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Structural Analysis for
SBA Network Services, Inc.

300' Guyed Tower

SBA Site Name: Boiling Springs 2 NC
SBA Site ID: NC01884-B-01
AT&T Site ID: 478-601

FDH Project Number 146H961400

Analysis Results

Tower Components	95.8%	Sufficient
Foundation	90.1%	Sufficient

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11/19/14

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

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EXECUTIVE SUMMARY

At the request of SBA Network Services, Inc., FDH Engineering, Inc. performed a structural analysis of the existing guyed tower located in Bolivia, NC 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 the *2012 North Carolina State Building Code*. Information pertaining to the existing/proposed antenna loading, current tower geometry, the member sizes, foundation dimensions and geotechnical data was obtained from:

- ❑ Cellxion (Drawing No. TSBA00398) original design drawings dated February 17, 2000
- ❑ Law Engineering and Environmental Services, Inc. (Project No. 30720-9-3511) Geotechnical Summary Report and foundation design dated February 10, 2000
- ❑ Law Engineering and Environmental Services, Inc. (Project No. 30720-9-3511) foundation design dated February 10, 2000
- ❑ FDH Engineering (Project No. 04-0618-T) EIA/TIA Inspection Report dated June 28, 2004
- ❑ SBA Network Services, Inc.

The *basic design wind speed* per the *ANSI/TIA-222-G* standard and the *2012 North Carolina State Building Code* is 140 mph without ice and 30 mph with 1/4" radial ice. Ice is considered to increase in thickness with height. Furthermore, this structure as analyzed as a Class II structure in Exposure Category C with a topographical factor of 1 and Spectral Response Accelerations of S_S=0.328 and S_1=0.105.

Note: Per Section 2.7.3 of the *ANSI/TIA-222-G* standard, the seismic/earthquake loading effects can be ignored if spectral response acceleration at short periods (S_S) is less than or equal to 1.00 which is the case in Hamilton County, Ohio where the maximum value of Ss is 0.19. 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 AT&T in place at 300 ft, the tower meets the requirements of the *ANSI/TIA-222-G* standard and the *2012 North Carolina State Building Code* provided the **Recommendations** listed below are satisfied. Furthermore, provided the foundations were designed and constructed to support the original design reactions (see Law Engineering and Environmental Services, Inc. Project No. 30720-9-3511), the foundations should have the necessary capacity to support the existing and proposed 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 Engineering, Inc. 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 the *2012 North Carolina State Building Code* are met with the existing and proposed loading in place, we have the following recommendations:

1. Feed lines must be installed as shown in **Figure 1**.
2. RRU/RRH Stipulation: The equipment may be installed in any arrangement as determined by the client.

APPURTENANCE LISTING

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

Table 1 - Appurtenance Loading

Existing Loading:

Antenna Elevation (ft)	Description	Feedlines	Carrier	Mount Elevation (ft)	Mount Type
300	(6) Decibel DB982G90T2E-M w/ Mount Pipe (3) Kathreinscala 741-989 w/ Mount Pipe	(12) 2-1/4" (1) 3/8"	AT&T	300	(3) T-Frames
285	(2) Scala CA5-FM Yagis	(1) 7/8" RET	Church Planters of America	285	Direct
240	(3) Antel BXA-70063-8CF-2 (2) CSS AXP18-60-2 (1) CSS XP16-80-2 (1) CSS X7C-FRO-660 (1) CSS X7C-FRO-860 (1) CSS X7C-865 (6) Andrew 641280-DF DiplexerS	(12) 1-5/8"	Verizon	240	(3) T-Frames

Proposed Carrier Final Loading:

Antenna Elevation (ft)	Description	Feedlines	Carrier	Mount Elevation (ft)	Mount Type
300	(3) Kathrein 742-352 w/ Mount Pipe (3) Commscope SBNHH-1D65C w/ Mount Pipe (2) Raycap DC6-48-60-18-8F (3) Ericsson RRUS 11	(12) 2-1/4" (1) 3/8" RET (1) 7/8" Fiber (4) 7/8" DC	AT&T	300	(3) T-Frames (Kenwood P/N T1684KT12-4114)

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.

If the assumptions outlined in this report differ from actual field conditions, FDH Engineering, Inc. 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	300 - 280	Leg	2	71.7	Pass
		Diagonal	1 1/2	50.0	Pass
		Horizontal	1 1/4	52.6	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1 1/4	25.6	Pass
		Bottom Girt	1 1/4	7.8	Pass
		Guy A@293.194	3/4	87.8	Pass
		Guy B@293.194	3/4	92.1	Pass
		Guy C@293.194	3/4	90.4	Pass
		Torque Arm Top@293.194	L4x4x3/8	32.8	Pass
		Torque Arm Bottom@293.194	L4x4x3/8	45.8	Pass
T2	280 - 260	Leg	2 1/4	59.5	Pass
		Diagonal	1 3/8	29.2	Pass
		Horizontal	1	18.4	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	11.9	Pass
		Bottom Girt	1	6.9	Pass
T3	260 - 240	Leg	2 1/4	59.0	Pass
		Diagonal	1 3/8	43.7	Pass
		Horizontal	1	27.8	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	8.7	Pass
		Bottom Girt	1	19.0	Pass
T4	240 - 220	Leg	2 1/4	75.7	Pass
		Diagonal	1 1/2	70.2	Pass
		Horizontal	1 1/4	64.2	Pass
		Secondary Horizontal	3/4	0.0	Pass

Section No.	Elevation ft	Component Type	Size	% Capacity	Pass Fail
		Top Girt	1 1/4	30.4	Pass
		Bottom Girt	1 1/4	13.8	Pass
		Guy A@226.806	3/4	93.5	Pass
		Guy B@226.806	3/4	94.7	Pass
		Guy C@226.806	3/4	92.3	Pass
		Torque Arm Top@226.806	L4x4x3/8	35.3	Pass
		Torque Arm Bottom@226.806	L4x4x3/8	42.7	Pass
T5	220 - 200	Leg	2 1/4	69.6	Pass
		Diagonal	1 3/8	51.2	Pass
		Horizontal	1	33.5	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	21.0	Pass
		Bottom Girt	1	10.6	Pass
T6	200 - 180	Leg	2 1/4	61.2	Pass
		Diagonal	1 1/2	35.1	Pass
		Horizontal	1 1/4	18.9	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1 1/4	6.4	Pass
		Bottom Girt	1 1/4	12.4	Pass
T7	180 - 160	Leg	2 1/4	69.0	Pass
		Diagonal	1 1/2	38.0	Pass
		Horizontal	1 1/4	22.4	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1 1/4	11.8	Pass
		Bottom Girt	1 1/4	8.1	Pass
		Guy A@173.194	5/8	95.8	Pass
		Guy B@173.194	5/8	95.1	Pass
		Guy C@173.194	5/8	95.2	Pass
		Top Guy Pull-Off@173.194	2x3/8	20.7	Pass
T8	160 - 140	Leg	2 1/4	63.2	Pass
		Diagonal	1 1/4	52.1	Pass
		Horizontal	1	24.9	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	12.9	Pass
		Bottom Girt	1	15.9	Pass
T9	140 - 120	Leg	2 1/4	79.4	Pass
		Diagonal	1 1/2	38.5	Pass
		Horizontal	1 1/4	22.3	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1 1/4	10.9	Pass
		Bottom Girt	1 1/4	11.9	Pass
		Guy A@126.806	5/8	92.3	Pass
		Guy B@126.806	5/8	92.1	Pass
		Guy C@126.806	5/8	92.1	Pass
		Top Guy Pull-Off@126.806	2x3/8	21.5	Pass
T10	120 - 100	Leg	2 1/4	75.2	Pass
		Diagonal	1 3/8	47.1	Pass
		Horizontal	1	31.1	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	20.2	Pass
		Bottom Girt	1	11.7	Pass
T11	100 - 80	Leg	2 1/4	75.2	Pass

Section No.	Elevation ft	Component Type	Size	% Capacity	Pass Fail
		Diagonal	1 1/4	53.9	Pass
		Horizontal	1	25.9	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	11.6	Pass
		Bottom Girt	1	15.9	Pass
T12	80 - 60	Leg	2 1/4	71.3	Pass
		Diagonal	1 1/4	69.1	Pass
		Horizontal	1	36.1	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	17.5	Pass
		Bottom Girt	1	19.0	Pass
		Guy A@66.8056	5/8	75.5	Pass
		Guy B@66.8056	5/8	75.6	Pass
		Guy C@66.8056	5/8	75.6	Pass
		Top Guy Pull-Off@66.8056	2x3/8	26.0	Pass
T13	60 - 40	Leg	2 1/2	68.9	Pass
		Diagonal	1 1/4	69.0	Pass
		Horizontal	1	33.7	Pass
		Secondary Horizontal	3/4	0.0	Pass
		Top Girt	1	20.3	Pass
		Bottom Girt	1	13.4	Pass
T14	40 - 20	Leg	2 1/2	69.2	Pass
		Diagonal	1 1/4	45.7	Pass
		Horizontal	1	22.7	Pass
		Secondary Horizontal	3/4	0.1	Pass
		Top Girt	1	12.6	Pass
		Bottom Girt	1	13.5	Pass
T15	20 - 6.80729	Leg	2 1/2	68.0	Pass
		Diagonal	1 1/4	53.9	Pass
		Horizontal	1	28.7	Pass
		Secondary Horizontal	3/4	0.1	Pass
		Top Girt	1	15.2	Pass
T16	6.80729 - 0	Leg	2 1/2	48.1	Pass
		Horizontal	L4x4x3/8	52.8	Pass
		Top Girt	L4x4x3/8	17.7	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	3 k	267 k	2 k	298 k
Anchor	135 k	124 k	114 k	102 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.

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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 Engineering, Inc. 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 Engineering, Inc.

APPENDIX

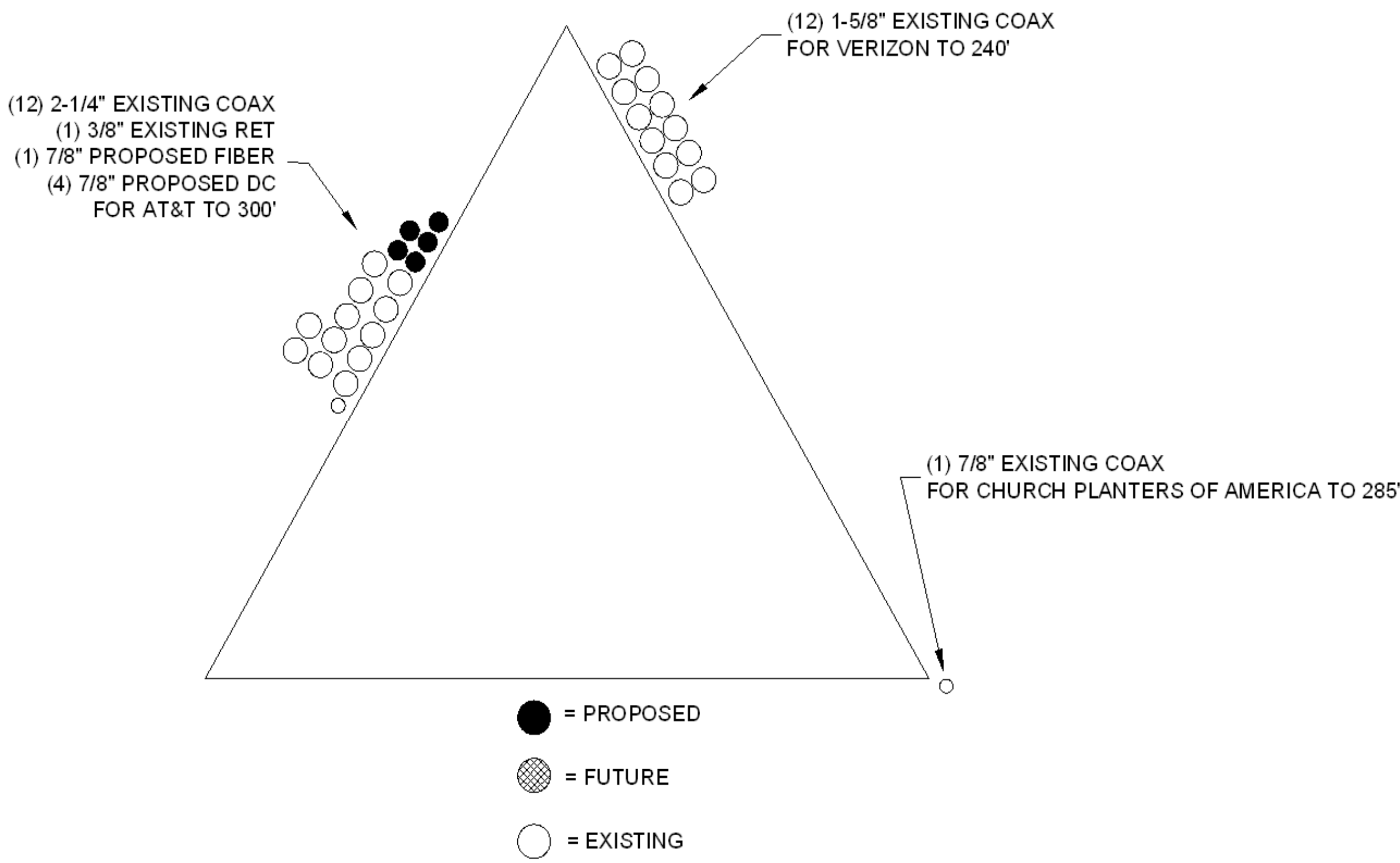

Figure 1 – Assumed Feedline Layout

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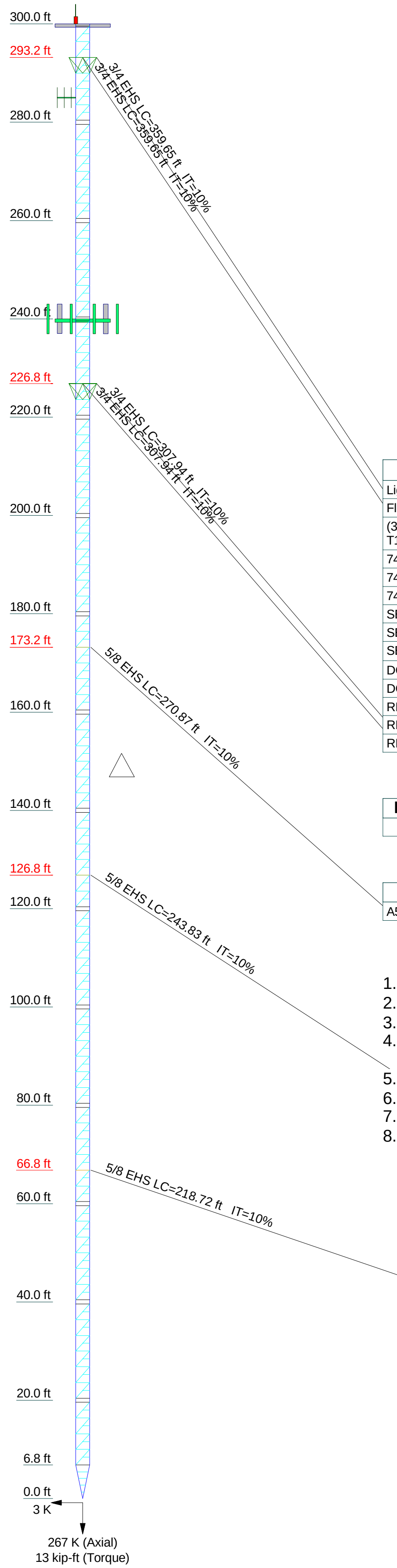
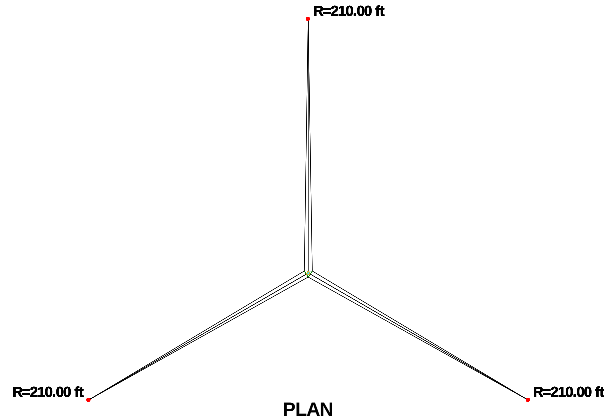
Section	Legs	Leg Grade	Diagonals	Diagonal Grade	Top Girts	Bottom Girts	Horizontals	Sec. Horizontals	Top Guy Pull-Offs	Face Width (ft)	# Panels @ (ft)	Weight (K)
T1	SR 2	A572-50	SR 1 1/2	A36	SR 1 1/4	SR 1 1/4	SR 1 1/4	SR 3/4	N.A.	3	88 @ 3.19444	1.8
T2	SR 2 1/4	A572-50	SR 1 3/8	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.4
T3	SR 2 1/4	A572-50	SR 1 3/8	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.4
T4	SR 2 1/4	A572-50	SR 1 1/2	A36	SR 1 1/4	SR 1 1/4	SR 1 1/4	SR 3/4	N.A.	3	88 @ 3.19444	2.0
T5	SR 2 1/4	A572-50	SR 1 3/8	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.4
T6	SR 2 1/4	A572-50	SR 1 1/2	A36	SR 1 1/4	SR 1 1/4	SR 1 1/4	SR 3/4	N.A.	3	88 @ 3.19444	1.6
T7	SR 2 1/4	A572-50	SR 1 1/2	A36	SR 1 1/4	SR 1 1/4	SR 1 1/4	SR 3/4	2x3/8	3	88 @ 3.19444	1.6
T8	SR 2 1/4	A572-50	SR 1 1/4	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.3
T9	SR 2 1/4	A572-50	SR 1 1/2	A36	SR 1 1/4	SR 1 1/4	SR 1 1/4	SR 3/4	2x3/8	3	88 @ 3.19444	1.6
T10	SR 2 1/4	A572-50	SR 1 3/8	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.4
T11	SR 2 1/4	A572-50	SR 1 1/4	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.3
T12	SR 2 1/4	A572-50	SR 1 1/4	A36	SR 1	SR 1	SR 1	SR 3/4	2x3/8	3	88 @ 3.19444	1.3
T13	SR 2 1/2	A572-50	SR 1 1/4	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.5
T14	SR 2 1/2	A572-50	SR 1 1/4	A36	SR 1	SR 1	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.5
T15	SR 2 1/2	A572-50	SR 1 1/4	A36	SR 1	N.A.	SR 1	SR 3/4	N.A.	3	88 @ 3.19444	1.0
T16	SR 2 1/2	A572-50	N.A.	N.A.	A	N.A.	A	N.A.	N.A.	3	B	0.6
												22.7





PLAN

DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Lightning Rod	300	(2) CA5-FM	285
Flash Beacon Lighting	300	(3) T-Frames	240
(3) Sector Frames (Kenwood P/N T1684KT12-4114)	300	BXA-70063/8CF_2 w/ mount pipe	240
		BXA-70063/8CF_2 w/ mount pipe	240
742 352 w/ Mount Pipe	300	BXA-70063/8CF_2 w/ mount pipe	240
742 352 w/ Mount Pipe	300	AXP18-60-2 w/ Mount Pipe	240
742 352 w/ Mount Pipe	300	AXP18-60-2 w/ Mount Pipe	240
SBNHH-1D65C w/ Mount Pipe	300	XP16-80-2 w/ mount pipe	240
SBNHH-1D65C w/ Mount Pipe	300	(2) 641280-DF Diplexer	240
SBNHH-1D65C w/ Mount Pipe	300	(2) 641280-DF Diplexer	240
DC6-48-60-18-8F	300	(2) 641280-DF Diplexer	240
DC6-48-60-18-8F	300	X7C-FRO-660 w/ Mount Pipe	240
RRUS 11	300	X7C-865 w/Mount Pipe	240
RRUS 11	300	X7C-FRO-860 w/ Mount Pipe	240
RRUS 11	300		

SYMBOL LIST

MARK	SIZE	MARK	SIZE
A	L4x4x3/8	B	5 @ 1.36146

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 Brunswick County, North Carolina.
2. Tower designed for Exposure C to the TIA-222-G Standard.
3. Tower designed for a 140 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: 95.8%

ALL REACTIONS ARE FACTORED

Reviewed For Code Compliance

BRUNSWICK COUNTY NORTH CAROLINA

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FDH
Tower Analysis

Job: **Boiling Springs 2, NC01884-B-01**			
Project: **146H961400**			
Client: SBA Network Services, Inc.	Drawn by: AGuli	App'd:	
Code: TIA-222-G	Date: 11/19/14	Scale: NTS	
Path:		Dwg No. E-1	