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# REPORT 270505

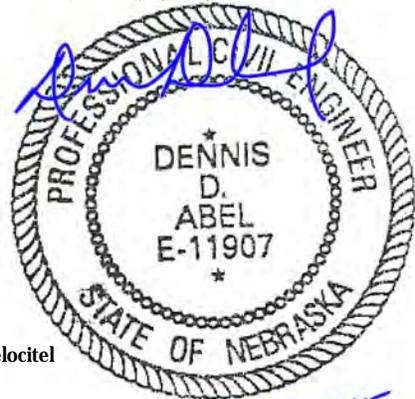
DATE: 09/20/2015

RIGOROUS STRUCTURAL ANALYSIS  
FOR A 1381-ft G-8 GUYED TOWER  
ALLIANCE, NE

PREPARED BY: PCC \_\_\_\_\_

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*09-22-2015*

Date	Pages	Remarks
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Rev.	Date	Description
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SECTION PAGE

A. AUTHORIZATION/PURPOSE ..... 1

B. TOWER HISTORY ..... 1

C. CONDITIONS INVESTIGATED ..... 2

D. LOADS AND STRESSES ..... 4

E. METHOD OF ANALYSIS ..... 4

F. RESULTS ..... 4

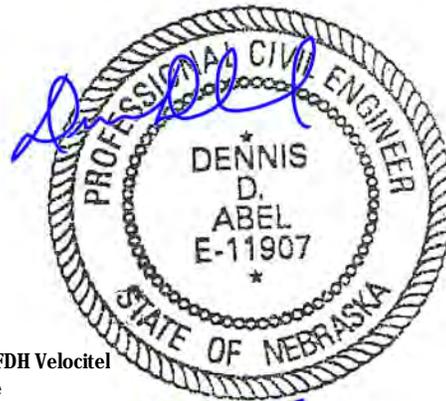
G. CONCLUSIONS AND RECOMMENDATIONS ..... 5

H. PROVISIONS OF ANALYSIS ..... 6

APPENDIX

GENERAL ARRANGEMENT ..... A-1

LINEAR APPURTENANCES ..... A-2



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A. AUTHORIZATION/PURPOSE

As authorized by Roger Book of Nebraska Educational Telecomm, a structural analysis was performed to investigate the adequacy of a 1381-ft guyed tower in Alliance, Nebraska to support specified equipment.

B. TOWER HISTORY

The tower was originally designed and furnished in 1978 by Stainless Inc. It was designed in accordance with EIA Standard RS-222- C for a wind pressure of 65 psf with no ice while supporting the following equipment:

1. One (1) RCA TW-18A13P top antenna with radome, fed by one (1) 6-1/8" rigid line.
2. One (1) side mounted RCA BFC-14B antenna at the 1270' level, fed by one (1) 3-1/8" rigid line. (Future)
3. One (1) grid dish antenna of area 7 ft<sup>2</sup> at the 1000' level, fed by one (1) 1-5/8" line. (Future)
4. One (1) grid dish antenna of area 7 ft<sup>2</sup> at the 600' level, fed by one (1) 7/8" line. (Future)
5. One (1) grid dish antenna of area 7 ft<sup>2</sup> at the 500' level, fed by one (1) 7/8" line. (Future)
6. One (1) 8-ft microwave parabolic antenna at the 250' level, fed by one (1) EW56 waveguide. (Future)
7. One (1) grid dish antenna of area 7 ft<sup>2</sup> at the 200' level, fed by one (1) 7/8" line. (Future)
8. One (1) 8-ft microwave parabolic antenna at the 140' level, fed by one (1) EW56 waveguide. (Future)
9. One (1) 3-1/8" rigid line for the full height of the tower. (Future)
10. One (1) climbing ladder for the full height of the tower.
11. One (1) A-10 lighting system fed by one (1) 1-1/4" conduit for the full height of the tower.

❖ In September 2001, the tower was modified by SpectraSite Broadcast Group per Job 270502. The modifications consisted of the following:

- a. Adjusted initial tensions in all guy levels.
- b. Replaced existing diagonal braces with new, higher capacity members at the following bays:

Location	No. of bays
1152.5' – 1158.8'	1
702.5' – 708.8'	1
533.8' – 540.0'	1
358.8' – 371.3'	2
127.5' – 158.8'	5

Stainless does not have any other record of modifications to the tower or its foundation.

Rev.	Date	Description
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C. CONDITIONS INVESTIGATED

The analysis was performed for the tower supporting equipment based upon the following sources:

- Stainless Proposal P15\_2705\_001 dated 07/01/2015.
- Tower Mapping Report by FDH Velocitel, FDHV Job Number: 15BGO1500, dated 09/15/2015.
- Tower top proposed antenna cut sheet for Electronics Research, Inc. ATW18V3-HTO-13 antenna, dated 06/18/2015.
- Tower top proposed antenna cut sheet for Dielectric THV-18A13-R (SP) antenna, dated 05/21/2015.

Condition 1: Dielectric Proposed Antenna

1. One (1) **proposed** Dielectric THV-18A13-R (SP) top antenna, fed by one (1) 4-1/16" rigid line (The existing 4-1/16" line terminates at the 1027' level, this line will be extended up to the 1381' level for the proposed top antenna).
2. One (1) transfer platform at the 1363' level.
3. One (1) Dielectric 12-bay FM antenna with radome from the 1160' to 1278' level (Radial Center at 1219'), fed by one (1) 3-1/8" rigid line.
4. Three (3) 4'x 4' grid dish backup antennas at the 1050' level, fed by three (3) 7/8" lines connecting to the 4-1/16" rigid line in item C.1. at the 1027' level. (These antennas will be removed after the top antenna is installed and are included in the analysis)
5. One (1) 4-bay 20-ft dipole antenna at the 726' level, fed by one (1) 7/8" line.
6. One (1) 7'x 6' ice shield at the 699' level.
7. Four (4) HDCA-10/URM/75N Yagi antennas at the 695', 691', 688' and 684' levels, and two (2) PDL4-222/75 RF Power Dividers at the 690' and 683' levels, all above equipment are fed by one (1) 7/8" line.
8. One (1) 8-bay 40-ft dipole antenna at the 486' level, fed by one (1) 7/8" line.
9. One (1) 5'x 8' ice shield at the 428' level.
10. One (1) Andrew HP6-59-P3A/K HP dish antenna with one (1) Ceragon HP-1R6L ODU unit at the 422' level, fed by one (1) 1/2" line.
11. One (1) 8-bay 20-ft dipole antenna on a 6' standoff mount at the 397' level, fed by one (1) 7/8" line.
12. One (1) 3'x 3' ice shield at the 384' level.
13. One (1) Andrew VHLP800-11-CR4 HP dish antenna with one (1) Ceragon 15HPS-1R-RFU-11 ODU unit at the 375' level, fed by one (1) 1/2" line.

Rev.	Date	Description
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14. One (1) 8-bay 20-ft dipole antenna on a 6' standoff mount at the 354.5' level, fed by one (1) 7/8" line.
15. One (1) low-band 4-antenna array at the 339' and 345' levels, fed by one (1) 7/8" line.
16. One (1) 3'x 3' ice shield at the 289' level.
17. One (1) Andrew VHLP800-11-CR4 HP dish antenna with one (1) Ceragon 15HPS-1R-RFU-11 ODU unit at the 280' level, fed by one (1) 1/2" line.
18. One (1) 2'x 2.1' ice shield at the 267' level.
19. One (1) Radiowaves SPD2-4.7NS dish antenna with one (1) Radiowaves 1047818-24.7 ODU (at the 266' level), one (1) 224PKJ TMA unit (at the 264' level), one (1) Motorola WB2900 PTP-LPU unit (at the 263.4' level), and one (1) Radiowaves SPD2-4.7NS dish antenna with one (1) Radiowaves 1047818-24.7 ODU (at the 262' level), fed by one (1) 3/8" fiber cable.
20. One (1) 2'x 2.1' ice shield at the 182.5' level.
21. One (1) Radiowaves SPD2-4.7NS dish antenna with one (1) Radiowaves 1047818-24.7 ODU (at the 181' level), one (1) 224PKJ TMA unit (at the 179' level), one (1) Motorola WB2900 PTP-LPU unit (at the 178.4' level), and one (1) Radiowaves SPD2-4.7NS dish antenna with one (1) Radiowaves 1047818-24.7 ODU (at the 177' level), fed by one (1) 3/8" fiber cable.
22. One (1) 4'x 4' ice shield at the 139' level.
23. One (1) Andrew VHLP4-11-CR4 HP dish antenna with one (1) Ceragon 15HPS-1R-RFU-11 ODU unit at the 130' level, fed by one (1) 1/2" line.
24. One (1) inside climbing ladder with **proposed** cable type safety device for the full height of the tower.
25. One (1) A-10 tower lighting system fed by one (1) 1-1/4" conduit for the full height of the tower.
26. One (1) 1-1/4" line support conduit to the 710.5' level.

**Condition 2: ERI Proposed Antenna**

Same as **Condition 1** except replace the **proposed** Dielectric THV-18A13-R (SP) top antenna with a **proposed** ERI ATW18V-HTO-13 top antenna.

The locations of the transmission lines are based upon Tower Mapping Report by FDH Velocitel, FDHV Job Number: 15BGYO1500, dated 09/15/2015. The line arrangement is summarized on page A-2 of this report. Deviating from this arrangement will affect the accuracy of this analysis.

Initial tensions of the guys are based on the values from SpectraSite Broadcast Group's Job 270502 dated September 2001.

Rev.	Date	Description
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D. LOADS AND STRESSES

The rigorous analysis was performed using the following design parameters in accordance with ANSI/TIA 222-G-2005, Structural Standard for Antenna Supporting Structures and Antennas, including addendum 1, 222-G-1, dated 2007:

- Structure Classification II
- 90 mph basic wind speed with no ice
- 60 mph basic wind speed with 1/4" design ice thickness
- Exposure Category C
- Topographic Category 1
- 0.12 earthquake spectral response acceleration at short periods ( $S_s$ )
- Earthquake Site Class D

Seismic effects need not be considered as the value of  $S_s$  is less than 1.0 per Section 2.7.3 of ANSI/TIA 222-G. The design ice thickness is 1/4", therefore the ice loading case need not be considered per Section 2.6.4 of ANSI/TIA 222-G.

Load and resistance factors used to evaluate the adequacy of the structure were also in accordance with ANSI/TIA 222-G.

E. METHOD OF ANALYSIS

The analysis was performed using tnxTower, a commercial computer-aided finite element tower program for the non-linear analysis of towers subject to simultaneous lateral and axial loads.

F. RESULTS

The results of the analysis show the following ratings:

LOCATION	SPAN	RATING %	
		Condition 1	Condition 2
Leg Compression	7	79	92
	6	92	99
	5	87	92
	4	68	69
	3	67	67
	2	68	68
	1	63	64

Rev.	Date	Description
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Leg Tension	7	95	82
	6	--	--
	5	--	--
	4	--	--
	3	--	--
	2	--	--
	1	--	--
Diagonals	7	72	74
	6	74	75
	5	72	75
	4	67	67
	3	69	70
	2	56	57
	1	59	59
Horizontals	7	59	61
	6	64*	64*
	5	56*	55*
	4	49*	49*
	3	44	45
	2	44*	45*
	1	44*	45*
Guys	7	65	67
	6	66	66
	5	62	62
	4	61	61
	3	61	61
	2	48	48
	1	46	46
Foundations	Base	77	77
	Inner anchors	63	63
	Outer anchors	72	73

Ratings of up to 105% are considered acceptable due to tolerances in calculating the applied loads on the tower as well as member design capacities.

\*: Guy pull-off horizontal members controls.

#### G. CONCLUSIONS AND RECOMMENDATIONS

Based on the preceding results, the following conclusions may be drawn:

1. The tower, supporting the equipment as specified in section C of this report, is adequate to achieve a design wind speed of 90 mph with no ice in accordance with ANSI/TIA 222-G and the analysis parameters of Section D for either **Condition 1** or **Condition 2**.

Rev.	Date	Description
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2. Please note that in general, except for the flange tension in the top span, the tower has lower rating values under **Condition 1** loading compared to **Condition 2**, especially for the legs where the maximum rating for **Condition 1** is 92% but 99% for **Condition 2**. Therefore the tower has more reserve capacity with the proposed Dielectric top antenna.

#### H. PROVISIONS OF ANALYSIS

The analysis performed and the conclusions contained herein are based on the assumption that the tower has been properly installed and maintained, including, but not limited to the following:

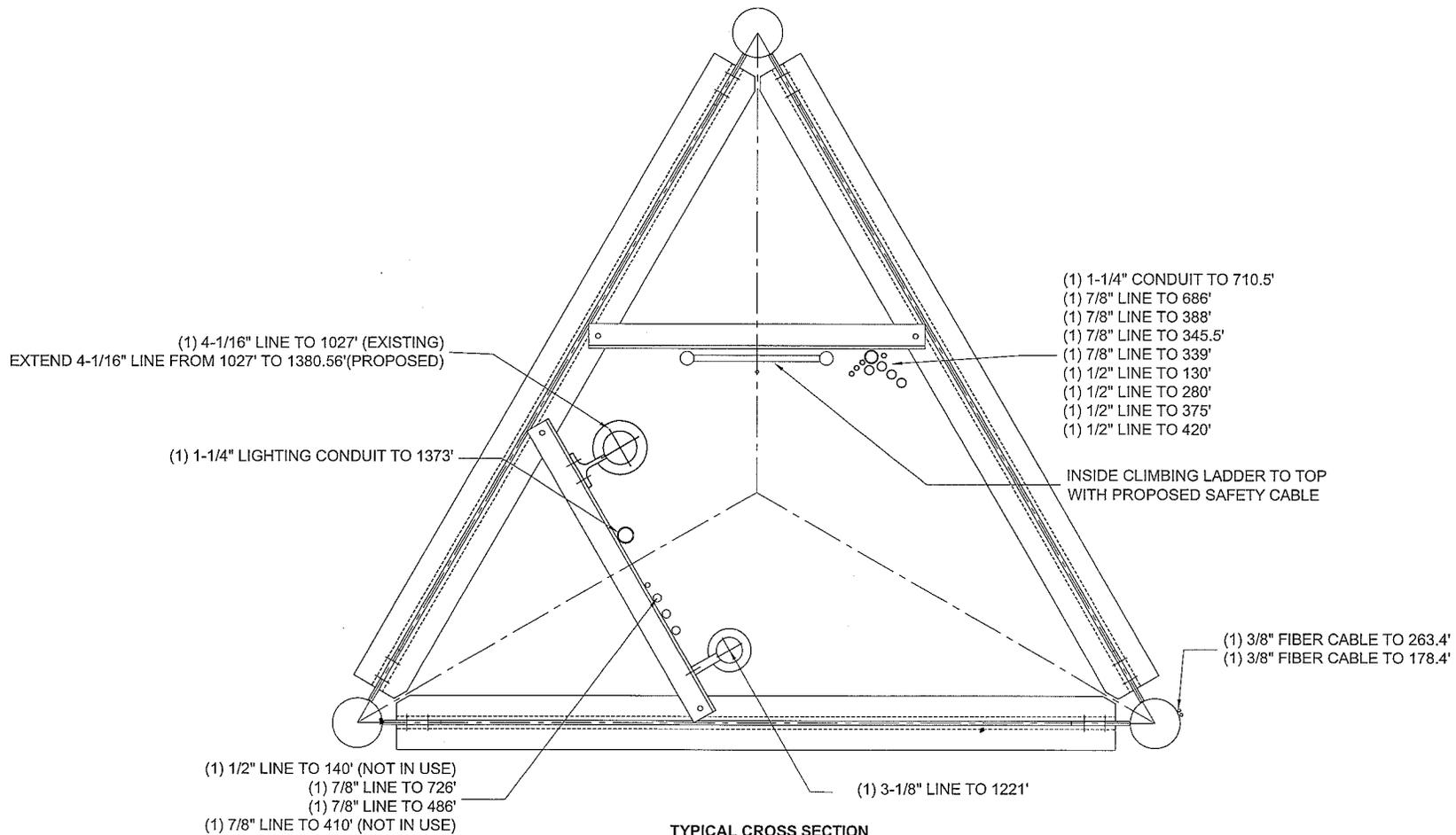
1. Proper alignment and plumbness.
2. Correct guy tensions.
3. Correct bolt tightness.
4. No significant deterioration or damage to any component.

Furthermore, the information and conclusions contained in this Report were determined by application of the current "state-of-the-arts" engineering and analysis procedures and formulae, and Stainless assumes no obligations to revise any of the information or conclusions contained in this Report in the event that such engineering and analysis procedures and formulae are hereafter modified or revised. In addition, under no circumstances will Stainless have any obligation or responsibility whatsoever for or on account of consequential or incidental damages sustained by any person, firm or organization as a result of any information or conclusions contained in the Report, and the maximum liability of Stainless, if any, pursuant to this Report shall be limited to the total funds actually received by Stainless for preparation of this Report.

Customer has requested Stainless to prepare and submit to Customer an engineering analysis with respect to the Subject Tower and has further requested Stainless to make appropriate recommendations regarding suggested structural modifications and changes to the Subject Tower. In making such request of Stainless, Customer has informed Stainless that Customer will make a determination as to whether or not to implement any of the changes or modifications which may be suggested by Stainless and that Customer will have any such changes or modifications made by riggers, erectors and other subcontractors of Customer's choice.

Customer hereby agrees and acknowledges that Stainless shall have no liability whatsoever to Customer or to others for any work or services performed by any persons other than Stainless in connection with the implementation of any structural changes or modifications recommended by Stainless including but not limited to any services rendered for Customer or for others by riggers, erectors or other subcontractors. Customer acknowledges and agrees that any riggers, erectors or subcontractors retained or employed by Customer shall be solely responsible to Customer and to others for the quality of work performed by them and that Stainless shall have no liability or responsibility whatsoever as a result of any negligence or breach of contract by any such rigger, erector or subcontractor.





**TYPICAL CROSS SECTION**

PREPARED BY		PCC	09/20/2015
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ENGINEER REVIEW			
PROJECT NUMBER		270505	
DRAWING NUMBER		A-2	
REV	BY	DATE	DESCRIPTION
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<b>LINEAR APPURTENANCES</b> <b>ALLIANCE, INC.</b>			
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