KRNE-TV

1,022-Foot Guyed Tower
Merriman, Cherry County, Nebraska
Nebraska Educational Telecommunications

Structural Analysis Report
January 25, 2021

Analysis and Report by: Jiantao Yu, P.E. (SC)
Checked by: Moses Berry, P.E. (SC)
Reviewed by: Jean Lecordier, P.E. (SC)

TCI Project No. 21.331.001

January 25, 2021

Nebraska Educational Telecommunications
1800 North 33rd Street
Lincoln, NE 68503

Attention: Mr. Chris Homer

Re: **Structural Analysis of Existing**
KRNE-TV 1,022-Foot Guyed Tower
Merriman, Cherry County, Nebraska
TCI Project # 21.331.001
Proposed Loading for KRNE-TV

Dear Mr. Homer,

We are pleased to submit our report for the structural analysis of the above referenced guyed tower to support the required antenna loading as listed in section 3.

The guyed tower **will require upgrades for Load Case 1 & Load Case 2 in order to conform** to the requirements of ANSI/TIA-222-H Standard for a 112-mph wind with no ice and seismic loading using S_S=0.194, with the required antenna loading. A preliminary design revealed the following modification requirement for **Load Case 1 & Load Case 2**: Reinforce outer guy anchors and adjust guy wire initial tension.

The analysis was performed using Structure Class II, Exposure Category C, Topographic Category 1 and an S_S=0.194 as design criteria from the ANSI/TIA-222-H Standard. Wind loading, ice and seismic parameters were obtained using ASCE 7 Hazards report for ASCE/SEI 7-16.

After the recommended upgrades are performed, the guyed tower and foundations will conform to the requirements of ANSI/TIA-222-H Standard for **Load Case 1 & Load Case 2** for a 112-mph wind with no ice and seismic loading using S_S=0.194, with the required antenna loading.

Should you have any questions or wish to discuss any aspect of this report, please do not hesitate to contact TCI.

Sincerely,

Jiantao Yu, P.E. (SC)
Senior Project Engineer
Tower Consultants, Inc.

Moses Berry, P.E. (SC)
Senior Design Engineer
Tower Consultants, Inc.

1. Authorization/Purpose

As authorized, Tower Consultants, Inc. (TCI) has completed a structural analysis of the existing 1,022-foot guyed tower located in Merriman, Nebraska. The analysis was performed per the request by Mr. Chris Homer of Nebraska Educational Telecommunications to determine the feasibility of the tower to support the required antenna loading as listed in section 3.

2. Tower History

The 1,022-foot three sided guyed tower located in Merriman, Nebraska was originally designed by Dresser in 1968 in accordance with the EIA RS-222-A Standard for a basic wind pressure of 50-psf with no ice.

The current structural analysis was performed on the basis that the information used is accurate. This information may consist of, but not limited to:

- Information supplied by the customer,
- Information supplied by potential tenant and/or tower owner,
- Information from documents or drawings available to TCI, or
- Information acquired during a field inspection mapping by National Tower Controls dated March 10, 2020.

All information used is as depicted in the attached appendices.

TCI did not perform a field inspection and mapping to verify the location and information about the current equipment on the tower. The locations and specifics of all equipment used for the loading of this analysis are based on information and photographs provide to TCI. Any deviation from the information and assumptions made in this analysis would void the results of the analysis.

3. Conditions Investigated

This analysis was performed to determine the feasibility of the tower to support the following antenna loading:

Elevation (ft.)	Equipment	Tx Line
952 – 1,022	(1) Dielectric TW-12B12-R	(1) 4-1/16" rigid (1) 1" deicer conduit
913.5	(1) Platform (SE face)	--
885	(3) OBS lights	(1) 1" conduit*
878	(1) 12-bay FM antenna (S leg)**	(1) 3-1/8" rigid
735	(3) OBS lights	(1) 1" conduit*
585	(1) Beacon	(1) 1" conduit*
508	(1) 4-bay FM antenna (S leg)	(1) 7/8" flex
485	(1) Ice shield (S leg)	--
475	(4) Yagi antennas (S leg)	(1) 7/8" flex
442	(1) Ice shield (NE leg)	--
440	(3) OBS lights	(1) 1" conduit*
438	(1) 3' HP dish (NE leg)	(1) 1/2" flex
414	(1) Dipole antenna (NW leg)	(1) 7/8" flex
413	(1) Dipole antenna (NE leg)	(1) 7/8" flex
364	(1) Dipole antenna (NE leg)	(1) 7/8" flex
357	(1) Ice shield (NW leg)	--
353	(1) 3' HP dish (NW leg)	(1) 1/2" flex
290	(1) Beacon	(1) 1" conduit*
254	(1) Dipole antenna (NE leg)	(1) 7/8" flex
237	(1) Dipole antenna (NE leg)	(1) 7/8" flex
185	(1) Ice shield (SE face)	--
185	(1) Ice shield (W face)	--
178	(1) 10' HP dish (SE face)	(1) 1/2" flex
178	(1) 10' HP dish (W face)	(1) 1/2" flex
145	(3) OBS lights	(1) 1" conduit*
0 - 413	--	(1) 1" conduit
0 - top	Climbing ladder with safety device	--

*** Shared conduit**

**** Equipment to be removed and replaced with:**

Load Case 1: New (1) DCRM12CR at 878' with new (1) 3-1/8" rigid

Load Case 2: New (1) DCRM10CR at 878' with new (1) 3-1/8" rigid

4. Loads and Stresses

An analysis was conducted in order to assess the structural performance of the tower per the current design standard ANSI/TIA-222-H, "Structural Standards for Antenna Supporting Structures, Antennas and Small Wind Turbine Support Structures". Member stresses, required strength and design strength used to evaluate the adequacy of the structure were in accordance with this standard.

5. Method of Analysis

A three-dimensional computer model was created using the *TNXTower Version 8.0.7.4 analysis program (Tower Numerics, Inc., 2020)*. TNXTower is a general-purpose modeling, analysis and design program created specifically for communication towers. The program generates nodes and elements for a finite element analysis (FEA) and determines the pressure coefficients, wind pressures, ice loads and resulting forces on the tower for standard framing types including self-supporting towers, guyed towers and poles.

6. Results

Associated with each loading condition are the tower elevations, member sizes and member stress percentages. The member stress percentage is the ratio of required strength to the nominal strength expressed as a percentage. A stress ratio greater than 100% denotes an overstress.

The following member stresses were calculated with a basic wind speed of 112-mph with no ice and seismic loading using S_S=0.194 in accordance with ANSI/TIA-222-H Standard with the required antenna loading:

Maximum Member Stresses

Element	Elevation (ft.)	Maximum % Load Case 1	Maximum % Load Case 2
Guy	950.5	**81.7**	**81.1**
Leg	28.5 – 33.5	**106.6****	**106.4****
Diagonal	6.75 – 13.5	**90.0**	**90.0**
Horizontal	173.5	**51.3**	**51.1**
Base Foundation	--	**88.1**	**88.1**
Guy Inner Anchor	--	**97.7**	**97.7**
Guy Outer Anchor	--	**117.7****	**116.4****

**** Member has unacceptable overstress.**

7. Conclusions and Recommendations

The tower is **overstressed** for **Load Case 1 & Load Case 2** with the required antenna loading when subjected to a basic wind speed of 112-mph with no ice and seismic loading using S_S=0.194 in accordance with the ANSI/TIA-222-H Standard.

In order to meet the requirements of ANSI/TIA-222-H Standard for a 112-mph wind with no ice and seismic loading using S_S=0.194 for **Load Case 1 & Load Case 2**, we recommend that the following upgrades be performed on the tower prior to installing the proposed equipment:

1. Reinforce outer guy anchors by adding overburden.
2. Adjust the guy wire tensions to the values listed on the following chart:

Guy Level	Guy Anchor	Existing Guy Tension	Proposed Guy Tension
		% of Ultimate Tension	% of Ultimate Tension
6th (top)	Outer Anchor	10.0%	**14.0%**
5th		10.0%	**12.0%**
4th		10.0%	10.0%
3rd	Inner Anchor	10.0%	10.0%
2nd		10.0%	10.0%
1st (bot)		10.0%	**14.0%**

Note: Values shown above are valid at 60 degree Fahrenheit; a P&T chart with temperature correction will be required for field adjustments. It is also assumed that adequate adjustment is available on guy hairpins to achieve the recommended tensions.

The following member stresses were calculated with a basic wind speed of 112-mph with no ice and seismic loading using S_S=0.194 in accordance with ANSI/TIA-222-H Standard with the required antenna loading after the upgrades mentioned above have been implemented:

Maximum Member Stresses

Element	Elevation (ft.)	Maximum % Load Case 1	Maximum % Load Case 2
Guy	950.5	**84.6**	**84.0**
Leg	28.5 – 33.5	**96.5**	**96.4**
Diagonal	358.5 – 363.5	**92.1**	**92.1**
Horizontal	173.5	**51.4**	**51.4**
Base Foundation	--	**88.1**	**88.1**
Guy Inner Anchor	--	**100.8***	**100.8***
Guy Outer Anchor	--	**89.3**	**89.3**

*** Member has acceptable overstress.**

Tower member detail drawings were not available. Therefore, an analysis was not performed on the member connections. However, it is common practice to design the member connections to a factor of safety that exceeds the capacity of the member. With the existing and the proposed loading, the tower member stresses are still within the allowable limits. Therefore, it may be concluded that the member connections appeared to be adequately sized for the existing and the proposed loading.

The following table summarizes the maximum foundation reactions after the upgrades mentioned above have been implemented:

Maximum Foundation Reactions

Foundation Reactions	Load Case 1 ANSI/TIA-222-H 112-mph with no ice Seismic S_S=0.194	Load Case 2 ANSI/TIA-222-H 112-mph with no ice Seismic S_S=0.194
Tower Base:		
Moment	996 ft.-kips	995 ft.-kips
Bearing Force	483 kips	482 kips
Shear Force	9 kips	9 kips
Inner Anchor:		
Uplift Force	69 kips	69 kips
Shear Force	98 kips	98 kips
Outer Anchor:		
Uplift Force	96 kips	96 kips
Shear Force	91 kips	90 kips

After the upgrades mentioned above are implemented, the guyed tower and foundations will be adequate for the required antenna loading.

8. 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.
5. All equipment, T/l's, antennas, etc, is properly secured to the tower per manufacturer's recommendation.
6. All mounts, if applicable, are considered adequate to support the loading.

Furthermore, the information and conclusions contained in this Report were determined by application of the current "state-of-the-art" engineering and analysis procedures and formulae.

Tower Consultants Incorporated assumes no obligation 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 Tower Consultants Incorporated 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 Tower Consultants Incorporated if any, pursuant to this Report shall be limited to the total funds actually received by Tower Consultants Incorporated for preparation of this Report.

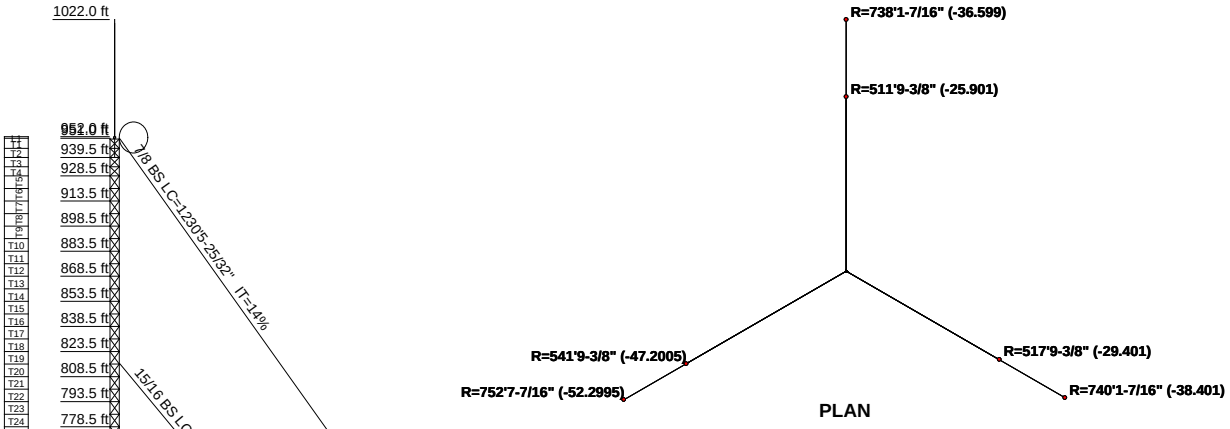
Customer has requested Tower Consultants Incorporated to prepare and submit to Customer an engineering analysis with respect to the Subject Tower and has further requested Tower Consultants Incorporated to make appropriate recommendations regarding suggested structural modifications and changes to the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

Tower Consultants Incorporated shall have the right to rely upon the accuracy of the information supplied by the customer and shall not be held responsible for the Customer's misrepresentation or omission of relevant fact whether intentional or otherwise.

Customer hereby agrees and acknowledges that Tower Consultants Incorporated shall have no liability whatsoever to Customer or to others for any work or services performed by any persons other than Tower Consultants Incorporated in connection with the implementation of services 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 Tower Consultants Incorporated shall have no liability or responsibility whatsoever as a result of any negligence or breach of contract by any such rigger, erector or subcontractor and that Customer and rigger, erector, or subcontractor will provide Tower Consultants Incorporated with a Certificate of Insurance naming Tower Consultants Incorporated as additionally insured.

Appendix E-1

Tower Elevation



DESIGNED APPURTENANCE LOADING

TYPE	ELEVATION	TYPE	ELEVATION
TW-12B12-R (#1)	952	Dipole (#13)	414
L1	951.5	Mounts for dipole (#14)	414
T1-T4	939.75	Dipole (#15)	413
DCRM12CR (Proposed 1) (P1)	937.099 - 818.901	Mounts for dipole (#16)	413
Mounts for DCRM12CR (Proposed 1) (P2)	937.099 - 818.901	T81-T86	403.5
		T87-T92	373.5
Platform (#4)	913.5	Dipole (#17)	364
T5-T8	913.5	Mounts for dipole (#18)	364
(3) OBS lights (#33)	885	Ice shield (#19)	357
T9-T12	883.5	3' HP dish (#20)	353
T13-T16	853.5	Pipe mount (#22)	351
T17-T20	823.5	Small equipment (#21)	348
T21-T24	793.5	T93-T98	343.5
T25-T28	763.5	T99-T104	313.5
(3) OBS lights (#33)	735	Beacon (#34)	290
T29-T32	733.5	T105-T110	283.5
T33-T36	703.5	Mounts for dipole (#24)	254
T37-T40	673.5	Dipole (#23)	254
T41-T44	643.5	T111-T116	253.5
T45-T48	613.5	Dipole (#25)	237
Beacon (#34)	585	Mounts for dipole (#26)	237
T49-T52	583.5	T117-T122	223.5
T53-T56	553.5	T123-T128	193.5
T57-T62	523.5	Ice shield (#27)	185
Mounts for 4-bay FM (#6)	523 - 493	Ice shield (#30)	185
4-bay FM (#5)	523 - 493	10' HP dish (#31)	178
T63-T68	493.5	Dish mount (#32)	178
Ice shield (#7)	485	Dish mount (#29)	178
(4) Yagi (#8)	480 - 470	10' HP dish (#28)	178
T69-T74	463.5	T129-T134	163.5
Ice shield (#9)	442	(3) OBS lights (#33)	145
(3) OBS lights (#33)	440	T135-T140	133.5
3' HP dish (#10)	438	T141-T146	103.5
Pipe mount (#12)	436	T147-T152	73.5
T75-T80	433.5	T153-T158	43.5
Small equipment (#11)	433	T159-T163	14.25

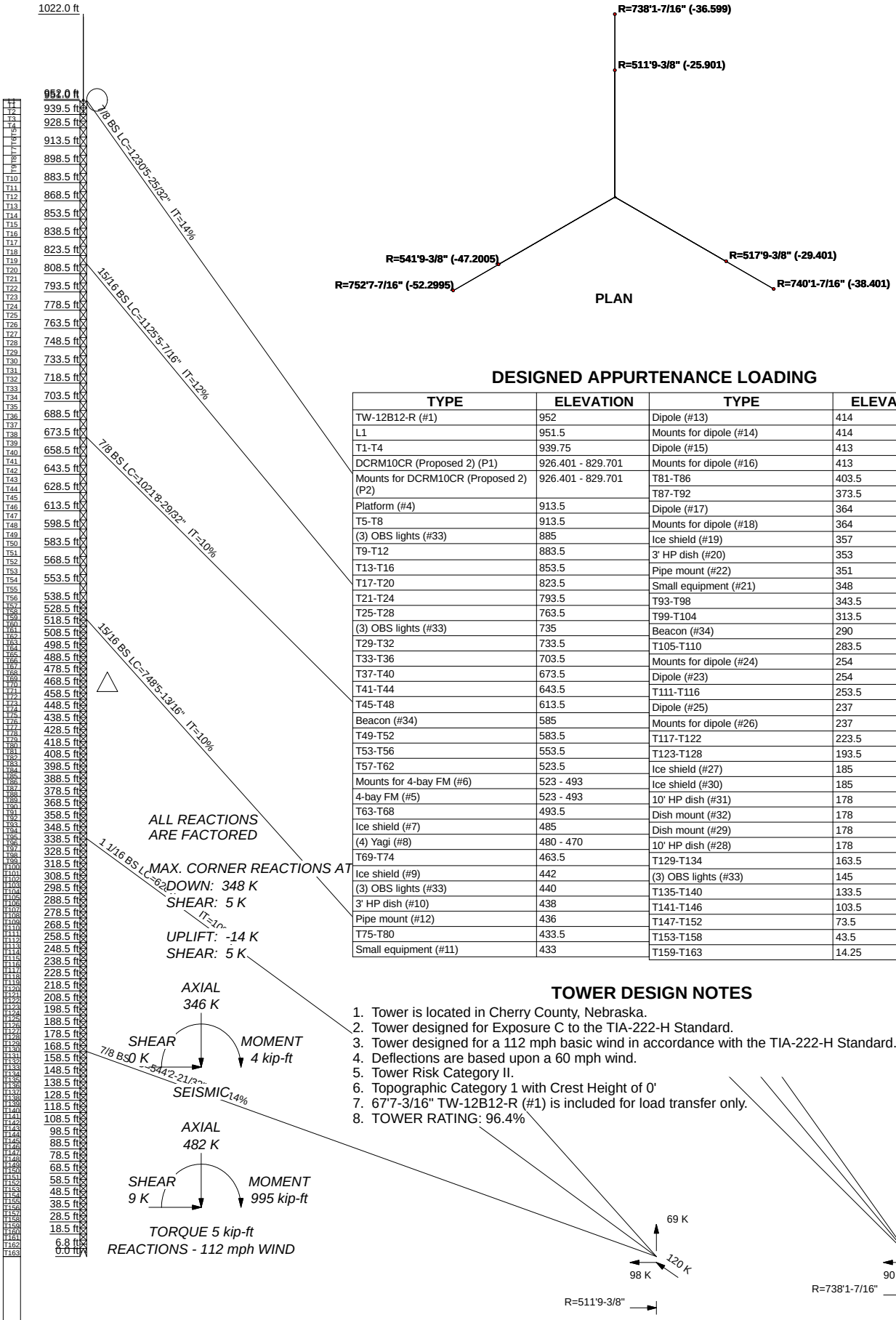
TOWER DESIGN NOTES

1. Tower is located in Cherry County, Nebraska.
2. Tower designed for Exposure C to the TIA-222-H Standard.
3. Tower designed for a 112 mph basic wind in accordance with the TIA-222-H Standard.
4. Deflections are based upon a 60 mph wind.
5. Tower Risk Category II.
6. Topographic Category 1 with Crest Height of 0'
7. 67'7-3/16" TW-12B12-R (#1) is included for load transfer only.
8. TOWER RATING: 96.5%

ALL REACTIONS ARE FACTORED

Tower Consultants, Inc.
15 Surrey Court
Columbia, SC, 29212
Phone: (803) 407-8489
FAX:
Consulting Engineers

Job: 21.331.001 Merriman, NE		
Project: 1022-ft, G-6, H-Code, 112-mph with no ice, Proposed 1, Mod		
Client: KRNE-TV	Drawn by: Jiantao Yu	App'd:
Code: TIA-222-H	Date: 01/21/21	Scale: NTS
Path: C:\My Documents\TCI\Merriman, NE\21.331.001 Merriman, NE (KRNE-TV)\Analysis\21.331.001 KRNE Proposed 1 Mod.eri		Dwg No. E-1



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L1	951.5	Mounts for dipole (#14)	414
T1-T4	939.75	Dipole (#15)	413
DCRM10CR (Proposed 2) (P1)	926.401 - 829.701	Mounts for dipole (#16)	413
Mounts for DCRM10CR (Proposed 2) (P2)	926.401 - 829.701	T81-T86	403.5
		T87-T92	373.5
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4. Deflections are based upon a 60 mph wind.
5. Tower Risk Category II.
6. Topographic Category 1 with Crest Height of 0'
7. 67'7-3/16" TW-12B12-R (#1) is included for load transfer only.
8. TOWER RATING: 96.4%

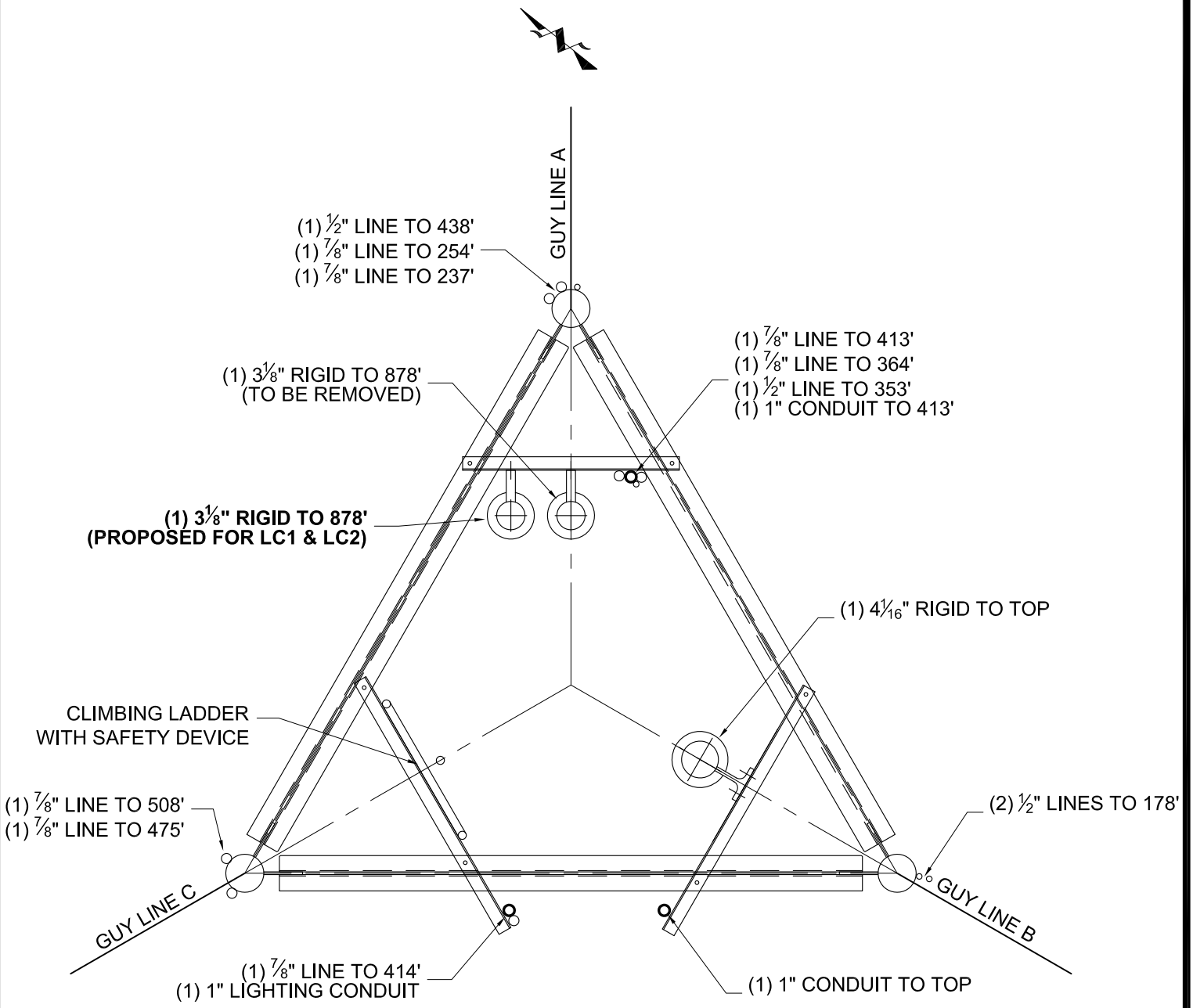
ALL REACTIONS ARE FACTORED

Tower Consultants, Inc.
15 Surrey Court
Columbia, SC, 29212
Phone: (803) 407-8489
FAX:
Consulting Engineers

Job: 21.331.001 Merriman, NE		
Project: 1022-ft, G-6, H-Code, 112-mph with no ice, Proposed 2, Mod		
Client: KRNE-TV	Drawn by: Jiantao Yu	App'd:
Code: TIA-222-H	Date: 01/21/21	Scale: NTS
Path: C:\My Documents\TCI\Merriman, NE\21.331.001 Merriman, NE (KRNE-TV)\Analysis\21.331.001 KRNE Proposed 2 Mod.eri		Dwg No. E-1

Appendix E-2

Cross Section



NOTE: ANALYSIS IS BASED ON THE ABOVE LAYOUT.
ANY DEVIATION FROM ABOVE WILL VOID THIS ANALYSIS.

TOWER CONSULTANTS, INC.
15 Surrey Court
Columbia, SC 29212
ph: 803-407-8489

1022-FT GT, 6'-0" FACE
MERRIMAN, NE

REV	BY	DATE	REVISION DESCRIPTION	D.CK	DATE	E.CK	DATE
*							
*							
*							
*							
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PREPARED BY	J.YU	01–07–21
CHECKED BY	M.BERRY	01–07–21
ENGINEER REVIEW	J.LECORDIER	01–07–21
PROJECT NUMBER	21.331.001	
DRAWING NUMBER	E-2	