Structural Analysis for
SBA Network Services, Inc.

280' Guyed Tower

SBA Site Name: Abbeville 3
SBA Site ID: AL13026-A-03
T-Mobile Site ID: 9BH0614A

FDH Velocitel Project Number 15BKQV1400

Analysis Results

Tower Components	89.7%	Sufficient
Foundation	71.0%	Sufficient

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04/22/15

April 22, 2015

Prepared pursuant to ANSI/TIA-222-G Structural Standard for Antenna Supporting Structures and Antennas and 2012 International Building Code

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EXECUTIVE SUMMARY

At the request of SBA Network Services, Inc., FDH Velocitel performed a structural analysis of the existing guyed tower located in Abbeville, AL to determine whether the tower is structurally adequate to support both the existing and proposed loads pursuant to the *Structural Standard for Antenna Supporting Structures and Antennas, ANSI/TIA-222-G* and *2012 International Building Code (IBC)*. Information pertaining to the existing/proposed antenna loading, current tower geometry, the member sizes, geotechnical data, and foundation dimensions was obtained from:

- ❑ Hemphill, Corp. (Job No. 1197) Tower Assembly Drawings & Information dated December 1, 2003
- ❑ Hemphill, Corp. (Job No. 1197) Tower Permit Drawings & Information dated November 5, 2003
- ❑ Hemphill, Corp. (Project No. 1197) Geotechnical Summary Report dated February 22, 2001
- ❑ FDH Engineering, Inc. (Job No. 08-07091T) TIA Inspection Report dated December 19, 2008
- ❑ FDH Engineering Inc. (Project No. 10-02313E S1) Modification & Extension Drawings for a 250' Guyed Tower dated April 26, 2010
- ❑ FDH Engineering Inc. (Project No. 10-02313E) Post Construction Inspection Report dated August 23, 2010
- ❑ FDH Engineering Inc. (Project No. 10-02313E S2) Modification & Extension Drawings for a 260' Guyed Tower dated August 31, 2010
- ❑ FDH Engineering Inc. (Project No. 10-02313E S2) Post Construction Inspection Report dated November 4, 2010
- ❑ SBA Network Services, Inc.

The ultimate design wind speed per the *2012 IBC* is 116 mph without ice and 30 mph with 1/4" radial ice. This is converted to a basic design wind speed per the *ANSI/TIA-222-G* standard and *2012 IBC* Section 1609.3.1 of 90 mph. Ice is considered to increase in thickness with height. Furthermore, this structure was analyzed as a Class II structure in Exposure Category C, Topographical Factor of 1, and Spectral Response Accelerations of S_S =0.100 and S_1 =0.062

Note: Per Section 2.7.3 of the *ANSI/TIA-222-G* standard, the seismic/earthquake loading effects can be ignored is spectral response acceleration at short periods (S_s) is less than or equal to 1.00. The tower's location mandates a design S_s of less than 1.00, thus seismic loading was not considered as part of the analysis of this structure

Conclusions

With the existing and proposed antennas from T-Mobile in place (see **Table 1**), the tower meets the requirements of the *ANSI/TIA-222-G* standard and *2012 IBC* provided the **Recommendations** listed below are satisfied. Furthermore, provided the foundation was designed and constructed to support the original design reactions (see Hemphill, Corp. Job No. 1197), the foundation should have the necessary capacity to support both the proposed and existing loading. For a more detailed description of the analysis of the tower, see the **Results** section of this report.

Our structural analysis has been performed assuming all information provided to FDH Velocitel is accurate (i.e., the steel data, tower layout, existing antenna loading, and proposed antenna loading) and that the tower has been properly erected and maintained per the original design drawings.

Recommendations

To ensure the requirements of the *ANSI/TIA-222-G* standard and *2012 IBC* are met with the existing and proposed loading in place, we have the following recommendations:

1. Feedlines must be installed as shown in **Figure 1**.
2. The existing and proposed TMAs should be installed directly behind the existing and proposed panel antennas.

APPURTENANCE LISTING

The proposed and existing antennas with their corresponding feedlines are shown in **Table 1**. *If the actual layout determined in the field deviates from the layout, FDH Velocitel should be contacted to perform a revised analysis.*

Table 1 - Appurtenance Loading

Existing Loading:

<table>
<tr><th>Antenna Elevation (ft)</th><th>Description</th><th>Feedlines[1]</th><th>Carrier</th><th>Mount Elevation (ft)</th><th>Mount Type</th></tr>
<tr><td>257</td><td>(6) Kathrein 741 990
(3) Commscope SBNHH-1D65C
(6) Powerwave LGP18601
(6) Kathrein 860 10025
(2) Raycap DC6-48-60-18-8F
(3) Ericsson WCS RRUS-11</td><td>(12) 1-5/8"
(1) 5/16"
(2) 3/8"
(2) 3/4"</td><td>New Cingular</td><td>257</td><td>(3) Sector Mounts</td></tr>
<tr><td>256</td><td>(3) Antel BCD-80010</td><td>(3) 1-5/8"</td><td>Sprint Nextel[2]</td><td rowspan="2">250</td><td rowspan="2">(3) Sector Mounts</td></tr>
<tr><td>250</td><td>(6) EMS RR90-18-00DP
(6) Ericsson 112 71/2</td><td>(9) 1-5/8"</td><td>T-Mobile</td></tr>
<tr><td>230</td><td>(9) CSA PCSA90-19-2
(1) Ericsson ANT2 0.6 11 HPX
(1) Minilink TN_HP</td><td>(12) 1-5/8"
(1) 1/2"</td><td rowspan="2">Sprint Nextel[2]</td><td>230</td><td>(3) Sector Mounts</td></tr>
<tr><td>163</td><td>(1) Gabriel 128871</td><td>(1) 1-5/8"</td><td>163</td><td>(1) 6'x4" Pipe mount</td></tr>
<tr><td>148</td><td>(1) Andrew 57W-PXA</td><td>(1) 2.25"</td><td rowspan="2">T-Mobile</td><td>148</td><td>(1) 5'x4" Pipe Mount</td></tr>
<tr><td>133</td><td>(2) Ericsson UKY 210 43/SC11R1B</td><td>(2) 1/2"</td><td>133</td><td>(2) 5'x4" Pipe Mount</td></tr>
</table>

1. See **Figure 1** for feedline layout.
2. Sprint Nextel lease terminated; Not included in this analysis

Proposed Carrier Final Loading:

<table>
<tr><th>Antenna Elevation (ft)</th><th>Description</th><th>Feedlines</th><th>Carrier</th><th>Mount Elevation (ft)</th><th>Mount Type</th></tr>
<tr><td>250</td><td>(6) EMS RR90-18-00DP
(3) RFS APXVF24-C-20
(6) Ericsson 112 71/2
(3) Ericsson 112 212/1</td><td>(9) 1-5/8"</td><td rowspan="3">T-Mobile</td><td>250</td><td>(3) Sector Mounts</td></tr>
<tr><td>148</td><td>(1) Andrew 57W-PXA</td><td>(1) 2.25"</td><td>148</td><td>(1) 5'x4" Pipe Mount</td></tr>
<tr><td>133</td><td>(2) Ericsson UKY 210 43/SC11R1B</td><td>(2) 1/2"</td><td>133</td><td>(2) 5'x4" Pipe Mount</td></tr>
</table>

RESULTS

The following yield strength of steel for individual members was used for analysis:

Table 2 - Material Strength

Member Type	Yield Strength
Legs	50 ksi
Bracing	36 ksi

Table 3 displays the summary of the ratio (as a percentage) of force in the member to their capacities. Values greater than 100% indicate locations where the maximum force in the member exceeds its capacity. *Note: Capacities up to 105% are considered acceptable.* **Table 4** displays the maximum foundation reactions. **Table 5** displays maximum antenna rotation at service wind speed (dishes only).

If the assumptions outlined in this report differ from actual field conditions, FDH Velocitel should be contacted to perform a revised analysis. Furthermore, as no information pertaining to the allowable twist and sway requirements for the existing or proposed appurtenances was provided, deflection and rotation were not taken into consideration when performing this analysis.

See the **Appendix** for detailed modeling information.

Table 3 - Summary of Working Percentage of Structural Components

Section No.	Elevation ft	Component Type	Size	% Capacity	Pass Fail
T1	280 - 260	Leg	P2.5x.276 (2.875 OD)	26.0	Pass
T2	260 - 250	Leg	P2.5x.276 (2.875 OD)	27.6	Pass
T3	250 - 230	Leg	P2.5x.276 (2.875 OD)	49.2	Pass
T4	230 - 210	Leg	P3x.300 (3.50 OD)	38.0	Pass
T5	210 - 190	Leg	P3x.300 (3.50 OD)	37.3	Pass
T6	190 - 170	Leg	P2.5x.276 (2.875 OD)	78.1	Pass
T7	170 - 150	Leg	P3x.300 (3.50 OD)	73.9	Pass
T8	150 - 130	Leg	P3x.300 (3.50 OD)	55.3	Pass
T9	130 - 110	Leg	P3x.300 (3.50 OD)	39.3	Pass
T10	110 - 90	Leg	P3x.300 (3.50 OD)	38.5	Pass
T11	90 - 70	Leg	P3x.300 (3.50 OD)	49.4	Pass
T12	70 - 50	Leg	P3x.300 (3.50 OD)	51.8	Pass
T13	50 - 30	Leg	P3x.300 (3.50 OD)	56.1	Pass
T14	30 - 10	Leg	P3x.300 (3.50 OD)	55.5	Pass
T15	10 - 5	Leg	P3x.300 (3.50 OD)	44.9	Pass
T16	5 - 0	Leg	P3x.300 (3.50 OD)	36.4	Pass
T1	280 - 260	Diagonal	L1 3/4x1 3/4x3/16	13.7 26.8 (b)	Pass
T2	260 - 250	Diagonal	L1 3/4x1 3/4x3/16	10.5 21.7 (b)	Pass
T3	250 - 230	Diagonal	L1 3/4x1 3/4x3/16	60.1 89.7 (b)	Pass
T4	230 - 210	Diagonal	L1 3/4x1 3/4x3/16	22.9 31.7 (b)	Pass
T5	210 - 190	Diagonal	L1 3/4x1 3/4x3/16	36.9	Pass

Section No.	Elevation ft	Component Type	Size	% Capacity	Pass Fail
				53.6 (b)	
T6	190 - 170	Diagonal	L1 3/4x1 3/4x3/16	59.2 86.9 (b)	Pass
T7	170 - 150	Diagonal	L2x2x1/4	43.8 70.8 (b)	Pass
T8	150 - 130	Diagonal	L1 3/4x1 3/4x3/16	57.3 81.3 (b)	Pass
T9	130 - 110	Diagonal	L1 3/4x1 3/4x3/16	21.1 22.9 (b)	Pass
T10	110 - 90	Diagonal	L1 3/4x1 3/4x3/16	37.6 47.7 (b)	Pass
T11	90 - 70	Diagonal	L1 3/4x1 3/4x3/16	47.8 69.6 (b)	Pass
T12	70 - 50	Diagonal	L1 3/4x1 3/4x3/16	45.4 61.3 (b)	Pass
T13	50 - 30	Diagonal	L1 3/4x1 3/4x3/16	24.0 28.4 (b)	Pass
T14	30 - 10	Diagonal	L1 3/4x1 3/4x3/16	31.1 39.8 (b)	Pass
T15	10 - 5	Diagonal	L1 3/4x1 3/4x3/16	35.1 47.7 (b)	Pass
T16	5 - 0	Horizontal	L2x2x1/4	6.2	Pass
T1	280 - 260	Top Girt	L1 3/4x1 3/4x3/16	0.8 1.2 (b)	Pass
T2	260 - 250	Top Girt	L1 3/4x1 3/4x3/16	2.2 5.5 (b)	Pass
T3	250 - 230	Top Girt	L1 3/4x1 3/4x3/16	14.2 26.9 (b)	Pass
T4	230 - 210	Top Girt	L1 3/4x1 3/4x3/16	6.5 12.7 (b)	Pass
T5	210 - 190	Top Girt	L1 3/4x1 3/4x3/16	2.8 6.8 (b)	Pass
T6	190 - 170	Top Girt	L1 3/4x1 3/4x3/16	10.0 20.0 (b)	Pass
T7	170 - 150	Top Girt	L2x2x1/4	9.6 17.7 (b)	Pass
T8	150 - 130	Top Girt	L1 3/4x1 3/4x3/16	13.7 31.4 (b)	Pass
T9	130 - 110	Top Girt	L1 3/4x1 3/4x3/16	4.4 10.6 (b)	Pass
T10	110 - 90	Top Girt	L1 3/4x1 3/4x3/16	3.3 7.9 (b)	Pass
T11	90 - 70	Top Girt	L1 3/4x1 3/4x3/16	8.1 18.4 (b)	Pass
T12	70 - 50	Top Girt	L1 3/4x1 3/4x3/16	9.4 22.5 (b)	Pass
T13	50 - 30	Top Girt	L1 3/4x1 3/4x3/16	5.1 12.4 (b)	Pass
T14	30 - 10	Top Girt	L1 3/4x1 3/4x3/16	4.3 10.4 (b)	Pass

Section No.	Elevation ft	Component Type	Size	% Capacity	Pass Fail
T15	10 - 5	Top Girt	L1 3/4x1 3/4x3/16	6.0 14.6 (b)	Pass
T16	5 - 0	Top Girt	L1 3/4x1 3/4x3/16	25.1 60.8 (b)	Pass
T1	280 - 260	Bottom Girt	L1 3/4x1 3/4x3/16	4.0 10.0 (b)	Pass
T2	260 - 250	Bottom Girt	L1 3/4x1 3/4x3/16	4.7 11.4 (b)	Pass
T3	250 - 230	Bottom Girt	L1 3/4x1 3/4x3/16	4.7 11.4 (b)	Pass
T4	230 - 210	Bottom Girt	L1 3/4x1 3/4x3/16	2.3 5.5 (b)	Pass
T5	210 - 190	Bottom Girt	L1 3/4x1 3/4x3/16	9.7 20.0 (b)	Pass
T6	190 - 170	Bottom Girt	L1 3/4x1 3/4x3/16	14.4 30.5 (b)	Pass
T7	170 - 150	Bottom Girt	L2x2x1/4	9.2 17.4 (b)	Pass
T8	150 - 130	Bottom Girt	L1 3/4x1 3/4x3/16	4.4 10.6 (b)	Pass
T9	130 - 110	Bottom Girt	L1 3/4x1 3/4x3/16	2.9 7.0 (b)	Pass
T10	110 - 90	Bottom Girt	L1 3/4x1 3/4x3/16	7.8 18.9 (b)	Pass
T11	90 - 70	Bottom Girt	L1 3/4x1 3/4x3/16	9.9 22.6 (b)	Pass
T12	70 - 50	Bottom Girt	L1 3/4x1 3/4x3/16	5.8 14.1 (b)	Pass
T13	50 - 30	Bottom Girt	L1 3/4x1 3/4x3/16	2.6	Pass
T14	30 - 10	Bottom Girt	L1 3/4x1 3/4x3/16	4.0	Pass
T15	10 - 5	Bottom Girt	L1 3/4x1 3/4x3/16	25.1	Pass
T1	280 - 260	Guy A@270.167	9/16	56.9	Pass
T3	250 - 230	Guy A@240	9/16	63.2	Pass
T7	170 - 150	Guy A@160	5/8	50.0	Pass
T11	90 - 70	Guy A@80	5/8	51.6	Pass
T1	280 - 260	Guy B@270.167	9/16	56.7	Pass
T3	250 - 230	Guy B@240	9/16	63.1	Pass
T7	170 - 150	Guy B@160	5/8	50.2	Pass
T11	90 - 70	Guy B@80	5/8	52.0	Pass
T1	280 - 260	Guy C@270.167	9/16	60.9	Pass
T3	250 - 230	Guy C@240	9/16	67.1	Pass
T7	170 - 150	Guy C@160	5/8	55.7	Pass
T11	90 - 70	Guy C@80	5/8	57.1	Pass
T1	280 - 260	Top Guy Pull-Off@270.167	L1 3/4x1 3/4x3/16	20.0 49.8 (b)	Pass
T11	90 - 70	Top Guy Pull-Off@80	L2x2x1/4	28.6 80.4 (b)	Pass
T3	250 - 230	Torque Arm Top@240	MC10x33.6	49.6	Pass
T7	170 - 150	Torque Arm Top@160	MC10x33.6	43.5	Pass

Table 4 - Maximum Base Reactions

	Current Analysis* *(ANSI/TIA-222-G)*		Original Design *(TIA/EIA-222-F)*	
Reaction	Horizontal	Vertical	Horizontal	Vertical
Tower Base	2 k	126 k	3 k	170 k
Anchor	54 k	61 k	62 k	64 k

*Current analysis reactions are within an allowable factor of 1.35 per the *ANSI/TIA-222-G* standard when the original design reactions are based on an allowable stress design.

Table 5 – Maximum Antenna Rotations at Service Wind Speed

Centerline Elevation (ft)	Antenna	Tilt (deg)*	Twist (deg)*
148	(1) Andrew 57W-PXA	0.0268	0.1437
133	(2) Ericsson UKY 210 43/SC11R1B	0.0237	0.1701

*Allowable tilt and twist values to be reviewed by the carrier.

GENERAL COMMENTS

This engineering analysis is based upon the theoretical capacity of the structure. It is not a condition assessment of the tower and its foundation. It is the responsibility of SBA Network Services, Inc. to verify that the tower modeled and analyzed is the correct structure (with accurate antenna loading information) modeled. If there are substantial modifications to be made or the assumptions made in this analysis are not accurate, FDH Velocitel should be notified immediately to perform a revised analysis.

LIMITATIONS

All opinions and conclusions are considered accurate to a reasonable degree of engineering certainty based upon the evidence available at the time of this report. All opinions and conclusions are subject to revision based upon receipt of new or additional/updated information. All services are provided exercising a level of care and diligence equivalent to the standard and care of our profession. No other warranty or guarantee, expressed or implied, is offered. Our services are confidential in nature and we will not release this report to any other party without the client's consent. The use of this engineering work is limited to the express purpose for which it was commissioned and it may not be reused, copied, or distributed for any other purpose without the written consent of FDH Velocitel.

APPENDIX

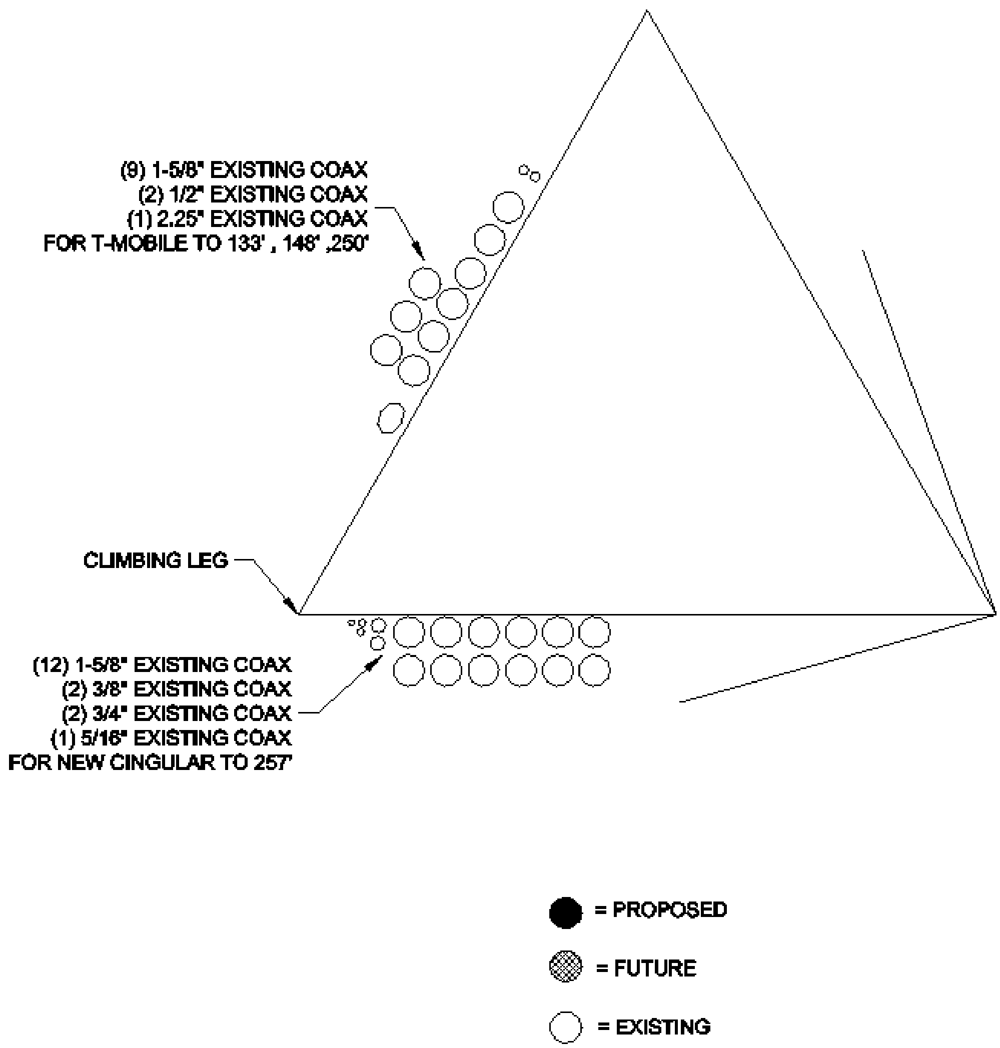
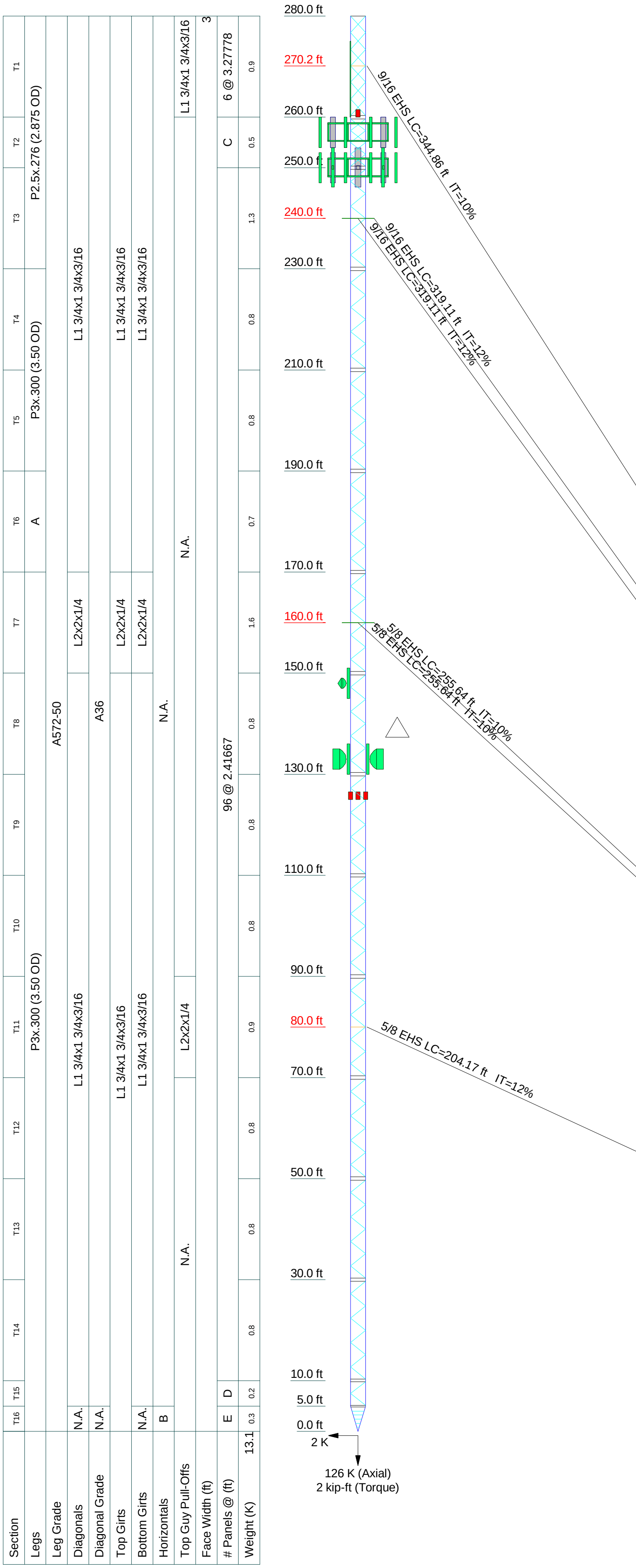
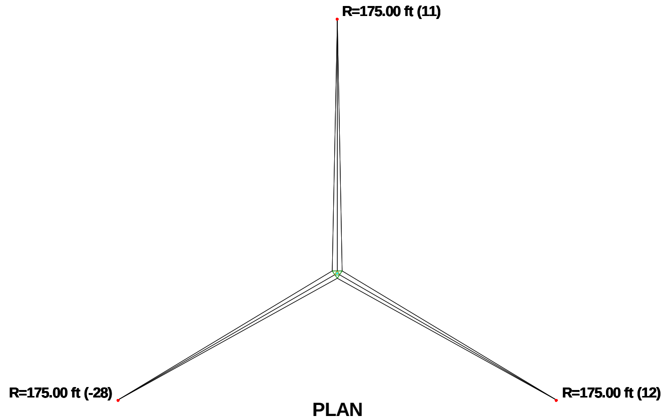


Figure 1 – Feedline Layout





DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Lightning Rod	260	(2) RR90-18-00DP w/Mount Pipe	250
Beacon	260	(2) RR90-18-00DP w/Mount Pipe	250
(2) 741 990 w/ Mount Pipe	257	(2) KRY 112 71/2	250
(2) 741 990 w/ Mount Pipe	257	(2) KRY 112 71/2	250
(2) 741 990 w/ Mount Pipe	257	(2) KRY 112 71/2	250
SBNHH-1D65C w/ Mount Pipe	257	Sector Mount [SM 1303-3]	250
SBNHH-1D65C w/ Mount Pipe	257	APXVF24-C-A20 w/ Mount Pipe	250
SBNHH-1D65C w/ Mount Pipe	257	APXVF24-C-A20 w/ Mount Pipe	250
(2) LGP18601 TMA	257	APXVF24-C-A20 w/ Mount Pipe	250
(2) LGP18601 TMA	257	KRY 112 212/1	250
(2) LGP18601 TMA	257	KRY 112 212/1	250
(2) 860 10025 RET	257	KRY 112 212/1	250
(2) 860 10025 RET	257	5'x4" Pipe Mount	148
(2) 860 10025 RET	257	57W-PXA	148
DC6-48-60-18-8F Surge Arrestor	257	5'x4" Pipe Mount	133
DC6-48-60-18-8F Surge Arrestor	257	5'x4" Pipe Mount	133
Sector Mount [SM 402-3]	257	UKY 210 43/SC11 R1B	133
WCS RRUS-11	257	UKY 210 43/SC11 R1B	133
WCS RRUS-11	257	Sidemarker	125
WCS RRUS-11	257	Sidemarker	125
(2) RR90-18-00DP w/Mount Pipe	250	Sidemarker	125

SYMBOL LIST

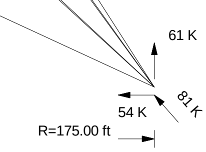
MARK	SIZE	MARK	SIZE
A	P2.5x.276 (2.875 OD)	D	2 @ 2.33333
B	L2x2x1/4	E	6 @ 0.805556
C	4 @ 2.33333		

MATERIAL STRENGTH

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

TOWER DESIGN NOTES

1. Tower is located in Henry County, Alabama.
2. Tower designed for Exposure C to the TIA-222-G Standard.
3. Tower designed for a 90 mph basic wind in accordance with the TIA-222-G Standard.
4. Tower is also designed for a 30 mph basic wind with 0.25 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: 89.7%



ALL REACTIONS ARE FACTORED

FDH VELOCITEL ENGINEERING INNOVATION Tower Analysis	**FDH Velocitel** 6521 Meridien Drive, Suite 107 Raleigh, North Carolina 27616 Phone: 9197551012 FAX: 9197551031	Job: ***Abbeville 3, AL13026-A-03*** Project: ***15BKQV1400*** Client: SBA Network Services, Inc. — Drawn by: Mohammed Douiche — App'd: Code: TIA-222-G — Date: 04/22/15 — Scale: NTS Path: — Dwg No. E-1