STAINLESS

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REPORT 229929

Site Number and Name: GRAMMI4637 GVSU

Site Address: Pierce Road and 48th Ave, Allendale, MI 49401

DATE: 12/28/2015

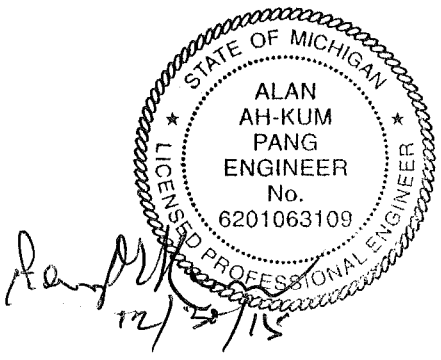
RIGOROUS STRUCTURAL ANALYSIS

FOR AN 802' G-7 GUYED TOWER

ALLENDALE, MI

PREPARED BY: AP APPROVED: AP

CHECKED BY: PCC



Date	Pages	Remarks

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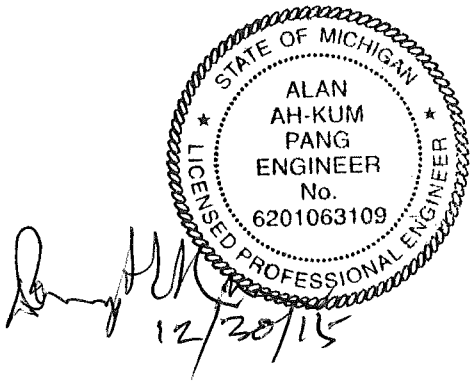
SECTION PAGE

APPENDIX



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A. AUTHORIZATION/PURPOSE

As authorized by Robert Lumbert of WGVU-TV, a structural analysis was performed to investigate the adequacy of an 802' guyed tower located at 4465 Pierce Road in Allendale, Michigan to support specified equipment.

B. TOWER HISTORY

The tower was originally designed and furnished in 1971 by Stainless, Inc. It was designed in accordance with EIA Standard RS-222-A for a wind load rating of 50 psf with 1/2" ice while supporting the following equipment:

1. One (1) RCA TFU-36J Ch. 35 top mounted antenna, fed by one (1) 6-1/8" coax.
2. One (1) RCA BFC-5B antenna at the 500' level, fed by one (1) 3-1/8" coax. (Future)
3. One (1) 8' x 12' reflector at the first guy level.
4. One (1) 10' x 15' reflector at the 300' level. (Future)
5. Two (2) Communications antennas at the 300' level, each fed by one (1) 7/8" line. (Future)
6. One (1) inside climbing ladder for the full height of the tower.
7. One (1) FAA red lighting kit with circuits contained within one (1) 2" conduit for the full height of the tower.
8. One (1) Sleetmelter circuit with circuits contained within one (1) 2" conduit for the full height of the tower.

- In 2005, the tower was modified by Stainless LLC per Report 229914. The modifications were as follows:
  - Replaced existing diagonal braces with new, higher capacity members at the following diagonal bracing panels:

Location	No of bays
675.4' – 692.1'	2

- In 2006, the tower was modified by others. Material was supplied by Stainless LLC per Report 229915 based on an analysis by KPFF Engineers, Inc. for the following modifications:
  - Replaced existing diagonal braces with new, higher capacity members at the following diagonal bracing panels:

Location	No of bays
783.8' – 800.4'	2

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- In 2007, the tower was modified by others. Material was supplied by Stainless LLC per Report 229916 based on an analysis by KPFF Engineers, Inc. for the following modifications:

  - Replaced existing guy wires at the following guy level:

Level	New guy size
1 (Bottom)	1-1/8" A586 Grade 1

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

Location	No of bays
242.1' – 267.1'	3
133.8' – 158.8'	3
100.4' – 117.1'	2
10.0' – 25.4'	2

  - Replaced existing horizontal braces with new, higher capacity members at the following levels:

Location	No of levels
150.4'	1
117.1'	1

- In June 2012, the tower was modified by Stainless LLC per Report 229921. The modification was as follows:

  - Adjusted guy initial tensions in all the guy levels.

C. CONDITIONS INVESTIGATED

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

- Stainless Proposal P15_2299_003 dated 10/21/2015.
- Stainless Report 229928 dated 8/4/2015.
- ATT drawings 10106576.GRAMMI4637.CD.REVA.LTE3C.08.10.15 Rev C dated 10/7/2015, prepared by Apex Engineers. Inc. and received on 12/28/2015.
- Two emails dated 12/28/2015 from Mark Korso of LCC Telecom Services with details of ATT existing and proposed equipment.

1. One (1) Dielectric TF-8HPS-H P200 top mounted antenna with a pedestal adapter, fed by one (1) existing 3-1/8" coax, one (1) 2" deicer wiring and one (1) 1/2" cable.

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2. Two (2) 20' mast antennas mounted on a 6' gate mount between the North and South legs at the 684' level, fed by two (2) 7/8" lines.
3. One (1) ENG antenna at the 650' level, fed by one (1) 7/8" line and one (1) 3/4" cable.
4. One (1) 8' diameter MW dish with radome at the 602' level, fed by one (1) EW63 line.
5. One (1) Dielectric TLP-16A antenna between the 560' and 585' levels, fed by one (1) 4-1/16" coax.
6. One (1) 20' dipole antenna between the 425' and 445' levels, fed by one (1) 1-5/8" line.
7. One (1) A2-45LP17 long panel antenna at the 423' level, fed from junction box.
8. Two (2) Andrew QD-2400 antennas at the 422' level, fed from junction box.
9. One (1) Scala CL-FMRX antenna at the 412' level, fed by one (1) 1/2" line.
10. One (1) Radio Waves 4-horn antenna at the 412' level, fed from junction box.
11. Internet antennas (number unknown) at the 400' level, fed by one (1) 1/2" line.
12. Two (2) Nema junction boxes at the 375' level, fed by one (1) 3/4" line and one (1) 1/2" line.
13. Two (2) Motorola Canopy 5210BHRF20 antennas at the 372' level, fed from junction box.
14. One (1) Til Tek TA2424 solid parabolic antenna at the 370' level, fed from junction box.
15. One (1) A2-45LP17 long panel antenna at the 354' level, fed from junction box.
16. One (1) 5LP3C Yagi antenna at the 354' level, fed by one (1) 1/2" line.
17. One (1) 9LPU1469C UHF Yagi antenna at the 258' level, fed by one (1) 1/2" line.
18. One (1) 10LP713C VHF Yagi antenna at the 252' level, fed by one (1) 1/2" line.
19. One (1) 8LP234C VHF Yagi antenna at the 235' level, fed by one (1) 1/2" line.
20. One (1) 5RY13C VHF Yagi antenna at the 218' level, fed by one (1) 1/2" line.
21. One (1) 9LPU1469C UHF Yagi antenna at the 211' level, fed by one (1) 1/2" line.
22. Three (3) **proposed** CCI DPA-65R-BUUUU-H8-K panel antennas, three (3) **proposed** Kaelus TMA2117F00V1 and twelve (12) Andrew ETM190G-12UBTMAs on sector mounts at the 200' level, fed by twelve (12) 1-5/8" lines, one (1) fiber optic cable, one (1) RET cable, and two (2) DC power cables. (NB: A total of 9 existing panel antennas will be removed and replaced by the proposed antennas)
23. Six (6) TMBXX-6517 and three (3) DBXNH-6565B-A2M panel antennas on sector mounts, one (1) Andrew VHLP2-11 2' diameter dish, three (3) ETW200VS12UB TMAs, three (3) FRIG radios, three (3) FRLBs, two (2) FXFB radios and one (1) ASSU9338TYP01 COVP unit at the 180' level, fed by six (6) 1-5/8" lines, one (1) RFF-12MM-606-218-SPE hybrid cable, one (1) 1.584" O.D. hybrid cable and one (1) 5/8" line.
24. One (1) 8' diameter MW grid dish at the 147' level, fed by one (1) 7/8" line.
25. Three (3) KMW ET-HB-X-AW-19-65-0TM-RET antennas at the 130' level, each mounted to one leg, and fed by six (6) 1-1/4" lines and two (2) grounding wires.
26. Two (2) KMW ET-X-TS-70-15-62-18-iR-RD, four (4) Commscope SBCHH-1D90B and three (3) KMW ET-X-WM-18-65-8P panel antennas; three (3) RRH-C2A, three (3) RRH-P4 and three (3) RRU-PH4 RRUs; one (1) RF filter; three (3) power junction and three (3)

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fiber optic junction cylinders; on three (3) sector mounts at the 120' level, fed by three (3) 1.24" O.D. hybrid cables and one (1) 1-5/8" hybrid cable.

27. One (1) Mark IV 960 MHz 4' diameter MW grid dish at the 98' level, fed by one (1) 7/8" line.
28. One (1) 1/2" line to 312' level for future use.
29. One (1) 1/2" line to 301' level for future use.
30. One (1) FAA lighting system with circuits contained within one (1) 2" conduit for the full height of the tower.
31. One (1) climbing ladder with cable type safety device for the full height of the tower.

The locations of the existing transmission lines were based upon Stainless Report 229928 dated 8/4/2015. The locations of all the transmission lines are shown on Page A-2 of this Report. Deviating from this appurtenance arrangement may affect the accuracy of the results presented in this Report.

D. LOADS AND STRESSES

The analysis was performed using the following design parameters in accordance with the 2012 Michigan Building Code, and ANSI/TIA 222-G-2005, Structural Standard for Antenna Supporting Structures and Antennas, including addenda 222-G-1 and 222-G-2, dated 2007 and 2009 respectively:

- Structure Classification II
- 115 mph ultimate design wind speed with no ice
- 40 mph nominal design wind speed with 3/4" design ice thickness
- Exposure Category C
- Topographic Category 1
- 0.07 earthquake spectral response acceleration at short periods (S_s)
- Earthquake Site Class D

The ultimate design wind speed was converted to a nominal design wind speed for use with ANSI/TIA 222-G based upon the following formula:

$$V_{asd} = V_{ult} * (0.6)^{1/2}$$
$$= 115 * (0.6)^{1/2}$$
$$= 89.1 \text{ mph, use } 89 \text{ mph}$$

Seismic effects need not be considered as the value of Ss is less than 1.0 per Section 2.7.3 of ANSI/TIA 222-G.

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

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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 %
Tower top	--	91
Leg compression	5	61
	4	67
	3	75
	2	78
	1	81
Leg tension	5	54
	4	20
	3	--
	2	--
	1	--
Diagonals	5	51
	4	72
	3	71
	2	90
	1	82
Horizontals	5	47
	4	69
	3	65
	2	89
	1	81
Guys	5	61
	4	62
	3	61
	2	62
	1	68
Foundations	Base	99
	Inner anchors	103
	Outer anchors	94

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.

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G. CONCLUSIONS AND RECOMMENDATIONS

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

1. The tower, with equipment as specified in section C, is adequate to achieve an ultimate design wind speed of 115 mph with no ice, and a nominal design wind speed of 40 mph with 3/4" design ice thickness in accordance with the 2012 Michigan Building Code, and ANSI/TIA 222-G with the analysis parameters of Section D.

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

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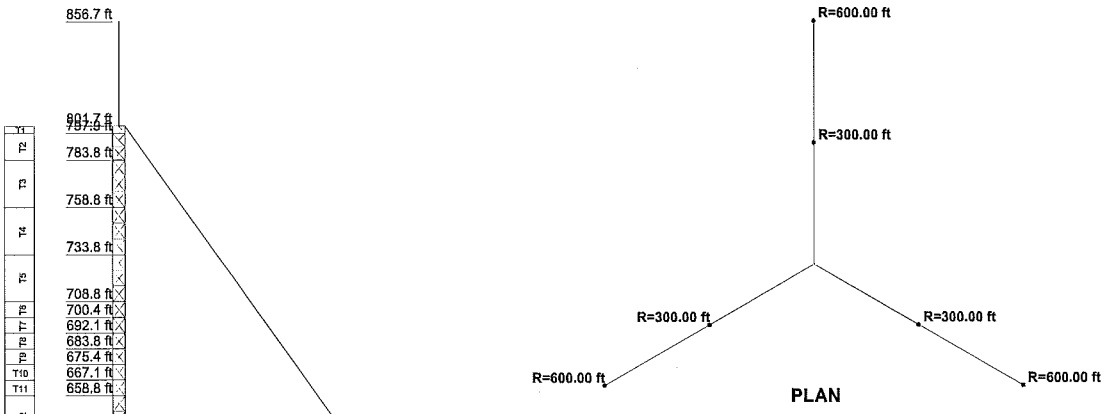
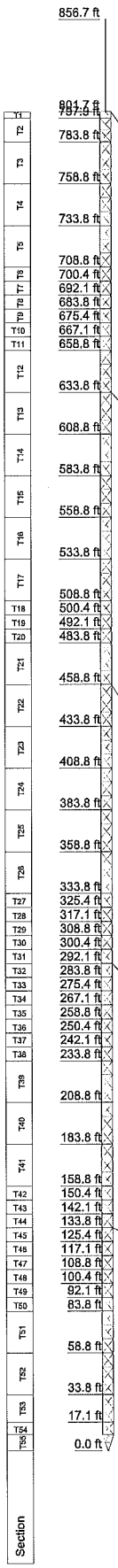
for others by riggers, erectors or other subcontractors. Customer acknowledges and agrees that any riggers, erectors or subcontractors retained or employed by Customer shall be solely responsible to Customer and to others for the quality of work performed by them and that Stainless shall have no liability or responsibility whatsoever as a result of any negligence or breach of contract by any such rigger, erector or subcontractor.





DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
Top plate	801	DBXNH-6565B-A2M panel antenna	180
Transfer platform	784	Sector frame	180
Obstruction lights	710	Andrew ETW200VS-12UB	180
(2) 20ft mast antennas	684	(2) TMBXX-6517 panel antennas	180
ENG antenna	650	DBXNH-6565B-A2M panel antenna	180
ENG antenna mount	650	Sector frame	180
8ft dish with radome	602	Andrew ETW200VS-12UB	180
Dielectric TLP-16A	572.5	(2) TMBXX-6517 panel antennas	180
Beacons	560	DBXNH-6565B-A2M panel antenna	180
Obstruction lights	435	Sector frame	180
20ft dipole antenna	425	Andrew ETW200VS-12UB	180
A2-45LP17 panel antenna	423	Andrew VHLP2-11	180
(2) Andrew QD-2400 antennas	422	(2) TMBXX-6517 panel antennas	180
Scala CI-FMRX Yagi	412	Obstruction lights	160
Radiowaves 4-horn antenna	412	8ft grid dish	147
Internet antennas	400	KMW ET-HB-X-AW-19-65-0TM-RET panel antenna leg mount	130
(2) Nema junction boxes	375	KMW ET-HB-X-AW-19-65-0TM-RET panel antenna leg mount	130
(2) Motorola Canopy 5210BHRF20 antennas	372	KMW ET-HB-X-AW-19-65-0TM-RET panel antenna leg mount	130
Tiltek TA2424 2' solid dish	370	RRH-P4	120
5LP3C Yagi antenna	354	RRH-PH4	120
A2-45LP17 panel antenna	354	Sector frame	120
Beacons	285	KMW ET-X-TS-70-15-62-18-IR-RD	120
9LPU1469C Yagi antenna	258	Commscope SBCHH-1D90H	120
10LP713C Yagi antenna	252	KMW ET-X-WM-18-65-SP	120
8LP234C Yagi antenna	235	RRH-C2A	120
5RY13C Yagi antenna	218	RRH-P4	120
9LPU1469C Yagi antenna	211	RRH-PH4	120
Sector frame	200	Sector frame	120
Kaelus TMA2117F00V1 (Prop)	200	(2) Commscope SBCHH-1D90H	120
(3) Andrew ETM190G-12UB	200	KMW ET-X-WM-18-65-SP	120
CCI DPA-65R-BUUUU-H8-K panel antennas (Prop)	200	RRH-C2A	120
Sector frame	200	RRH-P4	120
Kaelus TMA2117F00V1 (Prop)	200	RRH-PH4	120
(3) Andrew ETM190G-12UB	200	Sector frame	120
CCI DPA-65R-BUUUU-H8-K panel antennas (Prop)	200	Commscope SBCHH-1D90H	120
Sector frame	200	KMW ET-X-TS-70-15-62-18-IR-RD	120
Kaelus TMA2117F00V1 (Prop)	200	KMW ET-X-WM-18-65-SP	120
(3) Andrew ETM190G-12UB	200	RRH-C2A	120
CCI DPA-65R-BUUUU-H8-K panel antennas (Prop)	200	4ft grid dish	98

TOWER DESIGN NOTES

1. Tower is located in Ottawa County, Michigan.
2. Tower designed for Exposure C 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 0.75 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. 52.00 ft Dielecctric TF-8HPS-H P200 w/ 1ft adapter is included for load transfer only.
9. Weld together tower sections have flange connections.
10. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
11. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
12. Welds are fabricated with ER-70S-6 electrodes.

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Tower Engineers

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Job: **229929 Allendale MI**			
Project: ***WGVU-TV 803' steel height Stainless G-70 guyed towe***			
Client: Grand Valley State University	Drawn by: Alan Pang	App'd:	
Code: TIA-222-G	Date: 12/29/15	Scale: NTS	
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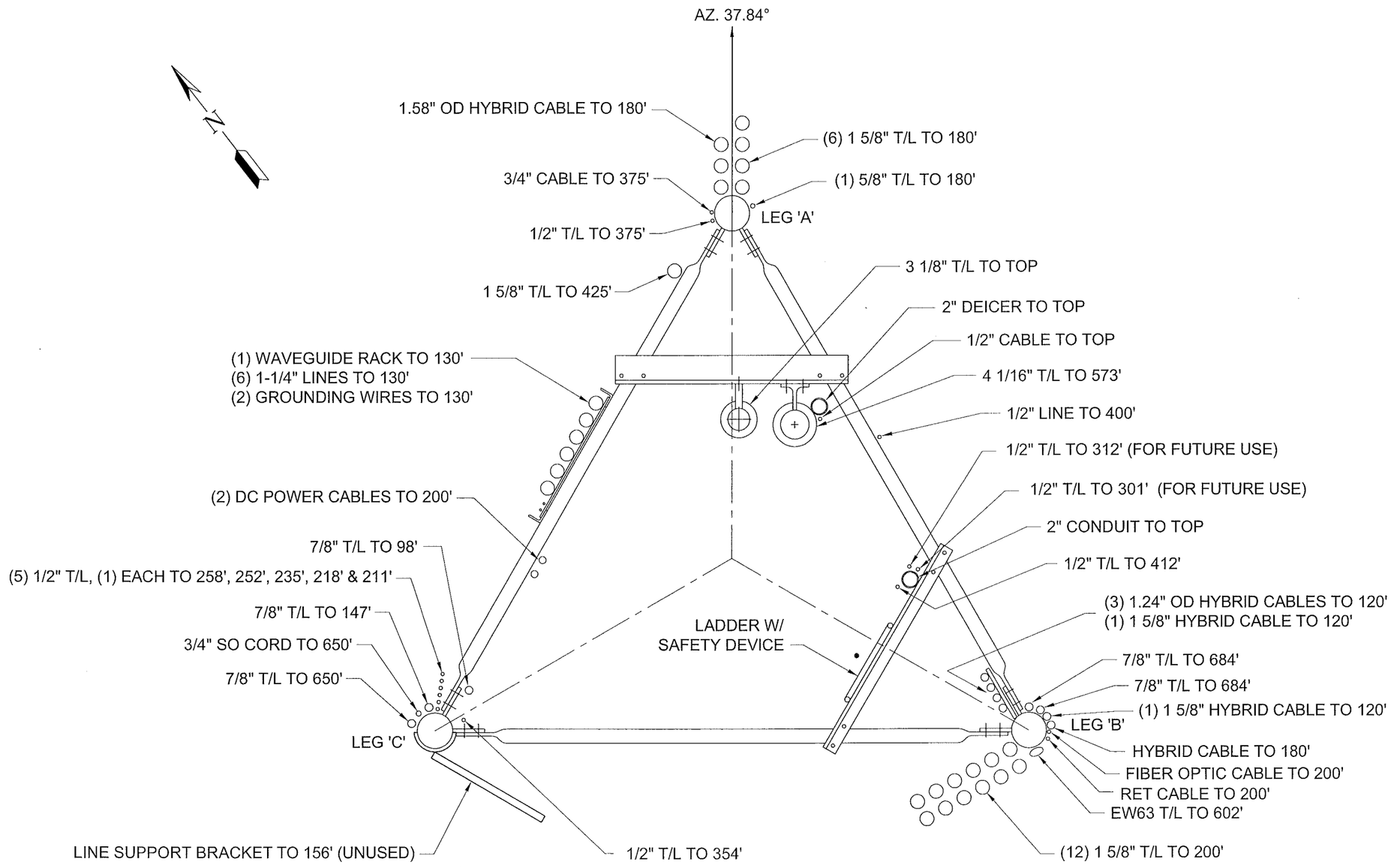

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GH			229929	A-2
12/29/15				

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A BUSINESS OF FOH VELOCITEL
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LINEAR APPURTENANCES
ALLENDALE, MI