FILE

RECEIVED

JAN 10 2017

PLANNING BOARD
GRAFTON, MA

Date: **October 30, 2016**

Charles McGuirt
Crown Castle
3530 Toringdon Way Suite 300
Charlotte, NC 28277

CROWN CASTLE

Crown Castle
2000 Corporate Drive
Canonsburg, PA, 15317
724-416-2000

Subject: **Structural Analysis Report**

Carrier Designation:

***T-Mobile* Co-Locate**
Carrier Site Number: 4WL0720A
Carrier Site Name: WL720/GraftonAT&

Crown Castle Designation:

Crown Castle BU Number: 842903
Crown Castle Site Name: GRAFTON ESTABROOK STREET (MA31
Crown Castle JDE Job Number: 404648
Crown Castle Work Order Number: 1317856
Crown Castle Application Number: 366568 Rev. 3

Engineering Firm Designation:

Crown Castle Project Number: 1317856

Site Data:

43 ESTABROOK STREET, GRAFTON, Worcester County, MA
Latitude *42° 13' 35.33"*, Longitude *-71° 39' 51.78"*
91 Foot - Monopole Tower

Dear Charles McGuirt,

Crown Castle is pleased to submit this **"Structural Analysis Report"** to determine the structural integrity of the above mentioned tower. This analysis has been performed in accordance with the Crown Castle Structural 'Statement of Work' and the terms of Crown Castle Purchase Order Number 1317856, in accordance with application 366568, revision 3.

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:

LC5: Existing + Proposed Equipment **Sufficient Capacity**
Note: See Table I and Table II for the proposed and existing loading, respectively.

The analysis has been performed in accordance with the TIA-222-G standard and 2009 IBC as amended by the 2010 Massachusetts State Building Code, Eighth Edition, based upon a wind speed of 100 mph 3-second gust. Exposure Category C was used in this analysis.

All equipment proposed in this report shall be installed in accordance with the attached drawings for the determined available structural capacity to be effective.

We at *Crown Castle* appreciate the opportunity of providing our continuing professional services to you and Crown Castle. If you have any questions or need further assistance on this or any other projects, please give us a call.

Structural analysis prepared by: Matthew Hussak/ AGH

Respectfully submitted by:

COMMONWEALTH OF MASSACHUSETTS
TERRY P. STYRAN
10/31/2016
CIVIL
NO. 52761
REGISTERED PROFESSIONAL ENGINEER

Terry P. Styran, P.E.
Senior Project Engineer
tnxTower Report - version
7.0.5.1

TABLE OF CONTENTS

1) INTRODUCTION

2) ANALYSIS CRITERIA
- Table 1 - Proposed Antenna and Cable Information
- Table 2 - Existing Antenna and Cable Information
- Table 3 - Design Antenna and Cable Information

3) ANALYSIS PROCEDURE
- Table 4 - Documents Provided
- 3.1) Analysis Method
- 3.2) Assumptions

4) ANALYSIS RESULTS
- Table 5 - Section Capacity (Summary)
- Table 6 – Tower Components vs. Capacity – LC5
- 4.1) Recommendations

5) APPENDIX A
- tnxTower Output

6) APPENDIX B
- Base Level Drawing

7) APPENDIX C
- Additional Calculations

1) INTRODUCTION

This tower is a 91ft Monopole tower mapped by GPD in February of 2016. The original design standard and wind speed are unknown.

2) ANALYSIS CRITERIA

The structural analysis was performed for this tower in accordance with the requirements of TIA-222-G Structural Standards for Steel Antenna Towers and Antenna Supporting Structures using a 3-second gust wind speed of 100 mph with no ice, 40 mph with 1 inch ice thickness and 60 mph under service loads, exposure category C.

Table 1 - Proposed Antenna and Cable Information

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
81.0	79.0	3	andrew	LNX-6515DS-A1M w/ Mount Pipe	1	1-5/8	-
		3	ericsson	RRUS 11 B12			

Table 2 - Existing Antenna and Cable Information

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
90.0	91.0	6	kathrein	782-10250	12	1 5/8	1
		6	kathrein	800 10121 w/ Mount Pipe			
		6	powerwave technologies	LGP21401			
	90.0	3	kathrein	800 10766 w/ Mount Pipe			
		1	tower mounts	Platform Mount (LP 1001-1)			
84.0	87.0	3	ericsson	RRUS 11 B12	1 2	3/8 5/8	1
		1	raycap	DC6-48-60-18-8F			
	84.0	1	tower mounts	Side Arm Mount [SO 104-3]			
81.0	81.0	1	tower mounts	Platform Mount (LP 1001-1)	12	7/8	1
	79.0	3	rfs celwave	AIR 21 B2A/B4P w/ Mount Pipe			
		3	rfs celwave	AIR 21 B4A/B2P w/ Mount Pipe			
		3	rfs celwave	ATMAA1412D-1A20			
		6	ericsson	KRY 112 71/2	-	-	2
77.0	77.0	1	andrew	VHLP2-180	6	1/2	1
		1	tower mounts	Pipe Mount [PM 601-1]			
69.0	70.0	3	alcatel lucent	RRH2X40-AWS	19	1-5/8	1
		6	css	AXP18-60-2 w/ Mount Pipe			
		1	css	X7C-665-4 w/ Mount Pipe			

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)	Note
		3	css	X7C-665-V w/ Mount Pipe			
		2	css	X7C-FRO-660-4 w/ Mount Pipe			
		1	raycap	RDC-4276-PF-48			
	69.0	1	tower mounts	Platform Mount [LP 304-1]			

Notes:
1) Existing Equipment
2) Equipment to be Removed; Not Considered in Analysis

Table 3 - Design Antenna and Cable Information

Mounting Level (ft)	Center Line Elevation (ft)	Number of Antennas	Antenna Manufacturer	Antenna Model	Number of Feed Lines	Feed Line Size (in)
Information Not Available						

3) ANALYSIS PROCEDURE

Table 4 - Documents Provided

Document	Remarks	Reference	Source
4-GEOTECHNICAL REPORTS	WEI	4291777	CCISITES
4-TOWER FOUNDATION DRAWINGS/DESIGN/SPECS	WEI (Mapping)	4291776	CCISITES
4-TOWER MANUFACTURER DRAWINGS	GPD (Mapping)	6103299	CCISITES

3.1) Analysis Method

tnxTower (version 7.0.5.1), 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.

3.2) Assumptions

1) Tower and structures were built in accordance with the manufacturer's specifications.
2) The tower and structures have been maintained in accordance with the manufacturer's specification.
3) 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 5 - Section Capacity (Summary)

Section No.	Elevation (ft)	Component Type	Size	Critical Element	P (K)	SF*P_allow (K)	% Capacity	Pass / Fail
L1	91 - 48.75	Pole	TP28.993x19.396x0.188	1	-14.629	1082.760	90.3	Pass
L2	48.75 - 0	Pole	TP42.875x27.71x0.25	2	-24.122	2069.030	94.7	Pass
							Summary	
						Pole (L2)	94.7	Pass
						Rating =	94.7	Pass

Table 6 - Tower Component Stresses vs. Capacity – LC5

Notes	Component	Elevation (ft)	% Capacity	Pass / Fail
1	Anchor Rods	0	81.8	Pass
1	Base Plate	0	81.9	Pass
1	Base Foundation	0	63.1	Pass
1	Base Foundation Soil Interaction	0	47.9	Pass

Structure Rating (max from all components) =	94.7%

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

4.1) Recommendations

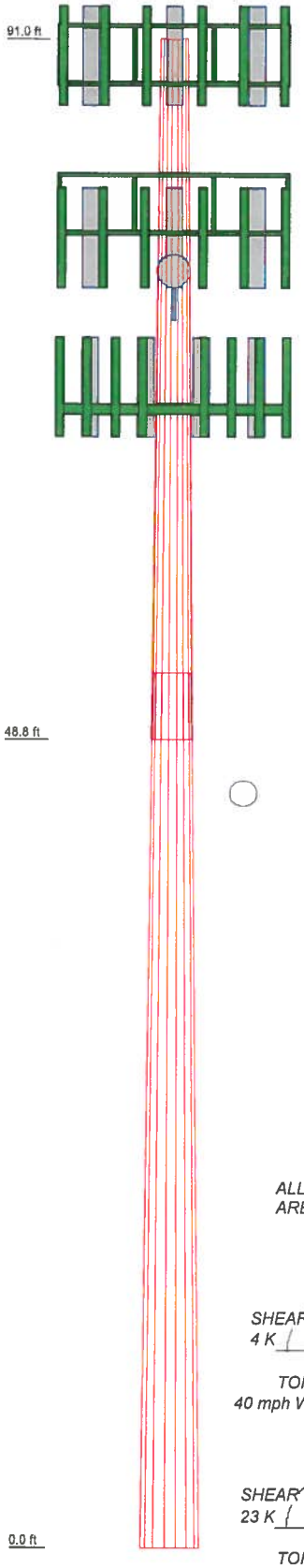
The tower and its foundation have sufficient capacity to carry the existing and proposed loads. No modifications are required at this time.

APPENDIX A

TNXTOWER OUTPUT

Section	1	2
Length (ft)	42.250	52.750
Number of Sides	18	18
Thickness (in)	0.188	0.250
Socket Length (ft)	4.000	
Top Dia (in)	19.396	27.710
Bot Dia (in)	28.993	42.875
Grade	A572-65	
Weight (K)	2.1	5.0

7.0



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Platform Mount (LP 1001-1)	90	AIR 21 B4A/B2P w/ Mount Pipe	81
800 10766 w/ Mount Pipe	90	AIR 21 B4A/B2P w/ Mount Pipe	81
800 10766 w/ Mount Pipe	90	AIR 21 B4A/B2P w/ Mount Pipe	81
800 10766 w/ Mount Pipe	90	LNX-6515DS-A1M w/ Mount Pipe	81
(2) 800 10121 w/ Mount Pipe	90	LNX-6515DS-A1M w/ Mount Pipe	81
(2) 800 10121 w/ Mount Pipe	90	LNX-6515DS-A1M w/ Mount Pipe	81
(2) 800 10121 w/ Mount Pipe	90	ATMAA1412D-1A20	81
(2) LGP21401	90	ATMAA1412D-1A20	81
(2) LGP21401	90	ATMAA1412D-1A20	81
(2) LGP21401	90	RRUS 11 B12	81
(2) 782-10250	90	RRUS 11 B12	81
(2) 782-10250	90	RRUS 11 B12	81
(2) 782-10250	90	Pipe Mount [PM 601-1]	77
Side Arm Mount [SO 104-3]	84	VHLP2-180	77
8'x2" Antenna Mount Pipe	84	X7C-665-V w/ Mount Pipe	69
8'x2" Antenna Mount Pipe	84	X7C-665-V w/ Mount Pipe	69
8'x2" Antenna Mount Pipe	84	X7C-665-V w/ Mount Pipe	69
RRUS 11 B12	84	(2) AXP18-60-2 w/ Mount Pipe	69
RRUS 11 B12	84	(2) AXP18-60-2 w/ Mount Pipe	69
RRUS 11 B12	84	(2) AXP18-60-2 w/ Mount Pipe	69
DC6-48-60-18-8F	84	X7C-FRO-660-4 w/ Mount Pipe	69
Platform Mount (LP 1001-1)	81	X7C-FRO-660-4 w/ Mount Pipe	69
8'x2" Mount Pipe	81	X7C-665-4 w/ Mount Pipe	69
8'x2" Mount Pipe	81	RRH2X40-AWS	69
8'x2" Mount Pipe	81	RRH2X40-AWS	69
AIR 21 B2A/B4P w/ Mount Pipe	81	RRH2X40-AWS	69
AIR 21 B2A/B4P w/ Mount Pipe	81	RDC-4276-PF-48	69
AIR 21 B2A/B4P w/ Mount Pipe	81	Platform Mount [LP 304-1]	69

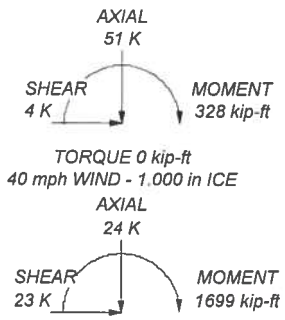
MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower is located in Worcester County, Massachusetts.
2. Tower designed for Exposure C to the TIA-222-G Standard.
3. Tower designed for a 100 mph basic wind in accordance with the TIA-222-G Standard.
4. Tower is also designed for a 40 mph basic wind with 1.00 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon a 60 mph wind.
6. Tower Structure Class II.
7. Topographic Category 1 with Crest Height of 0.000 ft
8. TOWER RATING: 94.7%

ALL REACTIONS ARE FACTORED



CROWN CASTLE
The Foundation for a Wireless World

Crown Castle
2000 Corporate Drive
Canonsburg, PA, 15317
Phone: 724-416-2000
FAX: 724-416-4623

Job: **BU# 842903**			
Project:			
Client: Crown Castle	Drawn by: agholami	App'd:	
Code: TIA-222-G	Date: 10/30/16	Scale: NTS	
Path: X:\ENG Work Area\Mikusak\WIP\842903 WO1317859\QA-AGH\842903 WO1317859.en		Dwg No. E-1	

Tower Input Data

There is a pole section.
This tower is designed using the TIA-222-G standard.
The following design criteria apply:

3) Tower is located in Worcester County, Massachusetts.
4) Basic wind speed of 100 mph.
5) Structure Class II.
6) Exposure Category C.
7) Topographic Category 1.
8) Crest Height 0.000 ft.
9) Nominal ice thickness of 1.000 in.
10) Ice thickness is considered to increase with height.
11) Ice density of 56.000 pcf.
12) A wind speed of 40 mph is used in combination with ice.
13) Temperature drops of 50.000 °F.
14) Deflections calculated using a wind speed of 60 mph.
15) A non-linear (P-delta) analysis was used.
16) Pressures are calculated at each section.
17) Stress ratio used in pole design is 1.
18) 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

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-G Bracing Resist. Exemption
Use TIA-222-G Tension Splice Exemption

Poles

√ Include Shear-Torsion Interaction
Always Use Sub-Critical Flow
Use Top Mounted Sockets

Tapered Pole Section Geometry

Section	Elevation ft	Section Length ft	Splice Length ft	Number of Sides	Top Diameter in	Bottom Diameter in	Wall Thickness in	Bend Radius in	Pole Grade
L1	91.000-48.750	42.250	4.000	18	19.396	28.993	0.188	0.750	A572-65 (65 ksi)
L2	48.750-0.000	52.750		18	27.710	42.875	0.250	1.000	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/ft
L1	19.695	11.431	532.876	6.819	9.853	54.082	1066.453	5.717	3.084	16.446
	29.440	17.143	1797.136	10.226	14.729	122.017	3596.637	8.573	4.773	25.455
L2	29.305	21.789	2075.709	9.748	14.076	147.459	4154.149	10.897	4.437	17.748
	43.536	33.823	7763.858	15.132	21.781	356.459	15537.931	16.915	7.106	28.424

Tower Elevation ft	Gusset Area (per face) ft^2	Gusset Thickness in	Gusset Grade	Adjust. Factor A_f	Adjust. Factor A_r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in	Double Angle Stitch Bolt Spacing Redundants in
L1 91.000-48.750				1	1	1			
L2 48.750-0.000				1	1	1			

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number	Number Per Row	Clear Spacing in	Width or Diameter in	Perimeter in	Weight klf
***										
***										

Feed Line/Linear Appurtenances - Entered As Area

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight klf
LDF7-50A(1-5/8")	C	No	Inside Pole	90.000 - 0.000	12	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
						1" Ice	0.000	0.001
***								
LDF2-50(3/8")	C	No	Inside Pole	84.000 - 0.000	1	No Ice	0.000	0.000
						1/2" Ice	0.000	0.000
						1" Ice	0.000	0.000
9776(5/8")	C	No	Inside Pole	84.000 - 0.000	2	No Ice	0.000	0.000
						1/2" Ice	0.000	0.000
						1" Ice	0.000	0.000
***								
LDF5-50A(7/8")	A	No	Inside Pole	81.000 - 0.000	12	No Ice	0.000	0.000
						1/2" Ice	0.000	0.000
						1" Ice	0.000	0.000
MLE Hybrid 9Power/18Fiber RL 2(1-5/8")	A	No	Inside Pole	81.000 - 0.000	1	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
						1" Ice	0.000	0.001
***								
LDF4-50A(1/2")	C	No	Inside Pole	77.000 - 0.000	6	No Ice	0.000	0.000
						1/2" Ice	0.000	0.000
						1" Ice	0.000	0.000
***								
LDF7-50A(1-5/8")	A	No	Inside Pole	69.000 - 0.000	19	No Ice	0.000	0.001
						1/2" Ice	0.000	0.001
						1" Ice	0.000	0.001
***								
***								

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	91.000-48.750	A	0.000	0.000	0.000	0.000	0.478
		B	0.000	0.000	0.000	0.000	0.000
		C	0.000	0.000	0.000	0.000	0.454
L2	48.750-0.000	A	0.000	0.000	0.000	0.000	1.005
		B	0.000	0.000	0.000	0.000	0.000
		C	0.000	0.000	0.000	0.000	0.554

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A_R ft²	A_F ft²	C_AA_A In Face ft²	C_AA_A Out Face ft²	Weight K
L1	91.000-48.750	A	2.153	0.000	0.000	0.000	0.000	0.478
		B		0.000	0.000	0.000	0.000	0.000
		C		0.000	0.000	0.000	0.000	0.454
L2	48.750-0.000	A	1.937	0.000	0.000	0.000	0.000	1.005
		B		0.000	0.000	0.000	0.000	0.000
		C		0.000	0.000	0.000	0.000	0.554

Feed Line Center of Pressure

Section	Elevation ft	CP_X in	CP_Z in	CP_X Ice in	CP_Z Ice in
L1	91.000-48.750	0.000	0.000	0.000	0.000
L2	48.750-0.000	0.000	0.000	0.000	0.000

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral Vert ft ft ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft²	C_AA_A Side ft²	Weight K
Platform Mount (LP 1001-1)	C	None		0.000	90.000	No Ice	47.700	47.700	3.017
						1/2" Ice	59.500	59.500	3.621
						1" Ice	71.300	71.300	4.225
800 10766 w/ Mount Pipe	A	From Leg	4.000 0.000 0.000	0.000	90.000	No Ice	11.549	8.938	0.091
						1/2" Ice	12.267	10.450	0.176
						1" Ice	12.995	11.986	0.271
800 10766 w/ Mount Pipe	B	From Leg	4.000 0.000 0.000	0.000	90.000	No Ice	11.549	8.938	0.091
						1/2" Ice	12.267	10.450	0.176
						1" Ice	12.995	11.986	0.271
800 10766 w/ Mount Pipe	C	From Leg	4.000	0.000	90.000	No Ice	11.549	8.938	0.091

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			1/2"	12.267	10.450	0.176
			0.000			Ice	12.995	11.986	0.271
						1" Ice			
(2) 800 10121 w/ Mount Pipe	A	From Leg	4.000	0.000	90.000	No Ice	5.388	4.600	0.066
			0.000			1/2"	5.813	5.351	0.114
			1.000			Ice	6.234	6.046	0.168
						1" Ice			
(2) 800 10121 w/ Mount Pipe	B	From Leg	4.000	0.000	90.000	No Ice	5.388	4.600	0.066
			0.000			1/2"	5.813	5.351	0.114
			1.000			Ice	6.234	6.046	0.168
						1" Ice			
(2) 800 10121 w/ Mount Pipe	C	From Leg	4.000	0.000	90.000	No Ice	5.388	4.600	0.066
			0.000			1/2"	5.813	5.351	0.114
			1.000			Ice	6.234	6.046	0.168
						1" Ice			
(2) LGP21401	A	From Leg	4.000	0.000	90.000	No Ice	1.104	0.207	0.014
			0.000			1/2"	1.239	0.274	0.021
			1.000			Ice	1.381	0.348	0.030
						1" Ice			
(2) LGP21401	B	From Leg	4.000	0.000	90.000	No Ice	1.104	0.207	0.014
			0.000			1/2"	1.239	0.274	0.021
			1.000			Ice	1.381	0.348	0.030
						1" Ice			
(2) LGP21401	C	From Leg	4.000	0.000	90.000	No Ice	1.104	0.207	0.014
			0.000			1/2"	1.239	0.274	0.021
			1.000			Ice	1.381	0.348	0.030
						1" Ice			
(2) 782-10250	A	From Leg	4.000	0.000	90.000	No Ice	0.449	0.245	0.006
			0.000			1/2"	0.541	0.321	0.010
			1.000			Ice	0.641	0.404	0.015
						1" Ice			
(2) 782-10250	B	From Leg	4.000	0.000	90.000	No Ice	0.449	0.245	0.006
			0.000			1/2"	0.541	0.321	0.010
			1.000			Ice	0.641	0.404	0.015
						1" Ice			
(2) 782-10250	C	From Leg	4.000	0.000	90.000	No Ice	0.449	0.245	0.006
			0.000			1/2"	0.541	0.321	0.010
			1.000			Ice	0.641	0.404	0.015
						1" Ice			
***									
Side Arm Mount [SO 104-3]	C	None		0.000	84.000	No Ice	3.300	3.300	0.287
						1/2"	4.130	4.130	0.317
						Ice	4.960	4.960	0.347
						1" Ice			
8'x2" Antenna Mount Pipe	A	From Leg	1.000	0.000	84.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
8'x2" Antenna Mount Pipe	B	From Leg	1.000	0.000	84.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
8'x2" Antenna Mount Pipe	C	From Leg	1.000	0.000	84.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
RRUS 11 B12	A	From Leg	1.000	0.000	84.000	No Ice	2.833	1.182	0.051
			0.000			1/2"	3.043	1.330	0.072
			3.000			Ice	3.259	1.485	0.095
						1" Ice			
RRUS 11 B12	B	From Leg	1.000	0.000	84.000	No Ice	2.833	1.182	0.051
			0.000			1/2"	3.043	1.330	0.072
			3.000			Ice	3.259	1.485	0.095
						1" Ice			
RRUS 11 B12	C	From Leg	1.000	0.000	84.000	No Ice	2.833	1.182	0.051

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			1/2"	3.043	1.330	0.072
			3.000			Ice	3.259	1.485	0.095
						1" Ice			
DC6-48-60-18-8F	A	From Leg	1.000	0.000	84.000	No Ice	0.791	0.791	0.020
			0.000			1/2"	1.274	1.274	0.035
			3.000			Ice	1.450	1.450	0.053
						1" Ice			
***									
Platform Mount (LP 1001-1)	C	None		0.000	81.000	No Ice	47.700	47.700	3.017
						1/2"	59.500	59.500	3.621
						Ice	71.300	71.300	4.225
						1" Ice			
8'x2" Mount Pipe	A	From Leg	4.000	0.000	81.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
8'x2" Mount Pipe	B	From Leg	4.000	0.000	81.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
8'x2" Mount Pipe	C	From Leg	4.000	0.000	81.000	No Ice	1.900	1.900	0.030
			0.000			1/2"	2.728	2.728	0.044
			0.000			Ice	3.401	3.401	0.064
						1" Ice			
AIR 21 B2A/B4P w/ Mount Pipe	A	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
AIR 21 B2A/B4P w/ Mount Pipe	B	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
AIR 21 B2A/B4P w/ Mount Pipe	C	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
AIR 21 B4A/B2P w/ Mount Pipe	A	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
AIR 21 B4A/B2P w/ Mount Pipe	B	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
AIR 21 B4A/B2P w/ Mount Pipe	C	From Leg	4.000	0.000	81.000	No Ice	6.162	5.545	0.103
			0.000			1/2"	6.600	6.303	0.159
			-2.000			Ice	7.033	6.998	0.222
						1" Ice			
LNX-6515DS-A1M w/ Mount Pipe	A	From Leg	4.000	0.000	81.000	No Ice	11.647	9.844	0.083
			0.000			1/2"	12.368	11.368	0.173
			-2.000			Ice	13.099	12.917	0.272
						1" Ice			
LNX-6515DS-A1M w/ Mount Pipe	B	From Leg	4.000	0.000	81.000	No Ice	11.647	9.844	0.083
			0.000			1/2"	12.368	11.368	0.173
			-2.000			Ice	13.099	12.917	0.272
						1" Ice			
LNX-6515DS-A1M w/ Mount Pipe	C	From Leg	4.000	0.000	81.000	No Ice	11.647	9.844	0.083
			0.000			1/2"	12.368	11.368	0.173
			-2.000			Ice	13.099	12.917	0.272
						1" Ice			
ATMAA1412D-1A20	A	From Leg	4.000	0.000	81.000	No Ice	0.407	1.000	0.013
			0.000			1/2"	0.497	1.126	0.021
			-2.000			Ice	0.593	1.259	0.030
						1" Ice			
ATMAA1412D-1A20	B	From Leg	4.000	0.000	81.000	No Ice	0.407	1.000	0.013

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			1/2"	0.497	1.126	0.021
			-2.000			Ice	0.593	1.259	0.030
						1" Ice			
ATMAA1412D-1A20	C	From Leg	4.000	0.000	81.000	No Ice	0.407	1.000	0.013
			0.000			1/2"	0.497	1.126	0.021
			-2.000			Ice	0.593	1.259	0.030
						1" Ice			
RRUS 11 B12	A	From Leg	4.000	0.000	81.000	No Ice	2.833	1.182	0.051
			0.000			1/2"	3.043	1.330	0.072
			-2.000			Ice	3.259	1.485	0.095
						1" Ice			
RRUS 11 B12	B	From Leg	4.000	0.000	81.000	No Ice	2.833	1.182	0.051
			0.000			1/2"	3.043	1.330	0.072
			-2.000			Ice	3.259	1.485	0.095
						1" Ice			
RRUS 11 B12	C	From Leg	4.000	0.000	81.000	No Ice	2.833	1.182	0.051
			0.000			1/2"	3.043	1.330	0.072
			-2.000			Ice	3.259	1.485	0.095
						1" Ice			
***									
Pipe Mount [PM 601-1]	A	From Leg	0.500	0.000	77.000	No Ice	3.000	0.900	0.065
			0.000			1/2"	3.740	1.120	0.079
			0.000			Ice	4.480	1.340	0.093
						1" Ice			
***									
Platform Mount [LP 304-1]	C	None		0.000	69.000	No Ice	17.460	17.460	1.349
						1/2"	22.440	22.440	1.625
						Ice	27.420	27.420	1.900
						1" Ice			
X7C-665-V w/ Mount Pipe	A	From Leg	4.000	0.000	69.000	No Ice	8.643	7.004	0.056
			0.000			1/2"	9.206	8.185	0.126
			1.000			Ice	9.734	9.081	0.204
						1" Ice			
X7C-665-V w/ Mount Pipe	B	From Leg	4.000	0.000	69.000	No Ice	8.643	7.004	0.056
			0.000			1/2"	9.206	8.185	0.126
			1.000			Ice	9.734	9.081	0.204
						1" Ice			
X7C-665-V w/ Mount Pipe	C	From Leg	4.000	0.000	69.000	No Ice	8.643	7.004	0.056
			0.000			1/2"	9.206	8.185	0.126
			1.000			Ice	9.734	9.081	0.204
						1" Ice			
(2) AXP18-60-2 w/ Mount Pipe	A	From Leg	4.000	0.000	69.000	No Ice	3.307	3.245	0.028
			0.000			1/2"	3.663	3.838	0.060
			1.000			Ice	4.026	4.447	0.098
						1" Ice			
(2) AXP18-60-2 w/ Mount Pipe	B	From Leg	4.000	0.000	69.000	No Ice	3.307	3.245	0.028
			0.000			1/2"	3.663	3.838	0.060
			1.000			Ice	4.026	4.447	0.098
						1" Ice			
(2) AXP18-60-2 w/ Mount Pipe	C	From Leg	4.000	0.000	69.000	No Ice	3.307	3.245	0.028
			0.000			1/2"	3.663	3.838	0.060
			1.000			Ice	4.026	4.447	0.098
						1" Ice			
X7C-FRO-660-4 w/ Mount Pipe	A	From Leg	4.000	0.000	69.000	No Ice	9.786	7.529	0.039
			0.000			1/2"	10.360	8.715	0.117
			1.000			Ice	10.899	9.615	0.203
						1" Ice			
X7C-FRO-660-4 w/ Mount Pipe	C	From Leg	4.000	0.000	69.000	No Ice	9.786	7.529	0.039
			0.000			1/2"	10.360	8.715	0.117
			1.000			Ice	10.899	9.615	0.203
						1" Ice			
X7C-665-4 w/ Mount Pipe	B	From Leg	4.000	0.000	69.000	No Ice	8.643	6.946	0.053
			0.000			1/2"	9.206	8.127	0.123
			1.000			Ice	9.734	9.021	0.201
						1" Ice			

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
RRH2X40-AWS	A	From Leg	4.000 0.000 1.000	0.000	69.000	No Ice 1/2" Ice 1" Ice	2.161 2.360 2.565	1.420 1.590 1.768	0.044 0.061 0.082
RRH2X40-AWS	B	From Leg	4.000 0.000 1.000	0.000	69.000	No Ice 1/2" Ice 1" Ice	2.161 2.360 2.565	1.420 1.590 1.768	0.044 0.061 0.082
RRH2X40-AWS	C	From Leg	4.000 0.000 1.000	0.000	69.000	No Ice 1/2" Ice 1" Ice	2.161 2.360 2.565	1.420 1.590 1.768	0.044 0.061 0.082
RDC-4276-PF-48	A	From Leg	4.000 0.000 1.000	0.000	69.000	No Ice 1/2" Ice 1" Ice	5.090 5.370 5.656	2.324 2.526 2.744	0.034 0.072 0.115
***									

Dishes

Description	Face or Leg	Dish Type	Offset Type	Offsets: Horz Lateral Vert ft	Azimuth Adjustment °	3 dB Beam Width °	Elevation ft	Outside Diameter ft		Aperture Area ft^2	Weight K
VHLP2-180	A	Paraboloid w/Shroud (HP)	From Leg	1.000 0.000 0.000	0.000		77.000	2.000	No Ice 1/2" Ice 1" Ice	3.140 3.407 3.674	0.025 0.042 0.060
#											

Load Combinations

Comb. No.	Description
1	Dead Only
2	1.2 Dead+1.6 Wind 0 deg - No Ice
3	0.9 Dead+1.6 Wind 0 deg - No Ice
4	1.2 Dead+1.6 Wind 30 deg - No Ice
5	0.9 Dead+1.6 Wind 30 deg - No Ice
6	1.2 Dead+1.6 Wind 60 deg - No Ice
7	0.9 Dead+1.6 Wind 60 deg - No Ice
8	1.2 Dead+1.6 Wind 90 deg - No Ice
9	0.9 Dead+1.6 Wind 90 deg - No Ice
10	1.2 Dead+1.6 Wind 120 deg - No Ice
11	0.9 Dead+1.6 Wind 120 deg - No Ice
12	1.2 Dead+1.6 Wind 150 deg - No Ice
13	0.9 Dead+1.6 Wind 150 deg - No Ice
14	1.2 Dead+1.6 Wind 180 deg - No Ice
15	0.9 Dead+1.6 Wind 180 deg - No Ice
16	1.2 Dead+1.6 Wind 210 deg - No Ice
17	0.9 Dead+1.6 Wind 210 deg - No Ice
18	1.2 Dead+1.6 Wind 240 deg - No Ice
19	0.9 Dead+1.6 Wind 240 deg - No Ice
20	1.2 Dead+1.6 Wind 270 deg - No Ice
21	0.9 Dead+1.6 Wind 270 deg - No Ice
22	1.2 Dead+1.6 Wind 300 deg - No Ice

Comb. No.	Description
23	0.9 Dead+1.6 Wind 300 deg - No Ice
24	1.2 Dead+1.6 Wind 330 deg - No Ice
25	0.9 Dead+1.6 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
L1	91 - 48.75	Pole	Max Tension	27	0.000	-0.000	-0.001
			Max. Compression	26	-37.662	0.099	2.101
			Max. Mx	8	-14.670	-545.264	1.010
			Max. My	14	-14.629	0.102	-552.437
			Max. Vy	8	19.791	-545.264	1.010
			Max. Vx	14	20.137	0.102	-552.437
			Max. Torque	8			0.899
L2	48.75 - 0	Pole	Max Tension	1	0.000	0.000	0.000
			Max. Compression	26	-50.950	0.101	2.144
			Max. Mx	8	-24.123	-1673.637	2.515
			Max. My	14	-24.122	0.628	-1698.780
			Max. Vy	8	22.958	-1673.637	2.515
			Max. Vx	14	23.291	0.628	-1698.780
			Max. Torque	8			0.896

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
Pole	Max. Vert	27	50.950	-0.001	4.279
	Max. H_x	20	24.155	22.924	0.008
	Max. H_z	2	24.155	-0.010	23.217
	Max. M_x	2	1696.427	-0.010	23.217
	Max. M_z	8	1673.637	-22.924	0.027
	Max. Torsion	8	0.892	-22.924	0.027
	Min. Vert	11	18.116	-19.820	-11.671
	Min. H_x	8	24.155	-22.924	0.027
	Min. H_z	14	24.155	0.010	-23.257

Location	Condition	Gov. Load Comb.	Vertical K	Horizontal, X K	Horizontal, Z K
	Min. M_x	14	-1698.780	0.010	-23.257
	Min. M_z	20	-1673.481	22.924	0.008
	Min. Torsion	20	-0.891	22.924	0.008

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	20.129	0.000	0.000	-0.315	-0.061	0.000
1.2 Dead+1.6 Wind 0 deg - No Ice	24.155	0.010	-23.217	-1696.427	-0.786	-0.096
0.9 Dead+1.6 Wind 0 deg - No Ice	18.116	0.010	-23.217	-1678.972	-0.759	-0.097
1.2 Dead+1.6 Wind 30 deg - No Ice	24.155	11.449	-20.124	-1470.573	-835.689	-0.497
0.9 Dead+1.6 Wind 30 deg - No Ice	18.116	11.449	-20.124	-1455.424	-827.113	-0.496
1.2 Dead+1.6 Wind 60 deg - No Ice	24.155	19.841	-11.650	-851.669	-1448.431	-0.801
0.9 Dead+1.6 Wind 60 deg - No Ice	18.116	19.841	-11.650	-842.853	-1433.581	-0.798
1.2 Dead+1.6 Wind 90 deg - No Ice	24.155	22.924	-0.027	-2.515	-1673.637	-0.892
0.9 Dead+1.6 Wind 90 deg - No Ice	18.116	22.924	-0.027	-2.389	-1656.486	-0.888
1.2 Dead+1.6 Wind 120 deg - No Ice	24.155	19.820	11.671	852.665	-1446.815	-0.633
0.9 Dead+1.6 Wind 120 deg - No Ice	18.116	19.820	11.671	844.040	-1431.982	-0.629
1.2 Dead+1.6 Wind 150 deg - No Ice	24.155	11.441	20.155	1472.326	-835.211	-0.299
0.9 Dead+1.6 Wind 150 deg - No Ice	18.116	11.441	20.155	1457.363	-826.641	-0.296
1.2 Dead+1.6 Wind 180 deg - No Ice	24.155	-0.010	23.257	1698.780	0.628	0.098
0.9 Dead+1.6 Wind 180 deg - No Ice	18.116	-0.010	23.257	1681.506	0.642	0.099
1.2 Dead+1.6 Wind 210 deg - No Ice	24.155	-11.458	20.165	1473.031	836.276	0.467
0.9 Dead+1.6 Wind 210 deg - No Ice	18.116	-11.458	20.165	1458.061	827.736	0.466
1.2 Dead+1.6 Wind 240 deg - No Ice	24.155	-19.830	11.687	853.889	1447.362	0.729
0.9 Dead+1.6 Wind 240 deg - No Ice	18.116	-19.830	11.687	845.253	1432.564	0.726
1.2 Dead+1.6 Wind 270 deg - No Ice	24.155	-22.924	-0.008	-1.101	1673.481	0.891
0.9 Dead+1.6 Wind 270 deg - No Ice	18.116	-22.924	-0.008	-0.988	1656.371	0.887
1.2 Dead+1.6 Wind 300 deg - No Ice	24.155	-19.831	-11.633	-850.448	1447.571	0.703
0.9 Dead+1.6 Wind 300 deg - No Ice	18.116	-19.831	-11.633	-841.642	1432.768	0.699
1.2 Dead+1.6 Wind 330 deg - No Ice	24.155	-11.432	-20.114	-1469.871	834.308	0.330
0.9 Dead+1.6 Wind 330 deg - No Ice	18.116	-11.432	-20.114	-1454.727	825.785	0.327
1.2 Dead+1.0 Ice+1.0 Temp	50.950	-0.000	-0.000	-2.144	0.101	-0.000
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	50.950	0.001	-4.279	-328.040	0.027	-0.011
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	50.950	2.115	-3.708	-284.573	-160.778	-0.079
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	50.950	3.665	-2.145	-165.583	-278.724	-0.131

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
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	50.950	4.234	-0.003	-2.512	-322.039	-0.148
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	50.950	3.663	2.148	161.428	-278.514	-0.111
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	50.950	2.114	3.712	280.512	-160.753	-0.056
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	50.950	-0.001	4.284	324.041	0.183	0.011
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	50.950	-2.116	3.713	280.590	161.099	0.076
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	50.950	-3.664	2.150	161.563	278.803	0.122
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	50.950	-4.234	-0.001	-2.356	322.250	0.148
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	50.950	-3.664	-2.143	-165.448	278.857	0.119
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	50.950	-2.113	-3.707	-284.496	160.854	0.059
Dead+Wind 0 deg - Service	20.129	0.002	-4.674	-339.953	-0.206	-0.020
Dead+Wind 30 deg - Service	20.129	2.305	-4.051	-294.723	-167.387	-0.100
Dead+Wind 60 deg - Service	20.129	3.994	-2.345	-170.791	-290.077	-0.161
Dead+Wind 90 deg - Service	20.129	4.615	-0.006	-0.759	-335.170	-0.181
Dead+Wind 120 deg - Service	20.129	3.990	2.349	170.480	-289.754	-0.129
Dead+Wind 150 deg - Service	20.129	2.303	4.058	294.566	-167.293	-0.061
Dead+Wind 180 deg - Service	20.129	-0.002	4.682	339.917	0.077	0.020
Dead+Wind 210 deg - Service	20.129	-2.307	4.060	294.708	167.409	0.096
Dead+Wind 240 deg - Service	20.129	-3.992	2.353	170.725	289.767	0.149
Dead+Wind 270 deg - Service	20.129	-4.615	-0.002	-0.476	335.041	0.181
Dead+Wind 300 deg - Service	20.129	-3.992	-2.342	-170.546	289.807	0.142
Dead+Wind 330 deg - Service	20.129	-2.301	-4.049	-294.582	167.013	0.066

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	-20.129	0.000	0.000	20.129	0.000	0.000%
2	0.010	-24.155	-23.217	-0.010	24.155	23.217	0.000%
3	0.010	-18.116	-23.217	-0.010	18.116	23.217	0.000%
4	11.449	-24.155	-20.124	-11.449	24.155	20.124	0.000%
5	11.449	-18.116	-20.124	-11.449	18.116	20.124	0.000%
6	19.841	-24.155	-11.650	-19.841	24.155	11.650	0.000%
7	19.841	-18.116	-11.650	-19.841	18.116	11.650	0.000%
8	22.924	-24.155	-0.027	-22.924	24.155	0.027	0.000%
9	22.924	-18.116	-0.027	-22.924	18.116	0.027	0.000%
10	19.820	-24.155	11.671	-19.820	24.155	-11.671	0.000%
11	19.820	-18.116	11.671	-19.820	18.116	-11.671	0.000%
12	11.441	-24.155	20.155	-11.441	24.155	-20.155	0.000%
13	11.441	-18.116	20.155	-11.441	18.116	-20.155	0.000%
14	-0.010	-24.155	23.257	0.010	24.155	-23.257	0.000%
15	-0.010	-18.116	23.257	0.010	18.116	-23.257	0.000%
16	-11.458	-24.155	20.165	11.458	24.155	-20.165	0.000%
17	-11.458	-18.116	20.165	11.458	18.116	-20.165	0.000%
18	-19.830	-24.155	11.687	19.830	24.155	-11.687	0.000%
19	-19.830	-18.116	11.687	19.830	18.116	-11.687	0.000%
20	-22.924	-24.155	-0.008	22.924	24.155	0.008	0.000%
21	-22.924	-18.116	-0.008	22.924	18.116	0.008	0.000%
22	-19.831	-24.155	-11.633	19.831	24.155	11.633	0.000%

Load Comb.	Sum of Applied Forces PX K	PY K	PZ K	Sum of Reactions PX K	PY K	PZ K	% Error
23	-19.831	-18.116	-11.633	19.831	18.116	11.633	0.000%
24	-11.432	-24.155	-20.114	11.432	24.155	20.114	0.000%
25	-11.432	-18.116	-20.114	11.432	18.116	20.114	0.000%
26	0.000	-50.950	0.000	0.000	50.950	0.000	0.000%
27	0.001	-50.950	-4.279	-0.001	50.950	4.279	0.000%
28	2.115	-50.950	-3.708	-2.115	50.950	3.708	0.000%
29	3.665	-50.950	-2.145	-3.665	50.950	2.145	0.000%
30	4.234	-50.950	-0.003	-4.234	50.950	0.003	0.000%
31	3.663	-50.950	2.148	-3.663	50.950	-2.148	0.000%
32	2.114	-50.950	3.712	-2.114	50.950	-3.712	0.000%
33	-0.001	-50.950	4.284	0.001	50.950	-4.284	0.000%
34	-2.116	-50.950	3.713	2.116	50.950	-3.713	0.000%
35	-3.664	-50.950	2.150	3.664	50.950	-2.150	0.000%
36	-4.234	-50.950	-0.001	4.234	50.950	0.001	0.000%
37	-3.664	-50.950	-2.143	3.664	50.950	2.143	0.000%
38	-2.113	-50.950	-3.707	2.113	50.950	3.707	0.000%
39	0.002	-20.129	-4.674	-0.002	20.129	4.674	0.000%
40	2.305	-20.129	-4.051	-2.305	20.129	4.051	0.000%
41	3.994	-20.129	-2.345	-3.994	20.129	2.345	0.000%
42	4.615	-20.129	-0.006	-4.615	20.129	0.006	0.000%
43	3.990	-20.129	2.349	-3.990	20.129	-2.349	0.000%
44	2.303	-20.129	4.058	-2.303	20.129	-4.058	0.000%
45	-0.002	-20.129	4.682	0.002	20.129	-4.682	0.000%
46	-2.307	-20.129	4.060	2.307	20.129	-4.060	0.000%
47	-3.992	-20.129	2.353	3.992	20.129	-2.353	0.000%
48	-4.615	-20.129	-0.002	4.615	20.129	0.002	0.000%
49	-3.992	-20.129	-2.342	3.992	20.129	2.342	0.000%
50	-2.301	-20.129	-4.049	2.301	20.129	4.049	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	0.00025256
3	Yes	4	0.00000001	0.00006776
4	Yes	5	0.00000001	0.00052760
5	Yes	5	0.00000001	0.00021981
6	Yes	5	0.00000001	0.00054928
7	Yes	5	0.00000001	0.00023007
8	Yes	4	0.00000001	0.00060120
9	Yes	4	0.00000001	0.00033992
10	Yes	5	0.00000001	0.00052665
11	Yes	5	0.00000001	0.00021964
12	Yes	5	0.00000001	0.00053990
13	Yes	5	0.00000001	0.00022560
14	Yes	4	0.00000001	0.00025696
15	Yes	4	0.00000001	0.00007365
16	Yes	5	0.00000001	0.00054314
17	Yes	5	0.00000001	0.00022706
18	Yes	5	0.00000001	0.00052595
19	Yes	5	0.00000001	0.00021924
20	Yes	4	0.00000001	0.00058102
21	Yes	4	0.00000001	0.00032688
22	Yes	5	0.00000001	0.00054682
23	Yes	5	0.00000001	0.00022903
24	Yes	5	0.00000001	0.00052907
25	Yes	5	0.00000001	0.00022064
26	Yes	4	0.00000001	0.00001357
27	Yes	5	0.00000001	0.00013175
28	Yes	5	0.00000001	0.00016212
29	Yes	5	0.00000001	0.00016299
30	Yes	5	0.00000001	0.00012885
31	Yes	5	0.00000001	0.00015715
32	Yes	5	0.00000001	0.00015863

33	Yes	5	0.00000001	0.00012848
34	Yes	5	0.00000001	0.00015905
35	Yes	5	0.00000001	0.00015740
36	Yes	5	0.00000001	0.00012900
37	Yes	5	0.00000001	0.00016302
38	Yes	5	0.00000001	0.00016232
39	Yes	4	0.00000001	0.00001430
40	Yes	4	0.00000001	0.00012713
41	Yes	4	0.00000001	0.00014635
42	Yes	4	0.00000001	0.00003119
43	Yes	4	0.00000001	0.00012465
44	Yes	4	0.00000001	0.00013755
45	Yes	4	0.00000001	0.00001430
46	Yes	4	0.00000001	0.00014029
47	Yes	4	0.00000001	0.00012384
48	Yes	4	0.00000001	0.00003095
49	Yes	4	0.00000001	0.00014420
50	Yes	4	0.00000001	0.00012859

Maximum Tower Deflections - Service Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	91 - 48.75	11.992	39	1.127	0.002
L2	52.75 - 0	4.017	39	0.730	0.001

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
90.000	Platform Mount (LP 1001-1)	39	11.756	1.117	0.002	21055
84.000	Side Arm Mount [SO 104-3]	39	10.345	1.059	0.002	15039
81.000	Platform Mount (LP 1001-1)	39	9.648	1.030	0.002	10527
77.000	VHLP2-180	39	8.736	0.990	0.001	7519
69.000	Platform Mount [LP 304-1]	39	6.996	0.909	0.001	4785

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
L1	91 - 48.75	59.892	14	5.631	0.009
L2	52.75 - 0	20.082	14	3.651	0.004

Critical Deflections and Radius of Curvature - Design Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
90.000	Platform Mount (LP 1001-1)	14	58.712	5.583	0.009	4279
84.000	Side Arm Mount [SO 104-3]	14	51.668	5.294	0.008	3056
81.000	Platform Mount (LP 1001-1)	14	48.191	5.148	0.008	2138
77.000	VHLP2-180	14	43.639	4.951	0.007	1526
69.000	Platform Mount [LP 304-1]	14	34.952	4.546	0.006	970

Compression Checks

Pole Design Data

Section No.	Elevation ft	Size	L ft	L_u ft	Kl/r	A in^2	P_u K	ϕP_n K	Ratio $\frac{P_u}{\phi P_n}$
L1	91 - 48.75 (1)	TP28.993x19.396x0.188	42.250	0.000	0.0	16.602	-14.629	1082.760	0.014
L2	48.75 - 0 (2)	TP42.875x27.71x0.25	52.750	0.000	0.0	33.823	-24.122	2069.030	0.012

Pole Bending Design Data

Section No.	Elevation ft	Size	M_{ux} kip-ft	ϕM_{nx} kip-ft	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	M_{uy} kip-ft	ϕM_{ny} kip-ft	Ratio $\frac{M_{uy}}{\phi M_{ny}}$
L1	91 - 48.75 (1)	TP28.993x19.396x0.188	552.438	621.837	0.888	0.000	621.837	0.000
L2	48.75 - 0 (2)	TP42.875x27.71x0.25	1698.783	1817.117	0.935	0.000	1817.117	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	91 - 48.75 (1)	TP28.993x19.396x0.188	20.137	541.382	0.037	0.098	1245.192	0.000
L2	48.75 - 0 (2)	TP42.875x27.71x0.25	23.291	1034.510	0.023	0.098	3638.683	0.000

Pole Interaction Design Data

Section No.	Elevation ft	Ratio $\frac{P_u}{\phi P_n}$	Ratio $\frac{M_{ux}}{\phi M_{nx}}$	Ratio $\frac{M_{uy}}{\phi M_{ny}}$	Ratio $\frac{V_u}{\phi V_n}$	Ratio $\frac{T_u}{\phi T_n}$	Comb. Stress Ratio	Allow. Stress Ratio	Criteria
L1	91 - 48.75 (1)	0.014	0.888	0.000	0.037	0.000	0.903 ✔	1.000	4.8.2 ✔
L2	48.75 - 0 (2)	0.012	0.935	0.000	0.023	0.000	0.947 ✔	1.000	4.8.2 ✔

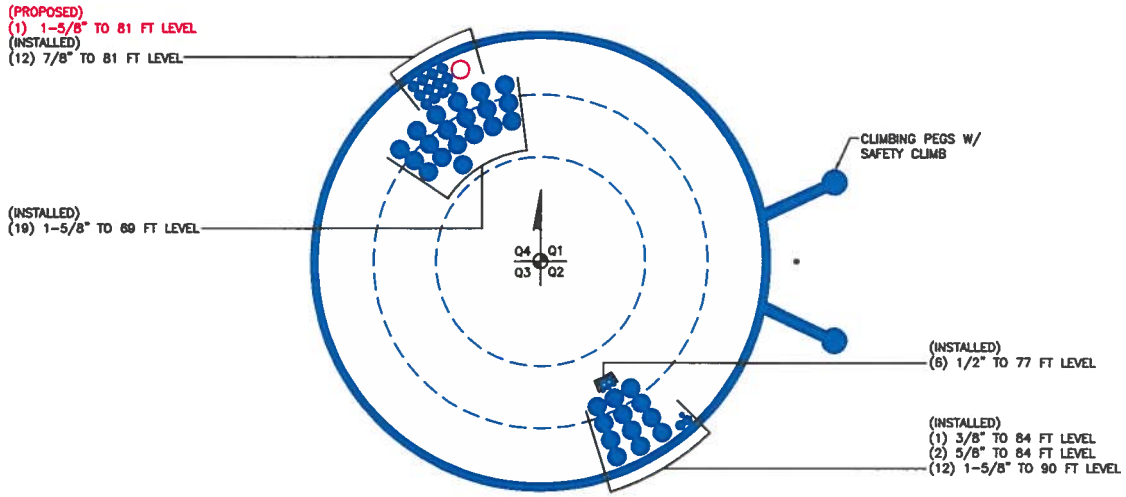
Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
L1	91 - 48.75	Pole	TP28.993x19.396x0.188	1	-14.629	1082.760	90.3	Pass
L2	48.75 - 0	Pole	TP42.875x27.71x0.25	2	-24.122	2069.030	94.7	Pass
							Summary	

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	$øP_{allow}$ K	% Capacity	Pass Fail
						Pole (L2)	94.7	Pass
						RATING =	**94.7**	**Pass**

APPENDIX B

BASE LEVEL DRAWING



BUSINESS UNIT: 842903 TOWER ID: C_BASELEVEL

APPENDIX C

ADDITIONAL CALCULATIONS

Stiffened or Unstiffened, Ungrouted, Circular Base Plate - Any Rod Material

TIA Rev G Assumption: Clear space between bottom of leveling nut and top of concrete not exceeding (1)*(Rod Diameter)

Site Data

BU#:	*842903*
Site Name:	*Grafton Estabrook St.*
App #:	*366568 Rev. 3*
Pole Manufacturer:	*Other*

Reactions		
Mu:	1699	ft-kips
Axial, Pu:	24	kips
Shear, Vu:	23	kips
Eta Factor, η	0.5	TIA G (Fig. 4-4)

If No stiffeners, Criteria:	AISC LRFD	<-Only Applcable to Unstiffened Cases

Anchor Rod Data		
Qty:	8	
Diam:	2.25	in
Rod Material:	A615-J	
Strength (Fu):	100	ksi
Yield (Fy):	75	ksi
Bolt Circle:	50	in

Plate Data		
Diam:	56	in
Thick:	2	in
Grade:	50	ksi
Single-Rod B-eff:	16.50	in

Stiffener Data (Welding at both sides)		
Config:	0	*
Weld Type:		
Groove Depth:		<-- Disregard
Groove Angle:		<-- Disregard
Fillet H. Weld:		in
Fillet V. Weld:		in
Width:		in
Height:		in
Thick:		in
Notch:		in
Grade:		ksi
Weld str.:		ksi

Pole Data		
Diam:	42.875	in
Thick:	0.25	in
Grade:	65	ksi
# of Sides:	18	"0" IF Round
Fu	80	ksi
Reinf. Fillet Weld	0	"0" if None

Anchor Rod Results

Max Rod (Cu+ Vu/ή):	212.7 Kips	Rigid
Allowable Axial, Φ*Fu*Anet:	260.0 Kips	AISC LRFD
Anchor Rod Stress Ratio:	81.8% Pass	φ*Tn

Base Plate Results Flexural Check

Base Plate Stress:	36.8 ksi	Rigid
Allowable Plate Stress:	45.0 ksi	AISC LRFD
Base Plate Stress Ratio:	81.9% Pass	φ*Fy
		Y.L. Length: 20.00

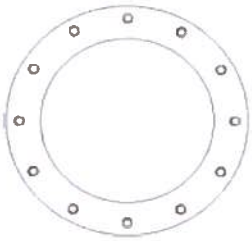
n/a

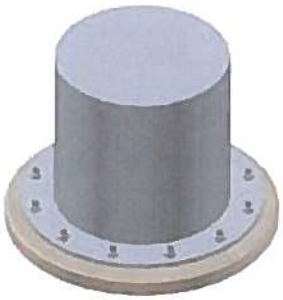
Stiffener Results

Horizontal Weld :	n/a
Vertical Weld:	n/a
Plate Flex+Shear, fb/Fb+(fv/Fv)^2:	n/a
Plate Tension+Shear, ft/Ft+(fv/Fv)^2:	n/a
Plate Comp. (AISC Bracket):	n/a

Pole Results

Pole Punching Shear Check:	n/a





* 0 = none, 1 = every bolt, 2 = every 2 bolts, 3 = 2 per bolt

** Note: for complete joint penetration groove welds the groove depth must be exactly 1/2 the stiffener thickness for calculation purposes

Monopole Pier and Pad Foundation

BU # : 842903
Site Name: Grafton Estabrook St.
App. Number: 366568 Rev. 3
TIA-222 Revision: G

Design Reactions		
Shear, **S**:	23	kips
Moment, **M**:	1699	ft-kips
Tower Height, **H**:	91	ft
Tower Weight, **Wt**:	24	kips
Base Diameter, **BD**:	3.57	ft

Foundation Dimensions		
Depth, **D**:	7	ft
Pad Width, **W**:	20	ft
Neglected Depth, **N**:	5	ft
Thickness, **T**:	3.50	ft
Pier Diameter, **Pd**:	6.00	ft
Ext. Above Grade, **E**:	0.67	ft
BP Dist. Above Pier:	3.125	in.
Clear Cover, **Cc**:	3.0	in

Soil Properties		
Soil Unit Weight, **γ**:	0.125	kcf
Ult. Bearing Capacity, Bc:	12.0	ksf
Angle of Friction, **Φ**:	36	deg
Cohesion, **Co**:	0.000	ksf
Passive Pressure, **Pp**:	0.000	ksf
Base Friction, **μ**:	0.40	

Material Properties		
Rebar Yield Strength, **Fy**:	60000	psi
Concrete Strength, **F'c**:	3000	psi
Concrete Unit Weight, **δc**:	0.150	kcf
Seismic Zone, **z**:	1	

Rebar Properties		
Pier Rebar Size, **Sp**:	8	
Pier Rebar Quanity, **mp**:	26	26
Pad Rebar Size, **Spad**:	8	
Pad Rebar Quanity, **mpad**:	12	12
Pier Tie Size, **St**:	3	3
Tie Quanity, **mt**:	6	6

Design Checks	Capacity/ Availability	Demand/ Limits	Check
Req'd Pier Diam.(ft)	6	5.07	**OK**
Overturning (ft-kips)	3546.54	1699.00	**47.9%**
Shear Capacity (kips)	138.78	23.00	**16.6%**
Bearing (ksf)	9.00	2.28	**25.3%**
Pad Shear - 1-way (kips)	759.14	175.76	**23.2%**
Pad Shear - 2-way (kips)	2196.11	56.53	**2.6%**
Pad Moment Capacity (k-ft)	1622.59	567.24	**35.0%**
Pier Moment Capacity (k-ft)	2843.68	1794.91	**63.1%**

Maximum Allowable Moment of a Circular Pier

Axial Load (Negative for Compression) = -24.00 kips

Pier Properties

Concrete:

Pier Diameter = 6.0 ft

Concrete Area = 4071.5 in^2

Reinforcement:

Clear Cover = 3.00 in

Cage Diameter = 5.42 ft

Bar Size = 8

Bar Diameter = 1.00 in

Bar Area = 0.79 in^2

Number of Bars = 26

Material Properties

Concrete compressive strength = 3000 psi

Reinforcement yield strength = 60000 psi

Modulus of elasticity = 29000 ksi

Reinforcement yield strain = 0.00207

Limiting compressive strain = 0.003

Seismic Properties

Seismic Zone = 1

Minimum Area of Steel

Required area of steel = 20.36 in^2

Provided area of steel = 20.54 in^2 **OK**

Axial Loading

Load factor = 1

Reduction factor = 0.9

Factored axial load = -26.6667 kips

Neutral Axis

Distance from extreme edge to neutral axis = 10.71 in

Equivalent compression zone factor = 0.85

Distance from extreme edge to equivalent compression zone factor = 9.11 in

Distance from centroid to neutral axis = 25.29 in

Compression Zone

Area of steel in compression zone = 3.16 in^2

Angle from centroid of pier to intersection of equivalent compression zone and edge of pier = 41.67 deg

Area of concrete in compression = 298.86 in^2

Force in concrete = 0.85 * f'c * Acc = 762.11 kips

Total reinforcement forces = -735.44 kips

Factored axial load = -26.67 kips

Force in concrete = -762.11 kips

Sum of the forces in concrete = 0.00 kips **OK**

Maximum Moment

First moment of the concrete area in compression about the centoid = 9138.78 in^3

Distance between centroid of concrete in compression and centroid of pier = 30.58 in

Moment of concrete in compression = 23303.90 in-kips

Total reinforcement moment = 14611.90 in-kips

Nominal moment strength of column = 37915.80 in-kips

Factored moment strength of column = 34124.22 in-kips

Maximum Allowable Moment = 2843.68 ft-kips

Individual Bars

Bar #	Angle from first bar (deg)	Distance to centroid (in)	Distance to neutral axis (in)	Distance to equivalent comp. zone (in)	Strain	Area of steel in compression (in^2)	Stress (ksi)	Axial force (kips)
1	0.00	0.00	-25.29	-26.89	-0.0070799	0.00	-60.00	-47.40
2	13.85	7.78	-17.51	-19.12	-0.0049022	0.00	-60.00	-47.40
3	27.69	15.10	-10.18	-11.79	-0.002851	0.00	-60.00	-47.40
4	41.54	21.55	-3.73	-5.34	-0.0010456	0.00	-30.32	-23.95
5	55.38	26.75	1.46	-0.15	0.0004092	0.00	11.87	9.37
6	69.23	30.39	5.10	3.50	0.0014287	0.79	41.43	30.72
7	83.08	32.26	6.98	5.37	0.0019537	0.79	56.66	42.74
8	96.92	32.26	6.98	5.37	0.0019537	0.79	56.66	42.74
9	110.77	30.39	5.10	3.50	0.0014287	0.79	41.43	30.72
10	124.62	26.75	1.46	-0.15	0.0004092	0.00	11.87	9.37
11	138.46	21.55	-3.73	-5.34	-0.0010456	0.00	-30.32	-23.95
12	152.31	15.10	-10.18	-11.79	-0.002851	0.00	-60.00	-47.40
13	166.15	7.78	-17.51	-19.12	-0.0049022	0.00	-60.00	-47.40
14	180.00	0.00	-25.29	-26.89	-0.0070799	0.00	-60.00	-47.40
15	193.85	-7.78	-33.06	-34.67	-0.0092577	0.00	-60.00	-47.40
16	207.69	-15.10	-40.39	-42.00	-0.0113089	0.00	-60.00	-47.40
17	221.54	-21.55	-46.84	-48.44	-0.0131143	0.00	-60.00	-47.40
18	235.38	-26.75	-52.03	-53.64	-0.014569	0.00	-60.00	-47.40
19	249.23	-30.39	-55.67	-57.28	-0.0155885	0.00	-60.00	-47.40
20	263.08	-32.26	-57.55	-59.16	-0.0161135	0.00	-60.00	-47.40
21	276.92	-32.26	-57.55	-59.16	-0.0161135	0.00	-60.00	-47.40
22	290.77	-30.39	-55.67	-57.28	-0.0155885	0.00	-60.00	-47.40
23	304.62	-26.75	-52.03	-53.64	-0.014569	0.00	-60.00	-47.40
24	318.46	-21.55	-46.84	-48.44	-0.0131143	0.00	-60.00	-47.40
25	332.31	-15.10	-40.39	-42.00	-0.0113089	0.00	-60.00	-47.40
26	346.15	-7.78	-33.06	-34.67	-0.0092577	0.00	-60.00	-47.40

CCISeismic - Design Category

Per *2012/2015 IBC*

Site BU:	842903
Work Order:	1317859
Application:	366568 Rev. 3

CROWN CASTLE

	Degrees	Minutes	Seconds		
Site Latitude =	42	13	35.33	42.2265	degrees
Site Longitude =	-71	39	51.78	-71.6644	degrees
Ground Supported Structure =	Yes				
Structure Class =	II			*(Table 2-1)*	
Site Class =	D - Stiff Soil			*(Table 2-11)*	

Spectral response acceleration short periods, S_S =	0.240	USGS Seismic Tool
Spectral response acceleration 1 s period, S_1 =	0.067	

Importance Factor, I =	1.0	*(Table 2-3)*
Acceleration-based site coefficient, F_a =	1.6	*(Table 2-12)*
Velocity-based site coefficient, F_v =	2.4	*(Table 2-13)*

Design spectral response acceleration short period, S_{DS} =	0.256	*(2.7.6)*
Design spectral response acceleration 1 s period, S_{D1} =	0.107	*(2.7.6)*

Seismic Design Category - Short Period Response =	B	*ASCE 7-05 Table 11.6-1*
Seismic Design Category - 1s Period Response =	B	*ASCE 7-05 Table 11.6-2*

Worst Case Seismic Design Category =	B	*ASCE 7-05 Tables 11.6-1 and 6-2*