deg - No Ice	9.45	3.74	-6.53	-316.11	-180.82	-0.00
0.9 Dead+1.0 Wind 30 deg - No Ice	7.08	3.74	-6.53	-312.61	-178.81	-0.00
1.2 Dead+1.0 Wind 60 deg - No Ice	9.45	6.49	-3.76	-182.00	-314.10	-0.10
0.9 Dead+1.0 Wind 60 deg - No Ice	7.08	6.49	-3.76	-179.97	-310.62	-0.10
1.2 Dead+1.0 Wind 90 deg - No Ice	9.45	7.51	0.02	0.83	-363.24	-0.17
0.9 Dead+1.0 Wind 90 deg - No Ice	7.08	7.51	0.02	0.86	-359.22	-0.16
1.2 Dead+1.0 Wind 120 deg - No Ice	9.45	6.51	3.79	183.40	-315.08	-0.19
0.9 Dead+1.0 Wind 120 deg - No Ice	7.08	6.51	3.79	181.43	-311.59	-0.19
1.2 Dead+1.0 Wind 150 deg - No Ice	9.45	3.77	6.55	316.79	-182.53	-0.17
0.9 Dead+1.0 Wind 150 deg - No Ice	7.08	3.77	6.55	313.35	-180.50	-0.16
1.2 Dead+1.0 Wind 180 deg - No Ice	9.45	0.02	7.55	365.25	-1.10	-0.09
0.9 Dead+1.0 Wind 180 deg - No Ice	7.08	0.02	7.55	361.28	-1.06	-0.09
1.2 Dead+1.0 Wind 210 deg - No Ice	9.45	-3.74	6.53	315.81	180.59	0.00
0.9 Dead+1.0 Wind 210 deg - No Ice	7.08	-3.74	6.53	312.38	178.64	0.00
1.2 Dead+1.0 Wind 240 deg - No Ice	9.45	-6.49	3.76	181.70	313.86	0.10
0.9 Dead+1.0 Wind 240 deg - No Ice	7.08	-6.49	3.76	179.75	310.45	0.10
1.2 Dead+1.0 Wind 270 deg - No Ice	9.45	-7.51	-0.02	-1.14	363.00	0.17
0.9 Dead+1.0 Wind 270 deg - No Ice	7.08	-7.51	-0.02	-1.08	359.05	0.17
1.2 Dead+1.0 Wind 300 deg	9.45	-6.51	-3.79	-183.71	314.84	0.19

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						
0.9 Dead+1.0 Wind 300 deg	7.08	-6.51	-3.79	-181.65	311.42	0.19
- No Ice						
1.2 Dead+1.0 Wind 330 deg	9.45	-3.77	-6.55	-317.09	182.29	0.16
- No Ice						
0.9 Dead+1.0 Wind 330 deg	7.08	-3.77	-6.55	-313.58	180.32	0.16
- No Ice						
Dead+Wind 0 deg - Service	7.87	-0.00	-1.53	-73.59	0.10	0.02
Dead+Wind 30 deg - Service	7.87	0.76	-1.32	-63.65	-36.43	-0.00
Dead+Wind 60 deg - Service	7.87	1.31	-0.76	-36.69	-63.23	-0.02
Dead+Wind 90 deg - Service	7.87	1.52	0.00	0.07	-73.10	-0.03
Dead+Wind 120 deg - Service	7.87	1.32	0.77	36.78	-63.42	-0.04
Dead+Wind 150 deg - Service	7.87	0.76	1.32	63.59	-36.77	-0.03
Dead+Wind 180 deg - Service	7.87	0.00	1.53	73.34	-0.29	-0.02
Dead+Wind 210 deg - Service	7.87	-0.76	1.32	63.40	36.23	0.00
Dead+Wind 240 deg - Service	7.87	-1.31	0.76	36.44	63.03	0.02
Dead+Wind 270 deg - Service	7.87	-1.52	-0.00	-0.32	72.91	0.03
Dead+Wind 300 deg - Service	7.87	-1.32	-0.77	-37.03	63.22	0.04
Dead+Wind 330 deg - Service	7.87	-0.76	-1.32	-63.84	36.57	0.03

Solution Summary

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX K	PY K	PZ K	PX K	PY K	PZ K	
1	0.00	-7.87	0.00	0.00	7.87	0.00	0.000%
2	-0.02	-9.45	-7.55	0.02	9.45	7.55	0.000%
3	-0.02	-7.08	-7.55	0.02	7.08	7.55	0.000%
4	3.74	-9.45	-6.53	-3.74	9.45	6.53	0.000%
5	3.74	-7.08	-6.53	-3.74	7.08	6.53	0.000%
6	6.49	-9.45	-3.76	-6.49	9.45	3.76	0.000%
7	6.49	-7.08	-3.76	-6.49	7.08	3.76	0.000%
8	7.51	-9.45	0.02	-7.51	9.45	-0.02	0.000%
9	7.51	-7.08	0.02	-7.51	7.08	-0.02	0.000%
10	6.51	-9.45	3.79	-6.51	9.45	-3.79	0.000%
11	6.51	-7.08	3.79	-6.51	7.08	-3.79	0.000%
12	3.77	-9.45	6.55	-3.77	9.45	-6.55	0.000%
13	3.77	-7.08	6.55	-3.77	7.08	-6.55	0.000%
14	0.02	-9.45	7.55	-0.02	9.45	-7.55	0.000%
15	0.02	-7.08	7.55	-0.02	7.08	-7.55	0.000%
16	-3.74	-9.45	6.53	3.74	9.45	-6.53	0.000%
17	-3.74	-7.08	6.53	3.74	7.08	-6.53	0.000%
18	-6.49	-9.45	3.76	6.49	9.45	-3.76	0.000%
19	-6.49	-7.08	3.76	6.49	7.08	-3.76	0.000%
20	-7.51	-9.45	-0.02	7.51	9.45	0.02	0.000%
21	-7.51	-7.08	-0.02	7.51	7.08	0.02	0.000%
22	-6.51	-9.45	-3.79	6.51	9.45	3.79	0.000%
23	-6.51	-7.08	-3.79	6.51	7.08	3.79	0.000%
24	-3.77	-9.45	-6.55	3.77	9.45	6.55	0.000%
25	-3.77	-7.08	-6.55	3.77	7.08	6.55	0.000%
26	-0.00	-7.87	-1.53	0.00	7.87	1.53	0.000%
27	0.76	-7.87	-1.32	-0.76	7.87	1.32	0.000%
28	1.31	-7.87	-0.76	-1.31	7.87	0.76	0.000%
29	1.52	-7.87	0.00	-1.52	7.87	-0.00	0.000%
30	1.32	-7.87	0.77	-1.32	7.87	-0.77	0.000%
31	0.76	-7.87	1.32	-0.76	7.87	-1.32	0.000%
32	0.00	-7.87	1.53	-0.00	7.87	-1.53	0.000%
33	-0.76	-7.87	1.32	0.76	7.87	-1.32	0.000%

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX K	PY K	PZ K	PX K	PY K	PZ K	
34	-1.31	-7.87	0.76	1.31	7.87	-0.76	0.000%
35	-1.52	-7.87	-0.00	1.52	7.87	0.00	0.000%
36	-1.32	-7.87	-0.77	1.32	7.87	0.77	0.000%
37	-0.76	-7.87	-1.32	0.76	7.87	1.32	0.000%

Non-Linear Convergence Results

Load Combination	Converged?	Number of Cycles	Displacement Tolerance	Force Tolerance
1	Yes	4	0.00000001	0.00000001
2	Yes	4	0.00000001	0.00042712
3	Yes	4	0.00000001	0.00019411
4	Yes	5	0.00000001	0.00063210
5	Yes	5	0.00000001	0.00028657
6	Yes	5	0.00000001	0.00063956
7	Yes	5	0.00000001	0.00029043
8	Yes	4	0.00000001	0.00058771
9	Yes	4	0.00000001	0.00032564
10	Yes	5	0.00000001	0.00062130
11	Yes	5	0.00000001	0.00028101
12	Yes	5	0.00000001	0.00065671
13	Yes	5	0.00000001	0.00029812
14	Yes	4	0.00000001	0.00056449
15	Yes	4	0.00000001	0.00030478
16	Yes	5	0.00000001	0.00062819
17	Yes	5	0.00000001	0.00028517
18	Yes	5	0.00000001	0.00061896
19	Yes	5	0.00000001	0.00028082
20	Yes	4	0.00000001	0.00075239
21	Yes	4	0.00000001	0.00044251
22	Yes	5	0.00000001	0.00065840
23	Yes	5	0.00000001	0.00029903
24	Yes	5	0.00000001	0.00062480
25	Yes	5	0.00000001	0.00028242
26	Yes	4	0.00000001	0.00000001
27	Yes	4	0.00000001	0.00012622
28	Yes	4	0.00000001	0.00013297
29	Yes	4	0.00000001	0.00002954
30	Yes	4	0.00000001	0.00011499
31	Yes	4	0.00000001	0.00014121
32	Yes	4	0.00000001	0.00002259
33	Yes	4	0.00000001	0.00012287
34	Yes	4	0.00000001	0.00011666
35	Yes	4	0.00000001	0.00003096
36	Yes	4	0.00000001	0.00014351
37	Yes	4	0.00000001	0.00011673

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	55.5 - 42	5.839	26	0.9259	0.0017
L2	44 - 0	3.738	26	0.8046	0.0011

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
60.00	MC-PM12M-AP4 w/ MT-195-12HD, PVS-050B-U Platform Mount [LP 301-1_KCKR]	26	5.839	0.9259	0.0017	5225
55.50	Lighting Rod 3/4" x 10'	26	5.839	0.9259	0.0017	5225
47.00	Commscope MC-PK8-DSH	26	4.247	0.8393	0.0013	3098

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	55.5 - 42	29.034	24	4.6111	0.0084
L2	44 - 0	18.589	24	4.0060	0.0057

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
60.00	MC-PM12M-AP4 w/ MT-195-12HD, PVS-050B-U Platform Mount [LP 301-1_KCKR]	24	29.034	4.6111	0.0085	1060
55.50	Lighting Rod 3/4" x 10'	24	29.034	4.6111	0.0085	1060
47.00	Commscope MC-PK8-DSH	24	21.120	4.1792	0.0064	628

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L _u ft	KI/r	A in ²	P _u K	φP _n K	Ratio P _u / φP _n
L1	55.5 - 42 (1)	TP15.448x12x0.1875	13.50	0.00	0.0	8.7779	-6.40	513.51	0.012
L2	42 - 0 (2)	TP25.8x14.5622x0.1875	44.00	0.00	0.0	15.242	-9.43	891.69	0.011

Pole Bending Design Data

Section No.	Elevation ft	Size	M _{ux} kip-ft	φM _{nx} kip-ft	Ratio M _{ux} / φM _{nx}	M _{uy} kip-ft	φM _{ny} kip-ft	Ratio M _{uy} / φM _{ny}
L1	55.5 - 42 (1)	TP15.448x12x0.1875	61.44	196.85	0.312	0.00	196.85	0.000
L2	42 - 0 (2)	TP25.8x14.5622x0.1875	365.76	534.60	0.684	0.00	534.60	0.000

Pole Shear Design Data

Section No.	Elevation ft	Size	Actual V_u K	ϕV_n K	Ratio $\frac{V_u}{\phi V_n}$	Actual T_u kip-ft	ϕT_n kip-ft	Ratio $\frac{T_u}{\phi T_n}$
L1	55.5 - 42 (1)	TP15.448x12x0.1875	6.31	154.05	0.041	0.16	198.99	0.001
L2	42 - 0 (2)	TP25.8x14.5622x0.1875	7.57	267.51	0.028	0.16	600.02	0.000

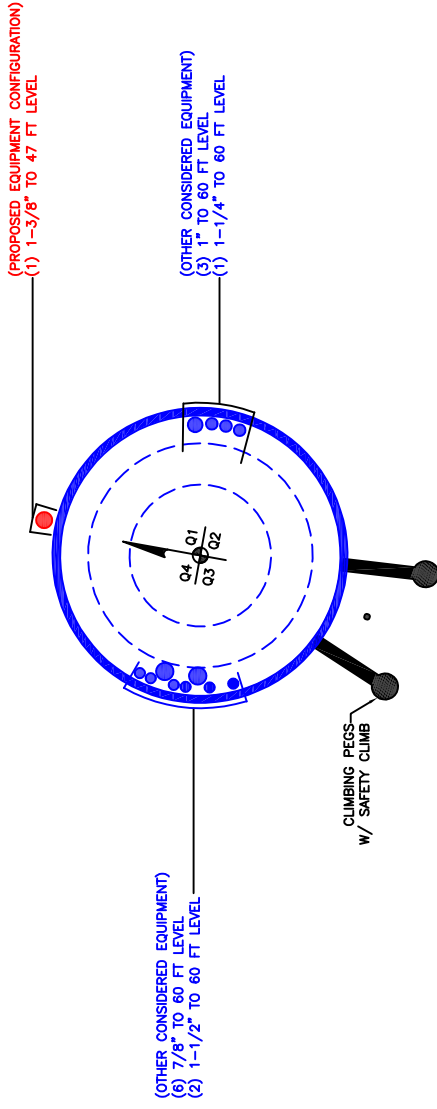
Pole Interaction Design Data

Section No.	Elevation ft	Ratio P_u ϕP_n	Ratio M_{ux} ϕM_{nx}	Ratio M_{uy} ϕM_{ny}	Ratio V_u ϕV_n	Ratio T_u ϕT_n	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	55.5 - 42 (1)	0.012	0.312	0.000	0.041	0.001	0.326	1.050	4.8.2
L2	42 - 0 (2)	0.011	0.684	0.000	0.028	0.000	0.696	1.050	4.8.2

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
L1	55.5 - 42	Pole	TP15.448x12x0.1875	1	-6.40	539.18	31.1	Pass
L2	42 - 0	Pole	TP25.8x14.5622x0.1875	2	-9.43	936.28	66.2	Pass
Summary								
Pole (L2)							66.2	Pass
RATING =							66.2	Pass

APPENDIX B
BASE LEVEL DRAWING



APPENDIX C
ADDITIONAL CALCULATIONS

Monopole Base Plate Connection

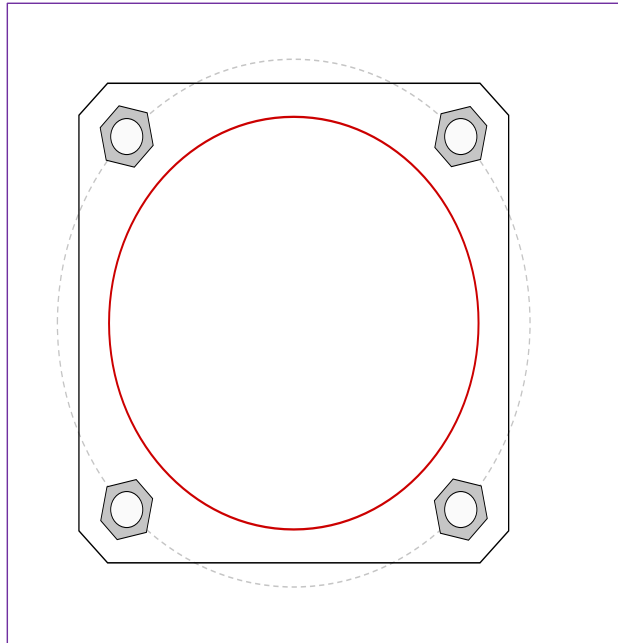


Site Info	
BU #	877033
Site Name	2460 WAYNOKA PL
Order #	642646 Rev. 2

Analysis Considerations	
TIA-222 Revision	H
Grout Considered:	No
I_{ar} (in)	2.3125

Applied Loads	
Moment (kip-ft)	365.75
Axial Force (kips)	9.43
Shear Force (kips)	7.57

*TIA-222-H Section 15.5 Applied



Connection Properties	Analysis Results
-----------------------	------------------

Anchor Rod Data
(4) 2-1/4" ϕ bolts (A615-75 N; $F_y=75$ ksi, $F_u=100$ ksi) on 33" BC
Base Plate Data
30" W x 2" Plate (A633 Gr. E; $F_y=60$ ksi, $F_u=70$ ksi); Clip: 2 in
Stiffener Data
N/A
Pole Data
25.8" x 0.1875" 18-sided pole (A572-65; $F_y=65$ ksi, $F_u=80$ ksi)

Anchor Rod Summary		<i>(units of kips, kip-in)</i>	
$Pu_t = 130.39$	$\phi Pn_t = 243.75$		Stress Rating
$Vu = 1.89$	$\phi Vn = 149.1$		50.9%
$Mu = 2.84$	$\phi Mn = 128.14$		Pass
Base Plate Summary			
Max Stress (ksi):	29.25		(Flexural)
Allowable Stress (ksi):	54		
Stress Rating:	51.6%		Pass

Drilled Pier Foundation

BU # :	877033
Site Name:	2460 WAYNOKA PL
Order Number:	642646 Rev. 2
TIA-222 Revisor:	H
Tower Type:	Monopole



Applied Loads		
	Comp.	Uplift
Moment (kip-ft)	365.75	
Axial Force (kips)	9.45	
Shear Force (kips)	7.56	

Material Properties		
Concrete Strength, f _c :	4	ksi
Rebar Strength, F _y :	60	ksi
Tie Yield Strength, F _{yt} :	40	ksi

Pier Design Data		
Depth	18	ft
Ext. Above Grade	0.5	ft
Pier Section 1		
<i>From 0.5' above grade to 18' below grade</i>		
Pier Diameter	5	ft
Rebar Quantity	10	
Rebar Size	11	
Clear Cover to Ties	4	in
Tie Size	5	
Tie Spacing	18	in

Rebar 2, F _y Override (ksi)	
Rebar 3, F _y Override (ksi)	

Rebar & Pier Options
Embedded Pole Inputs
Belled Pier Inputs

Analysis Results		
Soil Lateral Check	Compression	Uplift
D _{v=0} (ft from TOC)	5.04	-
Soil Safety Factor	6.20	-
Max Moment (kip-ft)	395.86	-
Rating*	20.4%	-

Soil Vertical Check	Compression	Uplift
Skin Friction (kips)	159.04	-
End Bearing (kips)	321.76	-
Weight of Concrete (kips)	56.56	-
Total Capacity (kips)	480.80	-
Axial (kips)	66.01	-
Rating*	13.1%	-

Reinforced Concrete Flexure	Compression	Uplift
Critical Depth (ft from TOC)	4.94	-
Critical Moment (kip-ft)	395.83	-
Critical Moment Capacity	1767.28	-
Rating*	21.3%	-

Reinforced Concrete Shear	Compression	Uplift
Critical Depth (ft from TOC)	14.91	-
Critical Shear (kip)	44.75	-
Critical Shear Capacity	456.39	-
Rating*	9.3%	-

Shear-Friction Methodology is Applied

Structural Foundation Rating*	21.3%
Soil Interaction Rating*	20.4%

*Rating per TIA-222-H Section 15.5

Check Limitation	
Apply TIA-222-H Section 15.5:	<input checked="" type="checkbox"/>
N/A	<input type="checkbox"/>
Additional Longitudinal Rebar	
Input Effective Depths (else Actual):	<input type="checkbox"/>
Shear Design Options	
Check Shear along Depth of Pier:	<input checked="" type="checkbox"/>
Utilize Shear-Friction Methodology:	<input checked="" type="checkbox"/>
Override Critical Depth:	<input type="checkbox"/>

[Go to Soil Calculations](#)

Soil Profile				
Groundwater Depth	12	# of Layers	5	

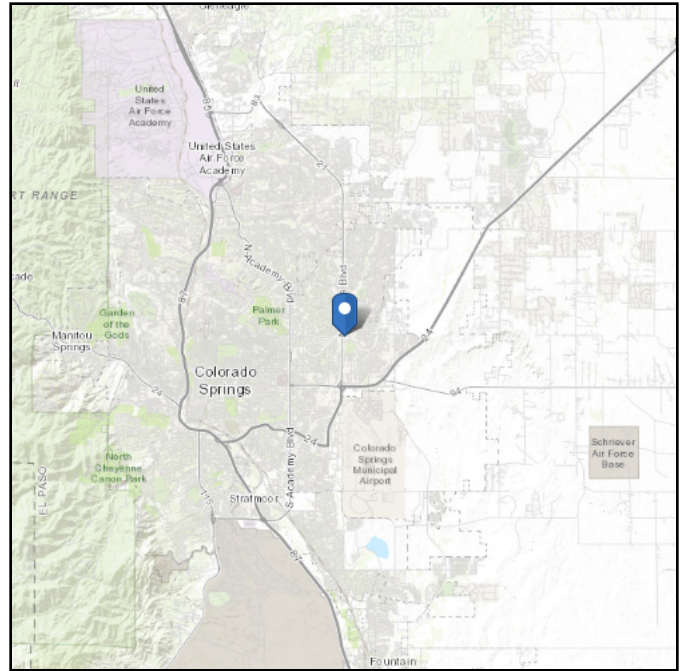
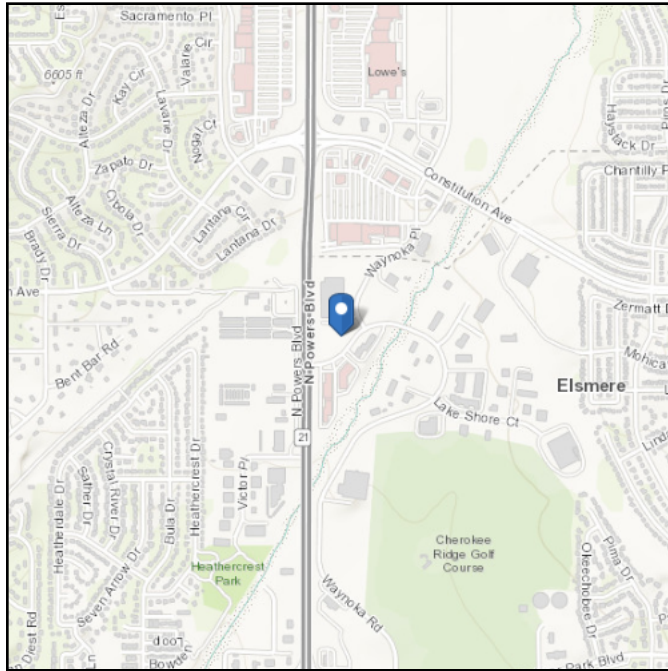
Layer	Top (ft)	Bottom (ft)	Thickness (ft)	Y _{soil} (pcf)	Y _{concrete} (pcf)	Cohesion (ksf)	Angle of Friction (degrees)	Calculated Ultimate Skin Friction Comp (ksf)	Calculated Ultimate Skin Friction Uplift (ksf)	Ultimate Skin Friction Comp Override (ksf)	Ultimate Skin Friction Uplift Override (ksf)	Ult. Net Bearing Capacity (ksf)	SPT Blow Count	Soil Type
1	0	2	2	129.499	150	0	0	0.000	0.000	0.00	0.00			Cohesionless
2	2	3	1	122.8	150	0	30	0.000	0.000	0.00	0.00			Cohesionless
3	3	9	6	122.8	150	0	30	0.000	0.000	0.90	0.60			Cohesionless
4	9	12	3	122.8	150	0	30	0.000	0.000	0.90	0.60			Cohesionless
5	12	18	6	60.4	87.6	0	30	0.000	0.000	0.90	0.60	20		Cohesionless

ASCE 7 Hazards Report

Address:
No Address at This Location

Standard: ASCE/SEI 7-10
Risk Category: II
Soil Class: D - Stiff Soil

Latitude: 38.866658
Longitude: -104.718939
Elevation: 6383 ft (NAVD 88)



Wind

Results:

Wind Speed	115 Vmph
10-year MRI	76 Vmph
25-year MRI	84 Vmph
50-year MRI	90 Vmph
100-year MRI	96 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: Mon Jan 16 2023

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).

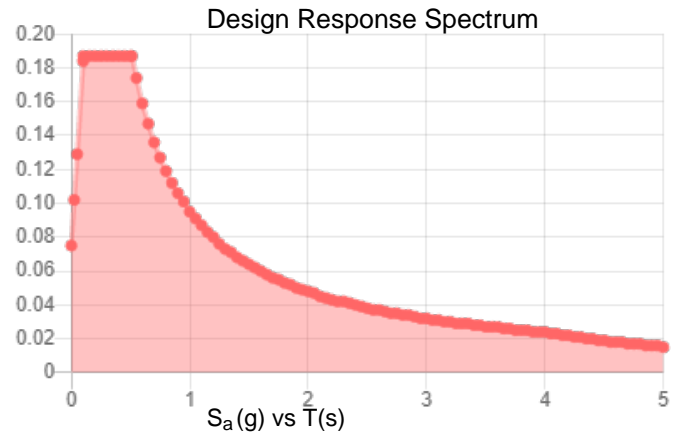
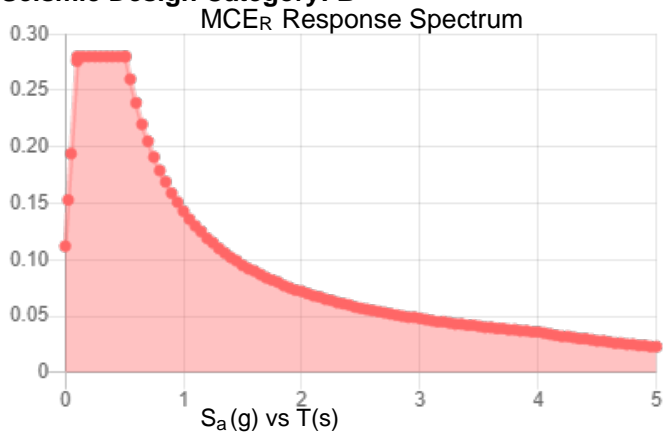
Site is not in a hurricane-prone region as defined in ASCE/SEI 7-10 Section 26.2.

Site Soil Class:

Results:

S_S :	0.175	S_{D1} :	0.095
S_1 :	0.06	T_L :	4
F_a :	1.6	PGA :	0.088
F_v :	2.4	PGA _M :	0.14
S_{MS} :	0.28	F_{PGA} :	1.6
S_{M1} :	0.143	I_e :	1
S_{DS} :	0.187		

Seismic Design Category: B



Data Accessed: Mon Jan 16 2023

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 in.

Concurrent Temperature: 5 F

Gust Speed 50 mph

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

Date Accessed: Mon Jan 16 2023

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

In the mountain west, ice thicknesses may exceed the mapped values in the foothills and passes. However, at elevations above 5,000 ft, freezing rain is unlikely.

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.

The ASCE 7 Hazard Tool is provided for your convenience, for informational purposes only, and is provided "as is" and without warranties of any kind. The location data included herein has been obtained from information developed, produced, and maintained by third party providers; or has been extrapolated from maps incorporated in the ASCE 7 standard. While ASCE has made every effort to use data obtained from reliable sources or methodologies, ASCE does not make any representations or warranties as to the accuracy, completeness, reliability, currency, or quality of any data provided herein. Any third-party links provided by this Tool should not be construed as an endorsement, affiliation, relationship, or sponsorship of such third-party content by or from ASCE.

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