Black & Veatch
30150 Telegraph Road, Suite 355
Bingham Farms, MI 48025
(913) 458-6785

GPD GROUP
Professional Corporation
A-2014041131, E-2014041305, LA-2014040814

Kevin Fraleigh
520 South Main Street, Suite 2531
Akron, OH 44311
(330) 572-2191
kfraleigh@gpdgroup.com

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RIGOROUS STRUCTURAL ANALYSIS REPORT

AT&T DESIGNATION:	**Site USID:**	**45545**
	Site FA:	**10000343**
	Client #:	**KS4130**
	Site Name:	**GREEN**
ANALYSIS CRITERIA:	**Codes:**	**TIA-222-G, 2012 IBC & ASCE 7-10** **115-mph Ultimate (3-second gust) with 0" ice** **89-mph Nominal (3-second gust) with 0" ice** **40-mph Nominal (3-second gust) with 1" ice**
SITE DATA:		**202 East Third Street, Lees Summit, MO 64063, Jackson County** **Latitude 38° 54' 50.004" N, Longitude 94° 22' 27.012" W** **Market: MISSOURI/KANSAS** **146' EEI Monopole**

Ms. Jackee Lukens,

GPD is pleased to submit this Rigorous Structural Analysis Report to determine the structural integrity of the aforementioned tower. The purpose of the analysis is to determine the suitability of the tower with the existing and proposed loading configuration detailed in the analysis report.

Analysis Results

Tower Stress Level with Proposed Equipment:	76.6%	Pass
Foundation Ratio with Proposed Equipment:	40.6%	Pass

We at GPD appreciate the opportunity of providing our continuing professional services to you and Black & Veatch. If you have any questions or need further assistance on this or any other projects please do not hesitate to call.

Respectfully submitted,

Christopher J. Scheks, P.E.
Missouri #: 2014028487

1/22/2018
Christopher J. Scheks - Professional Engineer
PE-2014028487

SUMMARY & RESULTS

The purpose of this analysis was to verify whether the existing structure is capable of carrying the proposed loading configuration as specified by AT&T Mobility to Black & Veatch. This report was commissioned by Ms. Jackee Lukens of Black & Veatch.

This analysis has been performed in accordance with the 2012 IBC based upon Risk Category II and a 115 mph ultimate 3-second gust wind speed converted to a nominal 3-second gust wind speed of 89 mph per section 1609.3.1 as required for used in the TIA-222-G Standard per Exception #5 of section 1609.1.1.

TOWER SUMMARY AND RESULTS

Member	Capacity	Results
Monopole	61.4%	Pass
Anchor Rods	76.6%	Pass
Base Plate	66.8%	Pass
Foundation	40.6%	Pass

ANALYSIS METHOD

tnxTower (Version 7.0.7.0), a commercially available software program, was used to create a three-dimensional model of the tower and calculate primary member stresses for various dead, live, wind, and ice load cases. Selected output from the analysis is included in Appendices B. The following table details the information provided to complete this structural analysis. This analysis is solely based on this information and is being completed without the benefit of a detailed site visit.

DOCUMENTS PROVIDED

Document	Remarks	Source
Construction Drawings	Black & Veatch Project #: 129039 Rev. A, dated 11/22/2017	B&V
Tower Design	EEI Job #: 1767, dated 6/21/1996	AT&T
Foundation Design	EEI Job #: 1767, dated 8/9/1996	AT&T
Geotechnical Report	Terracon Project #: 02965181, dated 7/31/1996	AT&T
Previous Structural Analysis	GPD Job #: 2017723.12.45545.01, dated 12/16/2016	AT&T

ASSUMPTIONS

This rigorous structural analysis is based on the theoretical capacity of the members and is not a condition assessment of the tower. This analysis is from information supplied, and therefore, its results are based on and are as accurate as that supplied data. GPD has made no independent determination, nor is it required to, of its accuracy. The following assumptions were made for this structural analysis.

1. The tower member sizes and shapes are considered accurate as supplied. The material grade is as per data supplied and/or as assumed and as stated in the materials section.
2. The appurtenance configuration is as supplied, determined from available photos, and/or as modeled in the analysis. It is assumed to be complete and accurate. All antennas, mounts, coax and waveguides are assumed to be properly installed and supported as per manufacturer requirements.
3. All mounts, if applicable, are considered adequate to support the loading. No actual analysis of the mount(s) is performed. This analysis is limited to analyzing the tower only.
4. The soil parameters are as per data supplied or as assumed and stated in the calculations.
5. Foundations are properly designed and constructed to resist the original design loads indicated in the documents provided.
6. The tower and structures have been properly maintained in accordance with TIA Standards and/or with manufacturer's specifications.
7. All welds and connections are assumed to develop at least the member capacity unless determined otherwise and explicitly stated in this report.
8. All prior structural modifications, if applicable, are assumed to be as per data supplied/available and to have been properly installed.
9. All existing loading was obtained from the previous analysis by GPD (Job #: 2017723.12.45545.01, dated 12/16/2016), site photos, and the provided construction drawings by Black & Veatch (Project #: 129039 Rev. A, dated 11/22/2017), and is assumed to be accurate.
10. All proposed loading has been obtained from the provided construction drawings by Black & Veatch (Project #: 129039 Rev. A, dated 11/22/2017) and is assumed to be accurate.

If any of these assumptions are not valid or have been made in error, this analysis may be affected, and GPD should be allowed to review any new information to determine its effect on the structural integrity of the tower.

DISCLAIMER OF WARRANTIES

GPD has not performed a detailed site visit to the tower to verify the member sizes or antenna/coax loading. If the existing conditions are not as represented on the tower elevation contained in this report, we should be contacted immediately to evaluate the significance of the discrepancy. This is not a condition assessment of the tower or foundation. This report does not replace a full tower inspection. The tower and foundations are assumed to have been properly fabricated, erected, maintained, in good condition, twist free, and plumb.

The engineering services rendered by GPD in connection with this Rigorous Structural Analysis are limited to a computer analysis of the tower structure and theoretical capacity of its main structural members. No allowance was made for any damaged, bent, missing, loose, or rusted members (above and below ground). No allowance was made for loose bolts or cracked welds.

This analysis is limited to the designated maximum wind and seismic conditions per the governing tower standards and code. Wind forces resulting in tower vibrations near the structure's resonant frequencies were not considered in this analysis and are outside the scope of this analysis. Lateral loading from any dynamic response was not evaluated under a time-domain based fatigue analysis.

GPD does not analyze the fabrication of the structure (including welding). It is not possible to have all the very detailed information needed to perform a thorough analysis of every structural sub-component and connection of an existing tower. GPD provides a limited scope of service in that we cannot verify the adequacy of every weld, plate connection detail, etc. The purpose of this report is to assess the capability of adding appurtenances usually accompanied by transmission lines to the structure.

It is the owner's responsibility to determine the amount of ice accumulation in excess of the code specified amount, if any, that should be considered in the structural analysis.

The attached sketches are a schematic representation of the analyzed tower. If any material is fabricated from these sketches, the contractor shall be responsible for field verifying the existing conditions, proper fit, and clearance in the field. Any mentions of structural modifications are reasonable estimates and should not be used as a precise construction document. Precise modification drawings are obtainable from GPD, but are beyond the scope of this report.

Miscellaneous items such as antenna mounts, etc., have not been designed or detailed as a part of our work. We recommend that material of adequate size and strength be purchased from a reputable tower manufacturer.

Towers are designed to carry gravity, wind, and ice loads. All members, legs, diagonals, struts, and redundant members provide structural stability to the tower with little redundancy. Absence or removal of a member can trigger catastrophic failure unless a substitute is provided before any removal. Legs carry axial loads and derive their strength from shorter unbraced lengths by the presence of redundant members and their connection to the diagonals with bolts or welds. If the bolts or welds are removed without providing any substitute to the frame, the leg is subjected to a higher unbraced length that immediately reduces its load carrying capacity. If a diagonal is also removed in addition to the connection, the unbraced length of the leg is greatly increased, jeopardizing its load carrying capacity. Failure of one leg can result in a tower collapse because there is no redundancy. Redundant members and diagonals are critical to the stability of the tower.

GPD makes no warranties, expressed and/or implied, in connection with this report and disclaims any liability arising from material, fabrication, and erection of this tower. GPD will not be responsible whatsoever for, or on account of, consequential or incidental damages sustained by any person, firm, or organization as a result of any data or conclusions contained in this report. The maximum liability of GPD pursuant to this report will be limited to the total fee received for preparation of this report.

APPENDIX A

Tower Analysis Summary Form

Tower Analysis Summary Form

General Info

Site Name	GREEN
Site Number	45545
FA Number	10000343
Date of Analysis	1/22/2018
Company Performing Analysis	GPD

The information contained in this summary report is not to be used independently from the PE stamped tower analysis.

Tower Info	Description	Date
Tower Type (G, SST, MP)	MP	
Tower Height (top of steel AGL)	146'	
Tower Manufacturer	Engineered Endeavors, Inc.	
Tower Model	N/A	
Tower Design	EEI Job #: 1767	6/21/1996
Foundation Design	EEI Job #: 1767	8/9/1996
Geotech Report	Terracon Project #: 02965181	7/31/1996
Tower Mapping	N/A	
Previous Structural Analysis	GPD Job #: 2017723.12.45545.01	12/16/2016
Foundation Mapping	N/A	

Design Parameters

Design Code Used	TIA-222-G, 2012 IBC ASCE 7-10
Location of Tower (County, State)	Jackson, MO
Nominal Wind Speed (mph)	89 (3-second gust)
Ice Thickness (in)	1
Structure Classification (I, II, III)	II
Exposure Category (B, C, D)	B
Topographic Category (1 to 5)	1

Analysis Results (% Maximum Usage)

Existing/Reserved + Future + Proposed Condition	
Tower (%)	61.4%
Tower Base (%)	76.6%
Foundation (%)	40.6%
Foundation Adequate?	Yes

Steel Yield Strength (ksi)

Monopole	65
Anchor Rods	75
Base Plate	60

Existing / Reserved Loading

Antenna								Mount			Transmission Line			
Antenna Owner	Mount Height (ft)	Antenna CL (ft)	Quantity	Type	Manufacturer	Model	Azimuth	Quantity	Manufacturer	Type	Quantity	Model	Size	Attachment Int/Ext
AT&T Mobility	146	149	3	Panel	Powerwave	P90-15-XLH-RR	4/124/244	1	Unknown	12' Platform w/ Handrails	4	Unknown	1-5/8"	External
AT&T Mobility	146	149	1	Panel	Powerwave	P65-17-XLH-RR	4				8	Unknown	1-5/8"	Internal
AT&T Mobility	146	149	4	Panel	Andrew	SBNHH-1D65C	4/124				1	RET	3/8"	Internal
AT&T Mobility	146	149	1	Panel	Kathrein	800-10766	124				6	DC	3/4"	Internal
AT&T Mobility	146	149	1	Panel	Powerwave	P65-16-XLH-RR	244				2	Fiber	3/8"	Internal
AT&T Mobility	146	149	2	Panel	Andrew	SBNHH-1D65B	244				3	Flex Conduit	2"	Internal
AT&T Mobility	146	149	3	TMA	Powerwave	TT08-19DB111-001								
AT&T Mobility	146	149	6	TMA	Andrew	ETD819G-12UB								
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	9442 RRH2x40W-07-L								
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	RRH2x60-1900A-4R								
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	RRH2x40-AWS+RDEM								
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	RRH2x60-850								
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	RRH4x25-WCS-4R								
AT&T Mobility	146	149	2	Surge	Raycap	DC6-48-6018-8F								
AT&T Mobility	146	149	1	Surge	Raycap	DC6-48-60-18-8C								

Note: (1) P65-17-XLH-RR, (2) SBNHH-1D65C, (1) 800-10766, (1) P65-16-XLH-RR, (1) SBNHH-1D65B, (6) ETD819G-12UB, (3) RRH2x60-1900A-4R, and (3) RRH2x40-AWS+RDEM at 146' shall be removed prior to the installation of the proposed configuration and have not been considered in this analysis. All other existing/reserved equipment shall be reused.

Proposed Loading

Antenna								Mount			Transmission Line			
Antenna Owner	Mount Height (ft)	Antenna CL (ft)	Quantity	Type	Manufacturer	Model	Azimuth	Quantity	Manufacturer	Type	Quantity	Model	Size	Attachment Int/Ext
AT&T Mobility	146	149	4	Panel	Quintel	QS86512-2	4/124			on the existing mount				
AT&T Mobility	146	149	2	Panel	Quintel	QS66512-2	244			on the existing mount				
AT&T Mobility	146	149	3	RRH	Nokia	Flexi RRH 4T4R B14 160W FRBI				on the existing mount				
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	B25 RRH4x30-4R				on the existing mount				
AT&T Mobility	146	149	3	RRH	Alcatel-Lucent	B66A RRH4x45				on the existing mount				

Note: The proposed loading shall be in addition to the existing equipment at the same elevation.

Future Loading

Antenna								Mount			Transmission Line			
Antenna Owner	Mount Height (ft)	Antenna CL (ft)	Quantity	Type	Manufacturer	Model	Azimuth	Quantity	Manufacturer	Type	Quantity	Model	Size	Attachment Int/Ext

APPENDIX B

tnxTower Output File

Tower Input Data

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

Tower is located in Jackson County, Missouri.
ASCE 7-10 Wind Data is used (wind speeds converted to nominal values).
Basic wind speed of 89 mph.
Structure Class II.
Exposure Category B.
Topographic Category 1.
Crest Height 0.00 ft.
Nominal ice thickness of 1.0000 in.
Ice thickness is considered to increase with height.
Ice density of 56 pcf.
A wind speed of 40 mph is used in combination with ice.
Temperature drop of 50 °F.
Deflections calculated using a wind speed of 60 mph.
A non-linear (P-delta) analysis was used.
Pressures are calculated at each section.
Stress ratio used in pole design is 1.
Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Feed Line/Linear Appurtenances - Entered As Round Or Flat

Description	*Sector*	*Component Type*	*Placement* *ft*	*Total Number*	*Number Per Row*	*Start/End Position*	*Width or Diameter* *in*	*Perimeter* *in*	*Weight* *plf*
Step Pegs	C	Surface Ar (CaAa)	146.00 - 8.00	1	1	0.000 0.000	0.8000		2.72
***									
LDF7-50A (1-5/8 FOAM)	A	Surface Ar (CaAa)	146.00 - 8.00	4	4	0.000 0.000	1.9800		0.82

Feed Line/Linear Appurtenances - Entered As Area

Description	*Face or Leg*	*Allow Shield*	*Component Type*	*Placement* *ft*	*Total Number*		C_AA_A *ft²/ft*	*Weight* *plf*
Safety Line (3/8")	C	No	CaAa (Out Of Face)	146.00 - 8.00	1	No Ice 1/2" Ice 1" Ice	0.04 0.14 0.24	0.22 0.75 1.28
LDF7-50A (1-5/8 FOAM)	A	No	Inside Pole	146.00 - 8.00	8	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.82 0.82 0.82
3/8" RET Cable	A	No	Inside Pole	146.00 - 8.00	1	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.10 0.10 0.10
3/4" DC Power Line	B	No	Inside Pole	146.00 - 8.00	6	No Ice 1/2" Ice 1" Ice	0.00 0.00 0.00	0.33 0.33 0.33

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number		C_AA_A ft^2/ft	Weight plf
3/8" Fiber Cable	B	No	Inside Pole	146.00 - 8.00	2	No Ice	0.00	0.10
						1/2" Ice	0.00	0.10
						1" Ice	0.00	0.10
2" Flex Conduit	B	No	Inside Pole	146.00 - 8.00	3	No Ice	0.00	0.32
						1/2" Ice	0.00	0.32
						1" Ice	0.00	0.32

Discrete Tower Loads

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
Sabre 12' LP Platform w/Rails	C	None		0.0000	146.00	No Ice	32.03	32.03	1.34
						1/2" Ice	38.71	38.71	1.80
						1" Ice	45.39	45.39	2.26
P90-15-XLH-RR w/ Mount Pipe	A	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.37	7.12	0.09
						1/2" Ice	8.93	8.30	0.16
						1" Ice	9.46	9.20	0.24
P90-15-XLH-RR w/ Mount Pipe	B	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.37	7.12	0.09
						1/2" Ice	8.93	8.30	0.16
						1" Ice	9.46	9.20	0.24
P90-15-XLH-RR w/ Mount Pipe	C	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.37	7.12	0.09
						1/2" Ice	8.93	8.30	0.16
						1" Ice	9.46	9.20	0.24
P65-17-XLH-RR w/ Mount Pipe	A	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.47	8.70	0.10
						1/2" Ice	12.08	10.11	0.18
						1" Ice	12.71	11.38	0.28
SBNHH-1D65C w/ Mount Pipe	A	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.35	8.28	0.06
						1/2" Ice	11.97	9.07	0.14
						1" Ice	12.59	9.87	0.22
SBNHH-1D65C w/ Mount Pipe	B	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.35	8.28	0.06
						1/2" Ice	11.97	9.07	0.14
						1" Ice	12.59	9.87	0.22
SBNHH-1D65C w/ Mount Pipe	A	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.35	8.28	0.06
						1/2" Ice	11.97	9.07	0.14
						1" Ice	12.59	9.87	0.22
SBNHH-1D65C w/ Mount Pipe	B	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.35	8.28	0.06
						1/2" Ice	11.97	9.07	0.14
						1" Ice	12.59	9.87	0.22
800 10766 w/ Mount Pipe	B	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.31	8.70	0.09
						1/2" Ice	11.93	10.11	0.17
						1" Ice	12.55	11.38	0.26
P65-16-XLH-RR w/ Mount Pipe	C	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.13	6.13	0.09
						1/2" Ice	8.59	7.07	0.15
						1" Ice	9.05	7.90	0.22
SBNHH-1D65B w/ Mount Pipe	C	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.16	6.16	0.06
						1/2" Ice	8.62	6.82	0.12
						1" Ice	9.09	7.51	0.19
SBNHH-1D65B w/ Mount Pipe	C	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	8.16	6.16	0.06
						1/2" Ice	8.62	6.82	0.12
						1" Ice	9.09	7.51	0.19
(2) QS86512-2 w/ Mount Pipe	A	From Centroid-Leg	4.00 / 0.00 / 3.00	0.0000	146.00	No Ice	11.47	11.90	0.19
						1/2" Ice	12.08	13.34	0.29
						1" Ice	12.71	14.43	0.40

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
(2) QS86512-2 w/ Mount Pipe	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	11.47 12.08 12.71	11.90 13.34 14.43	0.19 0.29 0.40
(2) QS66512-2 w/ Mount Pipe	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	8.37 8.93 9.46	8.46 9.66 10.55	0.14 0.21 0.30
TT08-19DB111-001	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.79 0.90 1.03	0.64 0.75 0.87	0.02 0.03 0.04
TT08-19DB111-001	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.79 0.90 1.03	0.64 0.75 0.87	0.02 0.03 0.04
TT08-19DB111-001	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.79 0.90 1.03	0.64 0.75 0.87	0.02 0.03 0.04
(2) ETD819G-12UB	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.84 2.01 2.19	0.45 0.55 0.66	0.03 0.04 0.06
(2) ETD819G-12UB	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.84 2.01 2.19	0.45 0.55 0.66	0.03 0.04 0.06
(2) ETD819G-12UB	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.84 2.01 2.19	0.45 0.55 0.66	0.03 0.04 0.06
9442 RRH2x40W-7-L	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.82 1.99 2.18	1.52 1.69 1.86	0.06 0.08 0.10
9442 RRH2x40W-7-L	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.82 1.99 2.18	1.52 1.69 1.86	0.06 0.08 0.10
9442 RRH2x40W-7-L	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.82 1.99 2.18	1.52 1.69 1.86	0.06 0.08 0.10
RRH2x60-1900A-4R	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.87 2.05 2.23	1.27 1.42 1.59	0.05 0.06 0.08
RRH2x60-1900A-4R	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.87 2.05 2.23	1.27 1.42 1.59	0.05 0.06 0.08
RRH2x60-1900A-4R	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.87 2.05 2.23	1.27 1.42 1.59	0.05 0.06 0.08
RRH2x40-AWS+RDEM	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.23 3.46 3.70	1.93 2.12 2.31	0.05 0.07 0.10
RRH2x40-AWS+RDEM	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.23 3.46 3.70	1.93 2.12 2.31	0.05 0.07 0.10
RRH2x40-AWS+RDEM	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.23 3.46 3.70	1.93 2.12 2.31	0.05 0.07 0.10
RRH4x25-WCS-4R	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.84 4.09 4.36	3.34 3.59 3.84	0.09 0.13 0.16
RRH4x25-WCS-4R	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.84 4.09 4.36	3.34 3.59 3.84	0.09 0.13 0.16

Description	Face or Leg	Offset Type	Offsets: Horz Lateral ft / Vert ft / ft	Azimuth Adjustment °	Placement ft		C_AA_A Front ft^2	C_AA_A Side ft^2	Weight K
RRH4x25-WCS-4R	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	3.84 4.09 4.36	3.34 3.59 3.84	0.09 0.13 0.16
RRH2x60-850	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.73 1.90 2.07	1.37 1.52 1.68	0.05 0.06 0.08
RRH2x60-850	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.73 1.90 2.07	1.37 1.52 1.68	0.05 0.06 0.08
RRH2x60-850	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	1.73 1.90 2.07	1.37 1.52 1.68	0.05 0.06 0.08
Flexi RRH 4T4R B14 160W FRBI	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.41 2.61 2.82	1.26 1.42 1.58	0.06 0.08 0.10
Flexi RRH 4T4R B14 160W FRBI	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.41 2.61 2.82	1.26 1.42 1.58	0.06 0.08 0.10
Flexi RRH 4T4R B14 160W FRBI	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.41 2.61 2.82	1.26 1.42 1.58	0.06 0.08 0.10
B25 RRH4x30-4R	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.14 2.33 2.53	1.31 1.46 1.63	0.05 0.07 0.09
B25 RRH4x30-4R	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.14 2.33 2.53	1.31 1.46 1.63	0.05 0.07 0.09
B25 RRH4x30-4R	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.14 2.33 2.53	1.31 1.46 1.63	0.05 0.07 0.09
B66A RRH4X45	A	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.54 2.75 2.97	1.61 1.79 1.98	0.06 0.08 0.10
B66A RRH4X45	B	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.54 2.75 2.97	1.61 1.79 1.98	0.06 0.08 0.10
B66A RRH4X45	C	From Centroid-Leg	4.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	2.54 2.75 2.97	1.61 1.79 1.98	0.06 0.08 0.10
DC6-48-60-18-8F Surge Suppression Unit	A	From Leg	1.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.92 1.46 1.64	0.92 1.46 1.64	0.02 0.04 0.06
DC6-48-60-18-8F Surge Suppression Unit	C	From Face	1.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.92 1.46 1.64	0.92 1.46 1.64	0.02 0.04 0.06
DC6-48-60-18-8C Surge Suppresion Unit	B	From Face	1.00 0.00 3.00	0.0000	146.00	No Ice 1/2" Ice 1" Ice	0.71 1.15 1.31	0.71 1.15 1.31	0.03 0.04 0.06

Critical Deflections and Radius of Curvature - Service Wind

Elevation ft	Appurtenance	Gov. Load Comb.	Deflection in	Tilt °	Twist °	Radius of Curvature ft
146.00	Sabre 12' LP Platform w/Rails	39	18.596	1.3696	0.0079	36494

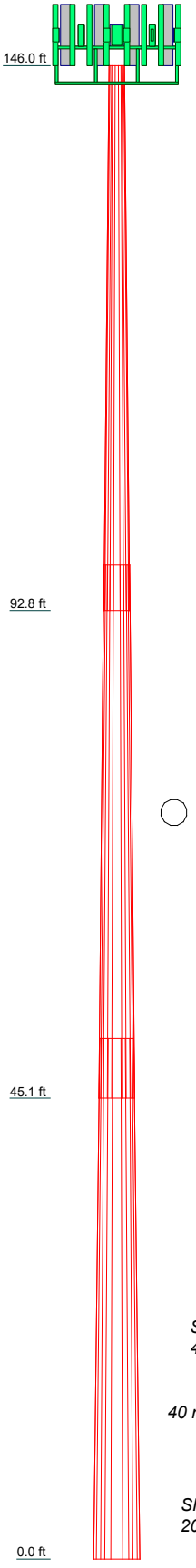
Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P K	ϕP_{allow} K	% Capacity	Pass Fail
L1	146 - 92.79	Pole	TP30.92x17.5x0.2188	1	-8.52	1271.89	61.4	Pass
L2	92.79 - 45.0767	Pole	TP42.38x29.3686x0.3125	2	-16.65	2550.97	51.7	Pass
L3	45.0767 - 0	Pole	TP53x40.299x0.375	3	-30.43	3793.24	49.4	Pass
						Summary	ELC:	E+P
						Pole (L1)	61.4	Pass
						Rating =	61.4	Pass

APPENDIX C

Tower Elevation Drawing

Section	Length (ft)	Number of Sides	Thickness (in)	Socket Length (ft)	Top Dia (in)	Bot Dia (in)	Grade	Weight (K)
1	53.21	12	0.2188	4.42	17.5000	30.9200		3.1
2	52.13	12	0.3125	5.83	29.3686	42.3800	A572-65	6.3
3	50.91	12	0.3750		40.2990	53.0000		9.7
								19.1



ALL REACTIONS ARE FACTORED

AXIAL 61 K

SHEAR 4 K *MOMENT 427 kip-ft*

TORQUE 0 kip-ft
40 mph WIND - 1.0000 in ICE

AXIAL 30 K

SHEAR 20 K *MOMENT 1976 kip-ft*

TORQUE 1 kip-ft
REACTIONS - 89 mph WIND

DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Sabre 12' LP Platform w/Rails	146	RRH2x60-1900A-4R	146
P90-15-XLH-RR w/ Mount Pipe	146	RRH2x60-1900A-4R	146
P90-15-XLH-RR w/ Mount Pipe	146	RRH2x40-AWS+RDEM	146
P90-15-XLH-RR w/ Mount Pipe	146	RRH2x40-AWS+RDEM	146
P65-17-XLH-RR w/ Mount Pipe	146	RRH2x40-AWS+RDEM	146
SBNHH-1D65C w/ Mount Pipe	146	RRH4x25-WCS-4R	146
SBNHH-1D65C w/ Mount Pipe	146	RRH4x25-WCS-4R	146
SBNHH-1D65C w/ Mount Pipe	146	RRH4x25-WCS-4R	146
SBNHH-1D65C w/ Mount Pipe	146	RRH2x60-850	146
800 10766 w/ Mount Pipe	146	RRH2x60-850	146
P65-16-XLH-RR w/ Mount Pipe	146	RRH2x60-850	146
SBNHH-1D65B w/ Mount Pipe	146	Flexi RRH 4T4R B14 160W FRBI	146
SBNHH-1D65B w/ Mount Pipe	146	Flexi RRH 4T4R B14 160W FRBI	146
(2) QS86512-2 w/ Mount Pipe	146	Flexi RRH 4T4R B14 160W FRBI	146
(2) QS86512-2 w/ Mount Pipe	146	B25 RRH4x30-4R	146
(2) QS66512-2 w/ Mount Pipe	146	B25 RRH4x30-4R	146
TT08-19DB111-001	146	B25 RRH4x30-4R	146
TT08-19DB111-001	146	B66A RRH4X45	146
TT08-19DB111-001	146	B66A RRH4X45	146
(2) ETD819G-12UB	146	B66A RRH4X45	146
(2) ETD819G-12UB	146	DC6-48-60-18-8F Surge Suppression Unit	146
(2) ETD819G-12UB	146		
9442 RRH2x40W-7-L	146	DC6-48-60-18-8F Surge Suppression Unit	146
9442 RRH2x40W-7-L	146		
9442 RRH2x40W-7-L	146	DC6-48-60-18-8C Surge Suppresion Unit	146
RRH2x60-1900A-4R	146		

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

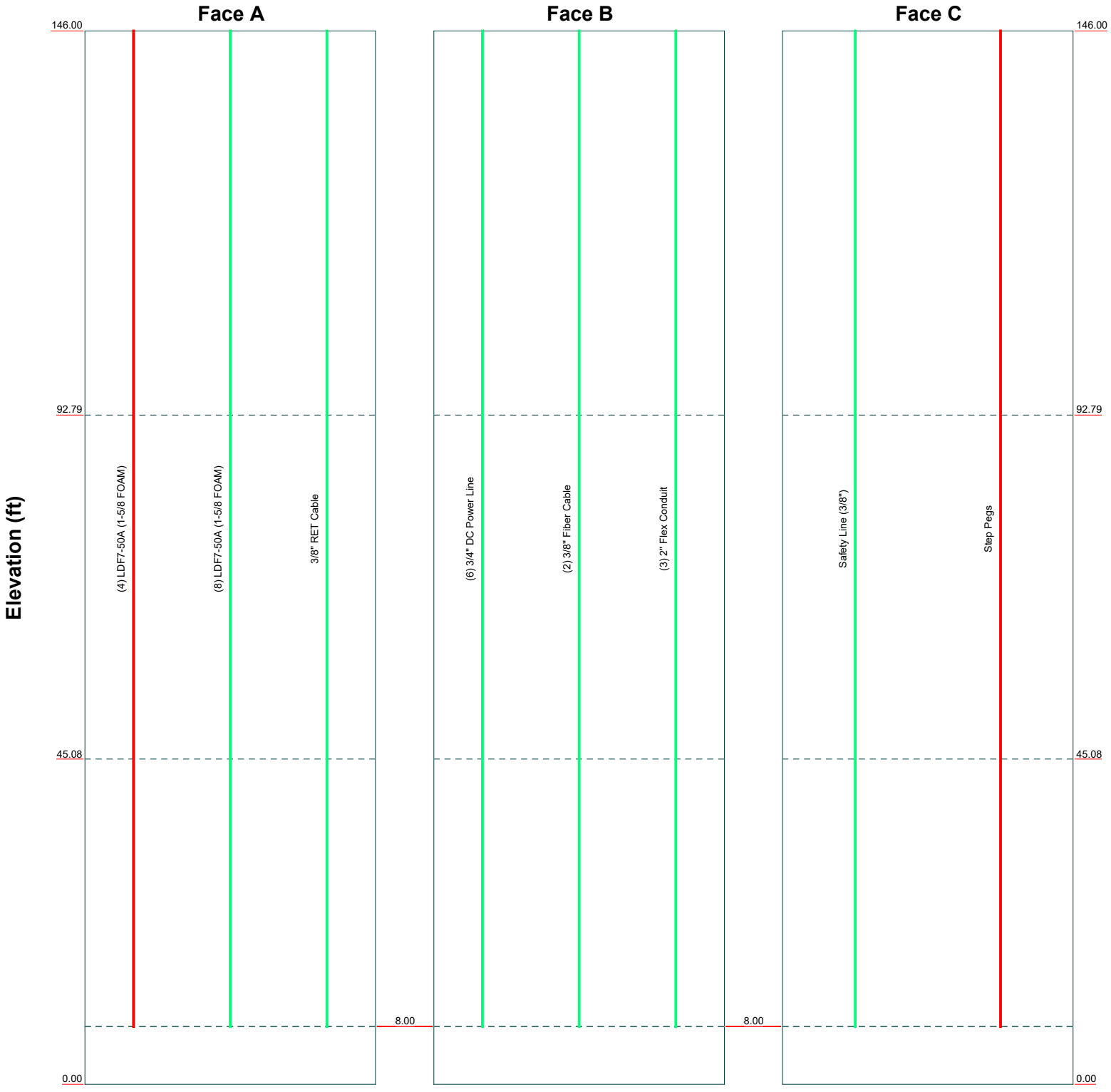
1. Tower is located in Jackson County, Missouri.
2. Tower designed for Exposure B to the TIA-222-G Standard.
3. Tower designed for a 89 mph basic wind in accordance with the TIA-222-G Standard.
4. Tower is also designed for a 40 mph basic wind with 1.00 in ice. Ice is considered to increase in thickness with height.
5. Deflections are based upon a 60 mph wind.
6. Tower Structure Class II.
7. Topographic Category 1 with Crest Height of 0.00 ft
8. TOWER RATING: 61.4%

GPD
520 South Main Street Suite 2531
Akron, Ohio 44311
Phone: (330) 572-2222
FAX: (330) 572-3722

Job:	***45545 - GREEN***		
Project:	***2018723.12.45545.02***		
Client: Black & Veatch	Drawn by: chake	App'd:	
Code: TIA-222-G	Date: 01/22/18	Scale: NTS	
Path: T:\ATandT\45545\02 2018723.12 45545 02 BV SA\tnx\45545 TNX.eri		Dwg No. E-1	

Feed Line Distribution Chart
0' - 146'

Round | Flat | App In Face | App Out Face | Truss Leg



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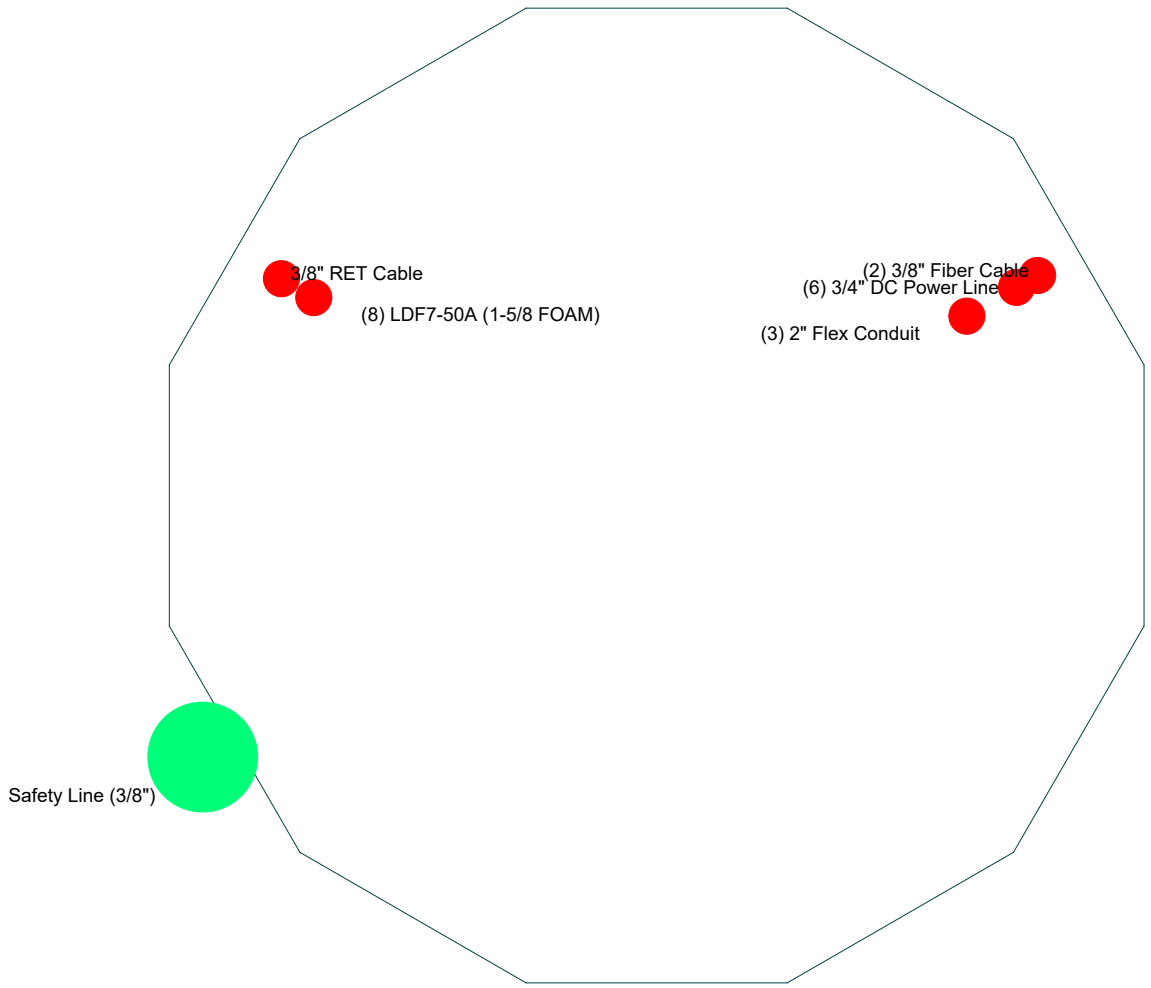
Client: Black & Veatch	Drawn by: chake	App'd:	
Code: TIA-222-G	Date: 01/22/18	Scale: NTS	
Path: T:\ATandT\45545\02 2018723.12.45545.02 BV SA\tnx\45545 TNX.eri		Dwg No. E-7	

Feed Line Plan

Round Flat App In Face App Out Face



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Phone: (330) 572-2222
FAX: (330) 572-3722

Job:	***45545 - GREEN***		
Project:	***2018723.12.45545.02***		
Client: Black & Veatch		Drawn by: chake	App'd:
Code: TIA-222-G		Date: 01/22/18	Scale: NTS
Path: T:\ATandT\45545\02 2018723.12.45545.02 BV SA\tnx\45545 TNX.eri			Dwg No. E-7

APPENDIX D

Anchor Rod and Base Plate Analysis

Anchor Rod and Base Plate Stresses, TIA-222-G-1

45545 - GREEN

2018723.12.455450.02

Overturning Moment =	1976.39	k*ft
Axial Force =	30.44	k
Shear Force =	20.01	k

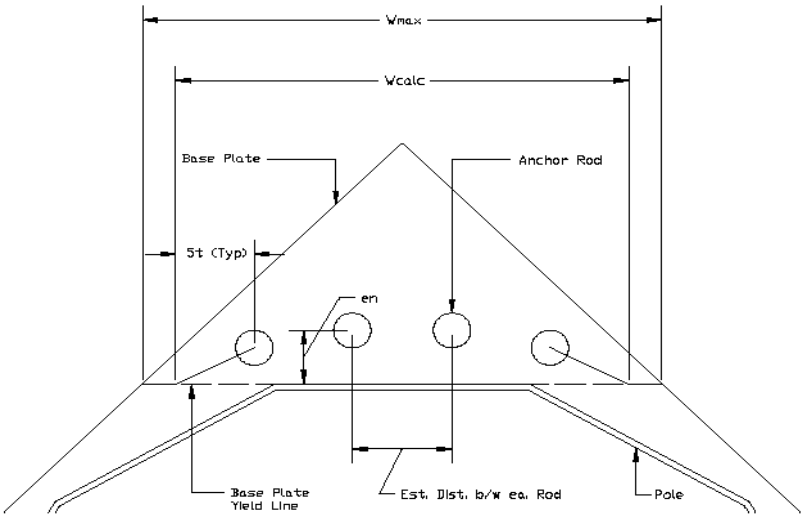
Acceptable Stress Ratio =	105.0%

Anchor Rods		
Pole Diameter =	53	in
Number of Rods =	8	
ϕ =	0.8	
Rod Ultimate Strength (F_u) =	100	ksi
Base Plate Detail Type* =	d	
Rod Circle =	62	in
Rod Diameter =	2.25	in
Net Tensile Area =	3.25	in^2
Max Tension on Rod =	186.44	kips
Max Compression on Rod =	194.05	kips
P_u =	194.05	kips
V_u =	2.50	kips
η =	0.50	
$P_u + V_u / \eta$ =	199.05	kips
φR_{nt} =	260.00	kips
Anchor Rod Capacity =	**76.6%**	**OK**

(Section 4.9.9, TIA-222-G-1)

Base Plate		
Plate Strength (Fy) =	60	ksi
ϕ =	0.9	
Plate Thickness =	2.75	in
Plate Width =	55	in
Est. Dist. b/w ea. Rod =	6	in
w_{calc} =	33.50	in
w_{max} =	24.78	in
w =	24.78	in
Z =	46.85	in^3
M_u =	1689.94	k-in
φM_n =	2530.06	k-in
Base Plate Capacity =	**66.8%**	**OK**

***This analysis assumes the clear distance from the top of the concrete to the bottom of the leveling nut is less than the diameter of the anchor rod. Notify GPD Group immediately if existing field conditions do not meet this assumption.**



APPENDIX E

Foundation Analysis

GPD GROUP

Caisson Analysis
45545 - GREEN
2018723.12.455450.02

General Info	
Code	TIA-222-G
Concrete Code	ACI 318-11
Seismic Design Category	B
Max Stress Ratio	1.05
Reinforcing Known?	Yes
Modified?	No

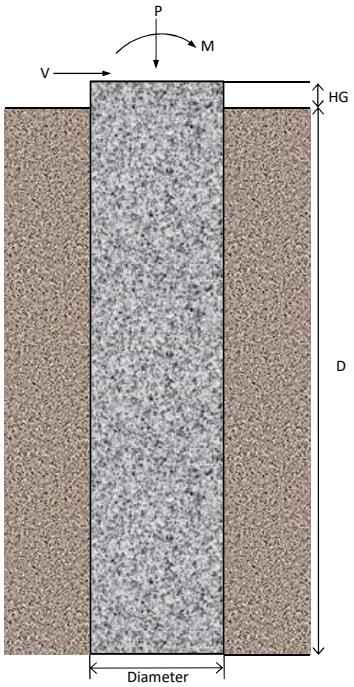
General Soil		
Ground Water	99.00	ft
Soil Depth to Neglect	7.50	ft

Reactions		
Moment, M	1976.39	k-ft
Axial, P	30.44	k
Shear, V	20.01	k

Pier Information		
Pier Diameter	7	ft
Pier Length Below Grade	25	ft
Distance Above Grade	1	ft
Vertical Bar Size	# 11	
Vertical Bar Quantity	21	
Tie Size	# 5	ft
fc' =	4	ksi
fy =	60	ksi
Clear Cover =	3	in

Soil Summary (Req. FS=1.33)		
Mu =	1976.39	k-ft
Mr =	7846.56	k-ft
FS =	3.97	
Capacity =	33.5%	Pass

Reinforcing Summary		
ϕMn =	5312.12	k-ft
Mu =	2155.23	k-ft
Min ρ =	0.00333	
Provided ρ =	0.00591	OK
Capacity =	40.6%	Pass



Soil Info

Layer	Soil Type	Thickness	γ, pcf	Cu, psf	ϕ	Kp	Top of Layer	Bot. of Layer
Layer 1	Clay	7.5	100	0	0	0.00	0.00	7.50
Layer 2	Clay	2.5	100	1500	0	0.00	7.50	10.00
Layer 3	Clay	8	100	1875	0	0.00	10.00	18.00
Layer 4	Clay	12	100	3000	0	0.00	18.00	30.00
Layer 5	Sand					1.00	30.00	30.00
Layer 6	Sand					1.00	30.00	30.00
Layer 7	Sand					1.00	30.00	30.00
Layer 8	Sand					1.00	30.00	30.00
Layer 9	Sand					1.00	30.00	30.00
Layer 10	Sand					1.00	30.00	30.00