

HASTINGS BOARD OF ADJUSTMENT

A meeting of the Hastings Board of Adjustment has been scheduled for Thursday, January 11, 2024 at 4:00 PM at the Hastings Municipal Airport, 3300 W 12th Street, City of Hastings..

AGENDA:

1. Call to Order
2. Roll Call
3. Pledge of Allegiance
4. Public Notice - Official Notice of the Regular Meeting was published in the Hastings Tribune on Saturday, December 30, 2023. Pursuant to Nebraska Revised Statute Section 84-1412, the public is advised that a copy of today's agenda and all reproducible written material which will be discussed at today's meeting is available for public review. Also, a current copy of the Nebraska Open Meetings Act is posted and accessible to all members of the public.
5. New Business
 - a. Election for Chairperson and Vice Chairperson
6. New Appeals or Requests
 - a. The Variance filed by Industrial Irrigation Service for two wind turbines to be constructed at 116 feet in height and as close as 30 feet to the north property line. The Variance is for the real property commonly known as 221 East J Street which is zoned I-2 Heavy Industrial District. This exceeds the maximum height and encroaches into the minimum rear yard setback for small wind energy systems, required by Hastings City Code Section 34-314.
7. Adjournment

Department: Development Services

Staff Contact:

Board of Adjustment Meeting Date: 1/11/2024

File No: 2024-11

Prepared By: Melissa Woodard, Administrative Assistant I

AGENDA ITEM SUMMARY SHEET

Description of Item:

Names of People/Business affected by this action:

Why Board of Adjustment action is required:

Type of action requested:

Suggested motion:

Deadlines associated with action:

Department head comments:

Recommendation:

Department: Development Services
Staff Contact: Chad Bunger
Board of Adjustment Meeting Date: 1/11/2024
File No: 2024-12
Prepared By: Melissa Woodard, Administrative Assistant I

AGENDA ITEM SUMMARY SHEET

Description of Item:

The public hearing is to request two variances related to the two proposed wind turbines to be constructed at 221 E. J Street in the I-2, Heavy Industrial District. The first Variance is to allow for the increase of the maximum structure height of a wind turbine from 80 feet to 116 feet ([Sec. 34-314\(2\)\(c\)](#)). The second Variance is to reduce the required setback for the tower of a wind turbine from 116 feet to 30 feet ([Sec. 34-314\(1\)](#)).

Motion to recommend approval of the Variance requests to increase the maximum height of a wind turbine to 116 feet and reduce the setback for the wind turbines to 30 feet for the two proposed wind turbines at the property commonly addressed as 221 East J Street, City of Hastings, Adams County, Nebraska.

Names of People/Business affected by this action:

The applicant, the surrounding neighborhood, the people of Hastings, and the City.

Why Board of Adjustment action is required:

Neb. Rev. Stat. 19-910 (1) The board of adjustment appointed pursuant to section 19-907 shall, subject to such appropriate conditions and safeguards as may be established by the city council or village board of trustees, have only the following powers: (a) To hear and decide appeals when it is alleged there is error in any order, requirement, decision, or determination made by an administrative official or agency based on or made in the enforcement of any zoning regulation or any regulation relating to the location or soundness of structures, except that the authority to hear and decide appeals shall not apply to decisions made under subsection (3) of section 19-929; (b) to hear and decide, in accordance with the provisions of any zoning regulation, requests for interpretation of any map; and (c) when by reason of exceptional narrowness, shallowness, or shape of a specific piece of property at the time of the enactment of the zoning regulations, or by reason of exceptional topographic conditions or other extraordinary and exceptional situation or condition of such piece of property, the strict application of any enacted regulation under this section and sections 19-901, 19-903 to 19-904.01, and 19-908 would result in peculiar and exceptional practical difficulties to or exceptional and undue hardships upon the owner of such property, to authorize, upon an appeal relating to the property, a variance from such strict application so as to relieve such difficulties or hardship, if such relief may be granted without substantial detriment to the public good and without substantially impairing the intent and purpose of any zoning regulation.

Type of action requested:

Motion

Suggested motion:

Approve the Variance to increase the maximum height for a wind turbine from 80 feet to 116 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Deny the Variance to decrease the minimum setback for a wind turbine from 116 feet to 30 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Deadlines associated with action:

Not Applicable

Department head comments:

Development Service staff has reviewed the Variance application for the proposed wind turbines at the property. The complete details of the staff's review and recommended findings are in the attached staff report.

Recommendation:

Approve the Variance to increase the maximum height for a wind turbine from 80 feet to 116 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Deny the Variance to decrease the minimum setback for a wind turbine from 116 feet to 30 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.



City of Hastings Planning Commission

STAFF REPORT

Variance:

File No. 2024-12

Applicant Industrial Irrigation Services

Property Location: 221 East J. Street

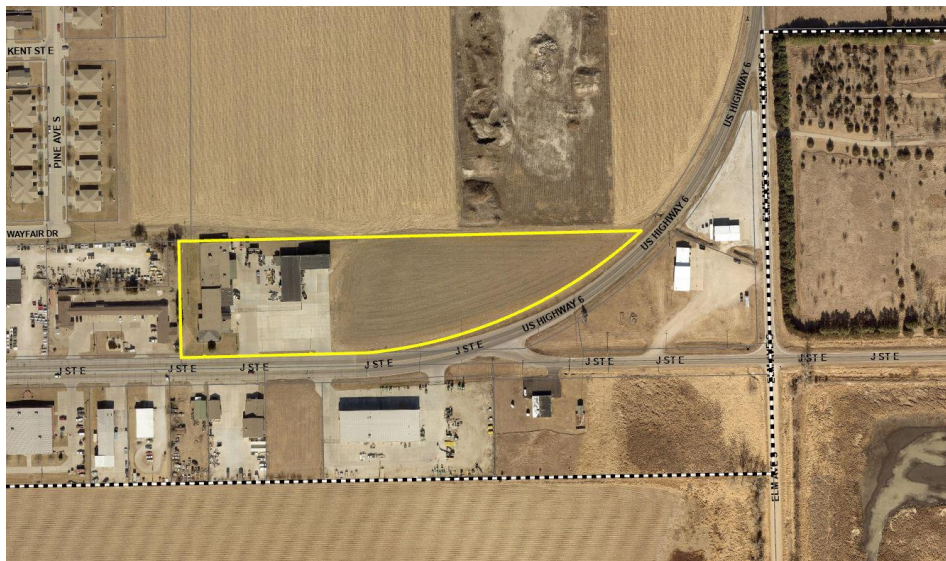
Lot Size: 6.75 Acres

Date of Public Hearing: January 11, 2024

Zoning I-2, Heavy Industrial District

Adjacent Zoning and Land Uses:

- North: I-2 District; undeveloped land currently used for row-crop agriculture and a storage yard for earth stockpiles and construction materials
- East: I-2 District and I-1, Light Industrial District; automotive repair and industrial warehousing
- South: I-1 District; various businesses devoted to the construction trade
- West: C-3, Commercial Business District; a motel and heavy automotive equipment sales



SECTION AND REQUIREMENT OF HASTINGS CODE OF ORDINANCE REQUESTED FOR VARIANCES:

- **Sec. 34-314(1):** The base of the tower shall be set back from all property lines, utility easements and rights of way equivalent to the height of the tower, including turbine blades. Any facility mounted on a building shall be set back from the edge of the building equivalent to the height of the facility measured from the building mount.
- **Sec. 34-314(2)(c):** Maximum tower height, measured to the highest point of the turbine blades: In Commercial and Industrial districts 80 feet.

DESCRIPTION OF VARIANCE REQUESTED: The applicant, Industrial Irrigation Services, has proposed to install two wind turbines to serve the industrial use “in an effort to control their long-term energy costs...” Both turbines are to be located on 100-foot tall, lattice-type towers. The total height of each turbine (tip of the blade) will be 116 feet. The turbines will have a 31.5-foot rotor diameter and each unit is intended to produce 15 kilowatts of power. The turbines are manufactured by Bergey Windpower.

Turbine #1 will be located approximately 30 feet from the northern property line to the immediate north of a small accessory building on the site. This turbine will be located approximately 120’ from the west property line, over 270 feet from the east property line, and approximately 300 feet from the south property line, along East J Street. This tower will be approximately 230 feet from the nearest existing structure on an adjacent property.

Turbine #2 is to be located immediately north of the existing eastern main building on the site. The tower will be approximately 60 feet from the north property line, approximately 150 feet from the east property line, and 270 feet to the south property line along East J. Street and over 240 feet to the west property line. Turbine #2 will be over 310 feet from the nearest existing structure on an adjacent property.

The proposed development requires two variances, as proposed.

1. Both proposed towers are located too close to the north property line. Sec. 34-314(1) requires the base of the tower shall be set back to the equivalent of the height of the tower, including turbine blades to all property lines, utility easements, and rights of way. The required setback is 116 feet. Turbine #1 will be 30 feet from the north property line. Turbine #2 will be 60 feet from the same property line.
2. The turbines are taller than allowed by Sec. 34—314(2)(c) for property in an industrial district. The maximum height of a small wind turbine in this zoning district is 80 feet to the highest point of the turbine blade. The proposed development would have a height of 116 feet.

In summary, the reasoning by the applicant to allow the two towers to be closer to the north property line than the minimum standard is that the applicant is unaware of any failures by the proposed type of tower. Additionally, the “surrounding area to the North is farmland, it does not appear to present any risk to the surrounding population.”

To summarize, the reason for the taller than allowed turbine is to capture more and cleaner wind, which will greatly enhance the performance of the turbines. By being taller and further away horizontally from surrounding obstructions, such as buildings and natural features, the turbines will operate more efficiently and produce more energy for the user.

More details from the applicant is provided in the application materials.

Property Description: The subject site is a 6.72-acre, unplatted tract of land to the north of East J Street. The site is relatively flat, with a gentle slope to the north and east.

Approximately the western third of the site is developed as a industrial manufacturing use. The developed area consists of approximately 67,000 square feet of production, warehouse, and office space devoted to automotive and agricultural industrial use.

The eastern two-thirds of the site is undeveloped and currently has a grass cover crop.

STANDARDS FOR VARIANCE:

Pursuant to [Sec. 34-706\(4\)](#) of the City Code of Ordinance, No such variance shall be authorized by the Board unless it finds that all four of the following conditions have been found to exist and the merits of the situation support such authorization:

(a) The strict application of the zoning regulations would produce undue hardship.

Structure Height: Sec. 34-314(2)(c) states that the maximum height for a small wind energy system in an industrial district can be no taller than 80 feet, measuring to the highest point of the turbine blade. The proposed turbines would be 116 feet, measured to the highest turbine blade.

As the applicant has stated, the reason for the proposed height is to provide the “cleanest” wind possible, with the least amount of obstruction by nearby developments, with the preferred height being at least 100 feet above the ground. The need to have unobstructed wind is to allow for improved airflow, thus maximizing the amount of energy capable of being generated by the turbines.

Not allowing the height of the proposed turbine would diminish the efficiency of the energy generation, thus limiting the return on investment of installing the small wind energy system. This could be considered a hardship.

Structure Setback: Sec. 34-314(1) requires that the base of the small wind energy system be setback from all property lines, utility easements, and rights-of-way at a height equal to the height of the tower, including the turbine blades. Although the failure of well-designed and constructed towers is rare, it can happen. The setback requirement intends to create a “fall zone” from the tower to neighboring properties, utilities, and roadways to reduce the amount of damage that could occur if a catastrophic failure of the tower occurred.

As proposed, Turbine #1 would be located as close as 30 feet to the north property line, and Turbine #2 would be 60 feet from that property line. It is assumed that the location of the towers is to strategically place them next to the industrial buildings they will serve to limit the amount of power transmission lines needed.

The property to the north is currently being used for row crop agriculture. No building or other development is located in this area of this adjacent property. If either of the towers were to fail, the damage would be limited to cropland.

However, the land is zoned I-2, Heavy Industrial District. This land could develop at any time in the future. Additionally, the I-2 District has a minimum building setback of three feet from a side property line and a zero-foot setback from a rear property line. Depending on how the adjacent property developed, a building could be placed within the fall zone of both towers. This could potentially place life and property at risk from the failure of the towers.

An alternative location for the towers could be to the east of the existing development. This area is currently vacant. The depth of the property in this area is approximately 305 feet, which would be adequate distance to place 116-foot tall turbines to be appropriately setback from both the property lines to the north and east, as well as to the property line along the East J Steet right-of-way. It is recognized that locating these towers in this area may make the project more expensive for the property owner due to the need to run additional transmission lines to the building the turbines will serve. Considering the alternative location, it does not appear that the strict application of the setback requirement is a hardship to the property owner.

(b) Such hardship is not shared generally by other properties in the same zoning district and the same vicinity.

Structure Height: The height limitation for a small wind energy system is equally applied throughout all commercial and industrial districts. As mentioned, the preferred height for this use is at least 100 feet to provide for unobstructed wind flow and to allow the turbines to spin and a more efficient rate, creating more energy for the user.

The hardship would generally be shared by other properties in the zoning district and the same vicinity. It is recognized that this is an issue with the zoning regulations and should be addressed with upcoming zoning regulation updates.

Structure Setback:

The setback issue is not unique to this property. The hardship expressed by the applicant could be shared by other property owners in the I-2 District if others decided that locating a tower within the required setback was more advantageous compared to meeting the regulations.

There are alternatives on the site to locating the turbines. The turbines could be located to the east of the existing building in the vacant area. However, siting the turbines in this location would most likely impact the expense of the project, as this location would presumably require more power transmission lines to connect the turbines to the building connection points. Additionally, siting the turbines in this vacant area may impact future site developments for the business, as it expands.

The authorization of such variance will not be of substantial detriment to adjacent property and the character of the district will not be changed by the granting of the variance.

Structure Height: Allowing the increase in height for the wind turbines should not be a substantial detriment to adjacent properties that the appropriate setback of these structures would mitigate. The I-2, Heavy Industrial District has no height limitations, other than when located within the airport zones for the Hastings Municipal Airport (Sec. 34-217). The airport zones do not apply to this property.

Any potential impacts from the 116-foot tall wind turbines would be like a similar-sized structure on the site, which would be permitted, without the need for a variance.

Structure Setback: Not complying with the required 1:1 setback for the wind turbine may have a detrimental impact on adjacent properties. The requirement to setback the turbine a distance equivalent to the height of the tower, including turbine blades, is designed to protect adjacent properties from a failure of the support tower.

The land most impacted by the location of the turbine is the adjacent property to the north. Currently, this property is undeveloped and is being used for row-crop agriculture. Although the land is being used for agricultural purposes, it is zoned I-2 District, which means that the land could be developed at some point in the future. The threat of having a turbine fall on adjacent buildings future is a concern.

- (c) The granting of such variance is based upon reason of demonstrable and exceptional hardship as distinguished from variations for purposes of convenience, profit or caprice. In no instance, shall a variance be granted which would allow the use of land or a building which is not permitted within the zoning use district in which the property is located. No variance shall be authorized unless the Board finds that the condition or situation of the property concerned is not of so general or recurring a**

nature as to make reasonably practicable the formulation of a general regulation to be adopted as an amendment to the zoning regulations.

Structure Height: As described by the applicant, granting the increase in height for the taller towers will allow the two turbines to work more efficiently, which will create more renewable energy for the business owner. Although this could be considered a purpose of convenience and/or profit, City staff is recognizing the limitations of the small wind generation system regulations, especially when considering that the I-2 District does not have a maximum height limit for other buildings. This limitation would create recurring variance requests and the regulations should be updated to be more in line with the I-2 District intent.

Structure Setback: The variance request for the setback of the turbine appears to be the purpose of the convenience or expense of the project to provide wind energy to the manufacturing business. Alternatives exist to site the two towers that would most likely comply with the requirements. As previously discussed, siting the turbines in the vacant area to the east of the buildings would most likely increase the project costs and impact future expansion plans for the business.

STAFF COMMENTS:

Structure Height: Staff recommends the Board of Adjustment **APPROVE** the **VARIANCE** request to allow the maximum height of the two proposed wind turbines to increase from 80 feet to 116 feet tall, as present, for the property at 221 East J Street, in the I-2, Heavy Industrial District, with the following condition of approval:

1. All applicable permits shall be applied for and issued, including any electrical permits for the connection of the wind turbines to the building(s).

Possible Motion

Approve the Variance to increase the maximum height for a wind turbine from 80 feet to 116 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Structure Setback: Staff recommends the Board of Adjustment **DENY** the **VARIANCE** request to reduce the required setback for the proposed wind turbines from 116 feet to 30 feet, for the property at 221 East J Street, in the I-2, Heavy Industrial District.

Possible Motion

Deny the Variance to decrease the minimum setback for a wind turbine from 116 feet to 30 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

If the Board is inclined to approve the request to reduce the required setback, the Board will need to clearly articulate its findings to approve the request.

Possible Motion

Approve the Variance to decrease the minimum setback for a wind turbine from 116 feet to 30 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District based on the Board’s findings that [STATE FINDINGS], with the following condition of approval:

1. All applicable permits shall be applied for and issued, including any electrical permits for the connection of the wind turbines to the building(s).

PREPARED BY: Chad Bunger, AICP, CFM Director of Development Services

DATE: January 3, 2024

ATTACHMENTS:

1. Application Materials

CITY of HASTINGS, NE

VARIANCE REQUEST

November 11, 2023





AMERICAN MADE, AMERICAN PROUD.

MAKE MONEY FROM THE WIND!

Current Federal incentives can offset your cost of installation by up to 100% in the first year of installation!

If you've ever thought about your own wind turbine to slash future energy operating costs, now's the time to take a closer look at the most advanced small wind turbine built in America.

HARD TO BELIEVE?

LET US PROVE IT!



AMERICAN
Windpower



For information, call
833-GO4-WIND

Email: info@american-windpower.com



November 14, 2023,

Honorable Zoning Committee Member,

This request is for a variance to allow a 100' tower (116' to the tip of the blade) for Justin Osborne of Industrial Irrigation Services located at 221 East J St., Hastings, NE.

Industrial Irrigation owns several acres for their business and in an effort to control their long-term energy costs has plans to install (2) 15 kW wind turbines manufactured by Bergey Windpower. The property is zoned Industrial.

The following information explains our reasoning behind our request. Essentially, performance is greatly enhanced and by avoiding turbulence, the turbines life expectancy is greatly prolonged.

Since 1983, thousands of these towers have been installed all over the World. I am not aware of any failures of this tower. Given that this property is zoned Industrial and the surrounding area to the North is farmland, it does not appear to present any risk to the surrounding population.

I hope you find the information informative and I look forward to addressing any issues you may have.

Respectfully,

Cody Buhrman
American Windpower
Installation Director

Bergey Windpower - A History of Excellence



Dr. Karl Bergey – Co-Founder (1922-2019)

As a boy, he developed a passion for model airplanes and all things aviation related – a passion he never lost. He studied at Penn State University before joining the Navy and attended flight navigation school, finishing near the end of WWII. After returning to college he received his degree in Aeronautical Engineering then worked at Grumman Aviation before entering the prestigious University, M.I.T., where he earned a Master's degree in Aeronautical Engineering. After college, Karl worked for North American Aviation in California. Karl joined Piper Aircraft in 1957. While at Piper, Karl led the development and certification of the iconic Piper Cherokee, which went on to become one of the best-selling planes in general aviation. Karl then joined Aero Commander as VP of Engineering in 1968 where he led the development of new small planes including the Aero Commander 114. In recognition of his contributions to general aviation received a Lifetime Achievement Award from the American Institute of Aeronautic and Astronauts (AIAA) in 2002. In 2003 he received an Outstanding Engineering Alumnus award from Penn State University.

Karl joined the University of Oklahoma as Professor of Aeronautical, Mechanical and Nuclear Engineering in 1970. Starting in 1971, well before the energy crisis, Karl authored feasibility studies on wind power and in 1975 testified before Congress on the potential of wind energy to become a significant source of energy for the U.S. In 1977, along with his son, Michael, founded Bergey Windpower, Co. (BWC). BWC went on to become the leading manufacturer of small wind turbines in the U.S. with installations in all 50 states and over 120 countries. The company's success has been in large part due to Karl's belief in the value of simplicity. He often quoted French author Antoine de Saint Exupery: "Perfection is achieved not when there is nothing more to add, but when is nothing more to take away". Karl was described as being an 'engineers engineer' and he leaves behind a legacy of design excellence, machines that make the world a better place.



Mike Bergey – President and Co-Founder

Co-Founder and President of Bergey Windpower since 1987, Mike is a Mechanical Engineer and an internationally recognized expert in the field of small wind turbines, distributed wind generation, and rural electrification. He has authored more than 70 technical papers and articles in the field, provided testimony to Congress and serves as a consultant to several government and international agencies.

He has twice served as President of the American Wind Energy Association (AWEA) and served on the AWEA Board of Directors from 1981 to 2007. He is past Chairman of the U.S. Export Council for Renewable Energy, member of the U.S. Department of Commerce Environmental Technology Trade Advisory Committee.

He chaired the AWEA Small Wind Turbine Committee for over 20 years and in 1981 was recognized by AWEA for 'Development of a National Performance Standard for Small Wind Turbines'. In 1994 he was recognized as the AWEA 'Man of the Year'. He is currently President of the Distributed Wind Energy Association in addition to his duties at BWC.

BERGEY EXCEL 15

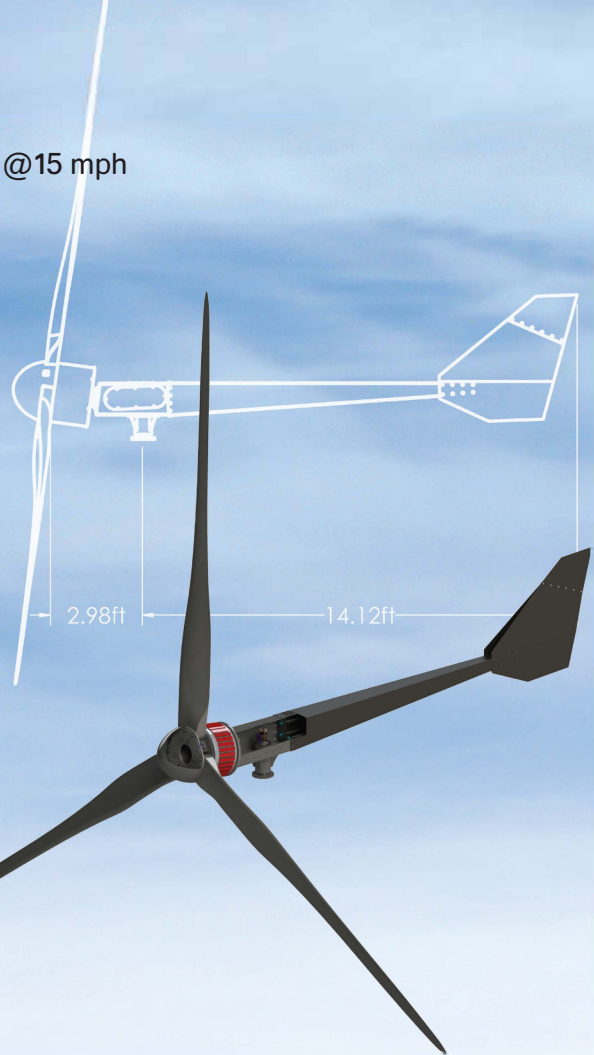
Performance*

- AWEA RATED POWER: 15.6 kW @ 11 m/s or 24.6 mph
- AWEA ANNUAL ENERGY: 30,100 kWh @ 11 mph, 56,250 kWh @ 15 mph
- PEAK POWER: 16.8 kW
- CUT-IN WIND SPEED: 7 mph (3 m/s)
- START-UP WIND SPEED: 10 mph (4.5 m/s)
- CUT-OUT WIND SPEED: None
- MAX DESIGN WIND SPEED: 134 mph (60 m/s)
- ROTOR SPEED: 0–140 rpm

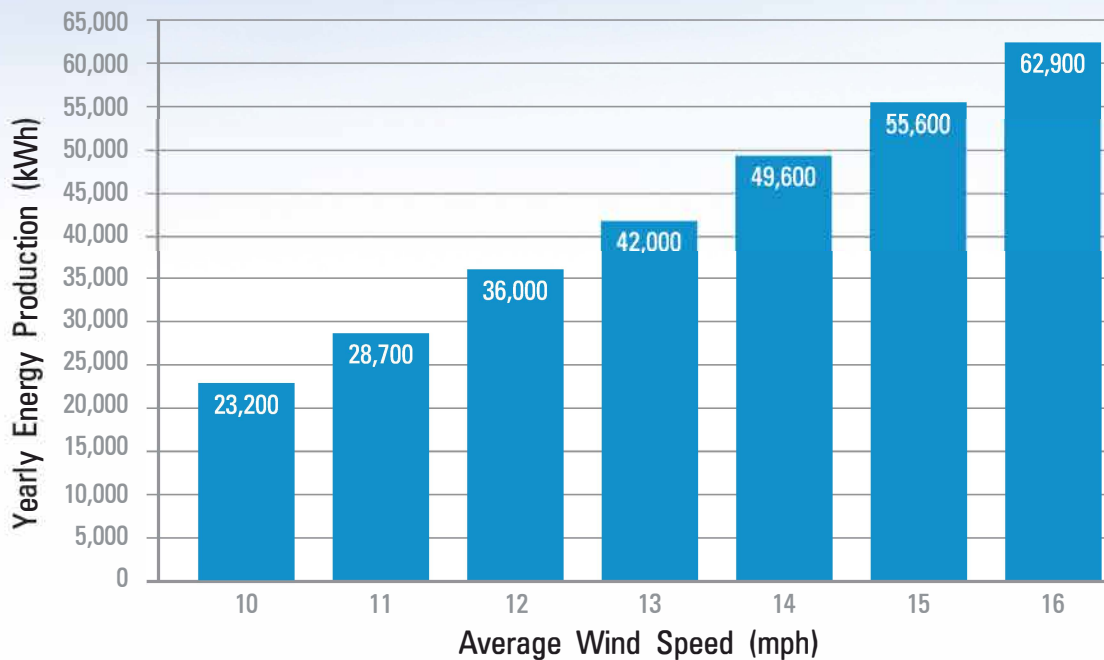
*preliminary, pre-certification

Specifications

- ROTOR DIAMETER: 31.5 ft. (9.6 m)
- WEIGHT: 1,400 lb. (640 kg)
- GEARBOX: None
- OVER SPEED PROTECTION: Blade Stall
- TEMPERATURE RANGE: -40/140° F (-40/60° C)
- TOWERS: Self-Supporting 'Tilt-Up' 100–120 ft. (30–36 m)
- INVERTER: 25 kW Powersync III, with dump load



Annual Energy Output*



Powersync III Inverter (15 kW)



Exclusively Offered By:





ICC-SWCC™ CERTIFICATION SWCC-16-05



Small Wind Turbine Certification Program

Certification Number: SWCC-16-05
Original Certification Date: Feb. 1, 2021
Expiration Date: Jan. 1, 2024
Certification subject to renewal annually.

www.smallwindcertification.org (888) 422-7233 3060 Saturn St., Suite 100, Brea, CA 92821 USA
A Program of the ICC Evaluation Service (ICC-ES)

Program: This wind turbine has been evaluated and certified by the Small Wind Certification Council (ICC-SWCC™), an ISO/IEC 17065 accredited Certification Body, in accordance with the Small Wind Turbine Certification Program, as defined in [ICC-SWCC Rules for Wind Turbine Listing Reports](#). This award of certification is subject to all terms and conditions of the current SWT Program Agreement and the documents incorporated therein by reference.

Products: Small Wind Turbines—electricity-producing wind turbines with a swept area up to 200 m²
Reference Standard: AWEA Small Wind Turbine Performance & Safety Standard (AWEA 9.1–2009)

Listee: **Bergey Windpower Company** www.bergey.com
2200 Industrial Boulevard (405) 364-4212
Norman, OK 73069, USA

Model: **Excel 15** (240 VAC, 1-phase, 60 Hz)

Changes to the design of this wind turbine are to be approved by ICC-SWCC. If changes are made to the turbine without approval, this Certificate is not valid.

The specifications of the certified wind turbine, relevant to this Certificate, are provided on the following page. This document must be reproduced in its entirety.

Shawn Martin

Vice President of Technical Services, ICC-SWCC

Please verify certification is active on the ICC-SWCC website: www.smallwindcertification.org
© Small Wind Certification Council (ICC-SWCC™)
3060 Saturn Street, Suite 100 ♦ Brea, CA 92821 ♦ (888) 422-7233

ICC-SWCC™

CERTIFICATION SWCC-16-05



Wind Turbine Specification:

Turbine Parameters

Manufacturer	Bergey Windpower Co.
Model	Excel 15
Power Form	240 VAC, 1-phase, 60 Hz
Rotor Diameter	9.6 m
Rotor Swept Area	72.4 m ²
Cut-In Wind Speed	3.0 m/s
Cut-Out Wind Speed	N/A
Maximum Power	21.5 kW
Maximum Voltage	600 V _{rms}
Maximum Current	55 A _{rms}

Turbine Ratings

AWEA Rated Annual Energy @ 5 m/s	29,800 kWh
AWEA Rated Sound Level	48.5 dB(A)
AWEA Rated Power	15.6 kW @ 11 m/s
Peak Power	20.6 kW @ 16 m/s

Design and Duration

Turbine design and duration test comply with AWEA Standard 9.1 – 2009 for an IEC Class III SWT with an average wind speed (V_{ave}) of 7.5 m/s and reference wind speed (V_{ref}) of 37.5 m/s.



2200 INDUSTRIAL BLVD.
 NORMAN, OK 73069 USA
 T: 405-364-4212
 F: 405-364-2078
 E-MAIL: mbergey@bergey.com
 WEB: www.bergey.com

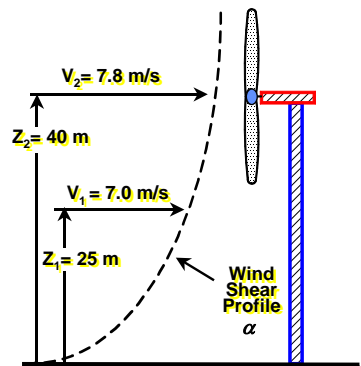
Why Short Towers are Very Bad for Small Wind Turbines

The smooth flow of the wind over the land is interrupted by obstructions and topographical variations. These interruptions bring about two important phenomena: **wind shear** and **turbulence**. Wind shear describes the fact that close to the ground the wind is slowed down by friction and the influence of obstacles. Thus, wind speed is low close to the ground and increases with increasing height above the ground. Wind shear is more pronounced over rough terrain and less pronounced over smooth terrain. Turbulence is essentially rough air caused by the wind passing over obstructions such as trees, buildings, or terrain features. Turbulent air reduces energy output because it diminishes the effectiveness of the

Wind Shear

The change in horizontal wind speed with height

- ❖ A function of **wind speed**, **surface roughness** (may vary with wind direction), and **atmospheric stability** (changes from day to night)
- ❖ Wind shear exponents are higher at low wind speeds, above rough surfaces, and during stable conditions
- ❖ Typical exponent (α) values:
 - ❖ .10 - .15: water/beach
 - ❖ .15 - .25: gently rolling farmland
 - ❖ .25 - .40+: forests/mountains



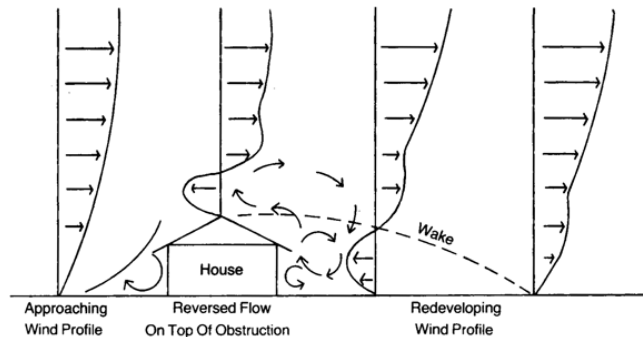
$$\alpha = \frac{\text{Log}_{10} [V_2/V_1]}{\text{Log}_{10} [Z_2/Z_1]} \quad V_2 = V_1(Z_2/Z_1)^\alpha$$

Graphic courtesy of AWS Scientific



aerodynamics of the rotor blades. Turbulence also puts greater strain on the wind turbine because it increases vibration.

Turbulence



Turbulence cuts performance by reducing the effectiveness of the blades



The effects of both wind shear and turbulence diminish with height and can be largely overcome simply by putting the machine sufficiently high above the ground. This may be accomplished by putting the machine on the highest possible ground and on the highest feasible tower. As a minimum, the machine should be at least 12 meters (40 feet) above any obstructions within 100 meters (330 feet) in the prevailing wind direction, and preferably in all directions. Even in perfectly flat areas, we recommend that the tower be at least 30 meters (100 feet) high for a 15 kW BWC Excel wind turbine installation. In areas with trees, please bear in mind that trees grow and the tower height needs to be based on the mature height of trees in the vicinity.

Further, the power in the wind increases as the cube of the wind velocity (i.e., doubling wind speed increases power by a factor of eight, $2 \times 2 \times 2 = 8$). Therefore, small increases in average wind speed will result in significant increases in long-term energy output.

Table 1 below shows the influence that tower height can have on annual energy output for the BWC Excel 15 wind turbine at a typical inland site.

Tower Height (ft)	Wind Speed at Top of Tower (mph)	Annual Energy Output (kWh)
60	12.4	34,022
100	13.9	45,082

Table 1: Variation in wind speed and expected annual energy output with tower height.

Going from 60' to 100' increases production by over 10,000 kWh's, an increase of over 34%, while also reducing component stress and increasing the life of the turbine.

The Bottom Line:

Putting a wind turbine on a short tower is like putting a solar system in the shade!

Tower heights for the 15 kW BWC Excel can range from 100 - 160 feet and most installations use the 100 ft. or 120 ft. towers.

The FAA does not require the approval of towers under 200 feet unless they are in close proximity to an active airport runway. The need to obtain FAA permission (known as a "determination") is triggered in this case if the tower punctures a slope of either 50:1 or 100:1, depending on the runway length, taken from the nearest point on the airport runway. For example, for a runway over 3,500 ft in length a 100 ft. (112 ft. to tip of blade) tower would need to be closer than 11,200 ft from the runway to require FAA approval. This situation has arisen about a dozen times over the last 25 years for BWC installations and the FAA has granted permission in every case.

WindReport by Bergey Windpower Co.
 Bergey Windpower Co. | 2200 Industrial Blvd. Norman, OK 73069 USA

Turbine Production:



Turbine Selection	Bergey Excel 15
Nameplate Capacity [kW]	15.0
Rotor Diameter [m]	9.6
Site Location:	
221 East J Street	
Hastings, Nebraska	
40.569° latitude	
-98.379° longitude	
Average Wind Speed [mph]	13.85
Tower Height [ft]	100.0
Altitude [ft]	100.0
Weibull K	2.0
Wind Shear	0.14
Turbulence Factor [%]	5.0
Average Output Power [kW]	5.1
Daily Energy Output [kWh]	123.5
Monthly Energy Output [kWh]	3,756.9
Annual Energy Output [kWh]	45,082.3
Hub Average Wind Speed [mph]	13.9
Air Density Coefficient	1.0
Operating Time [%]	99.3

WindReport by Bergey Windpower Co.
 Bergey Windpower Co. | 2200 Industrial Blvd. Norman, OK 73069 USA

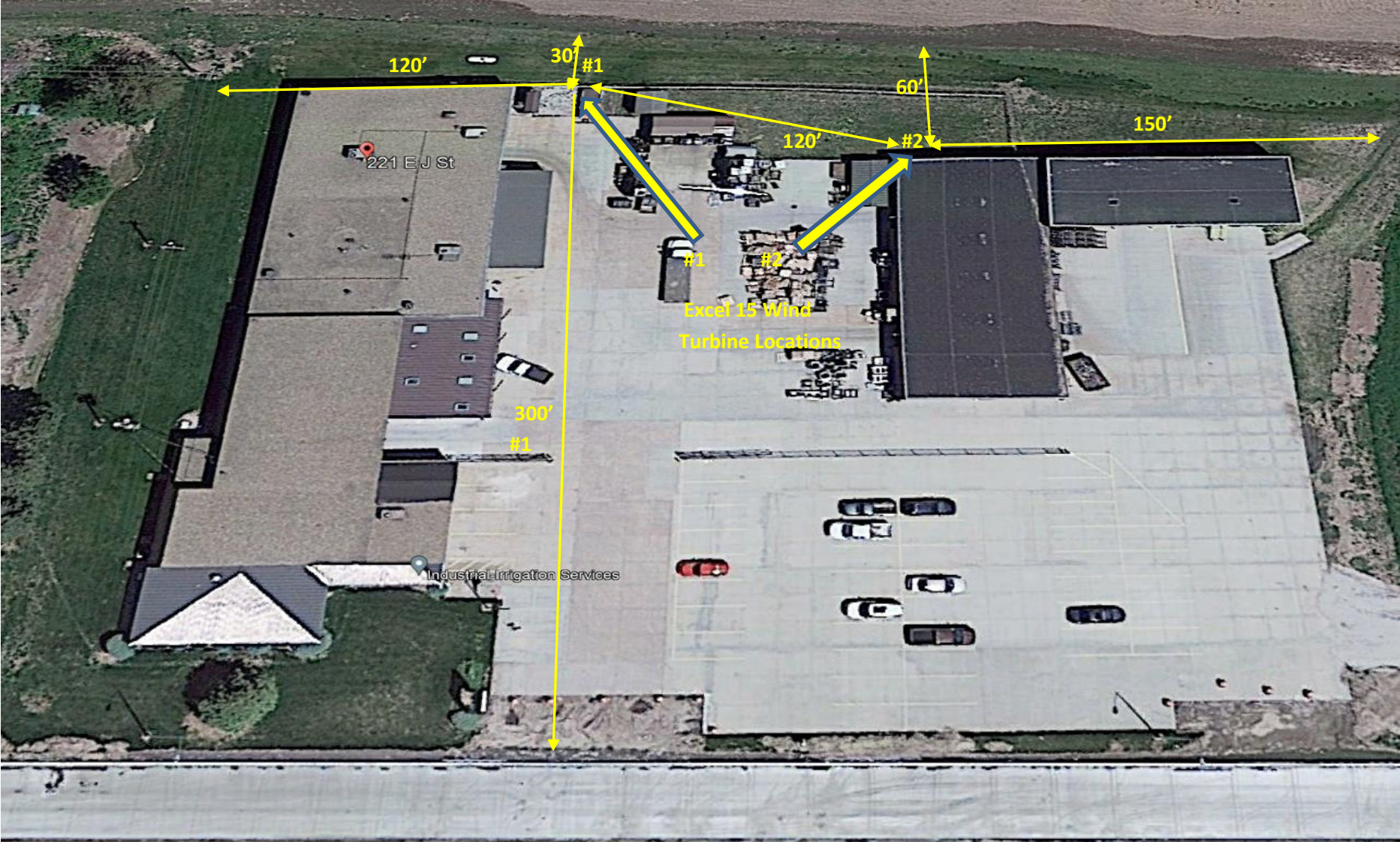
Turbine Production:



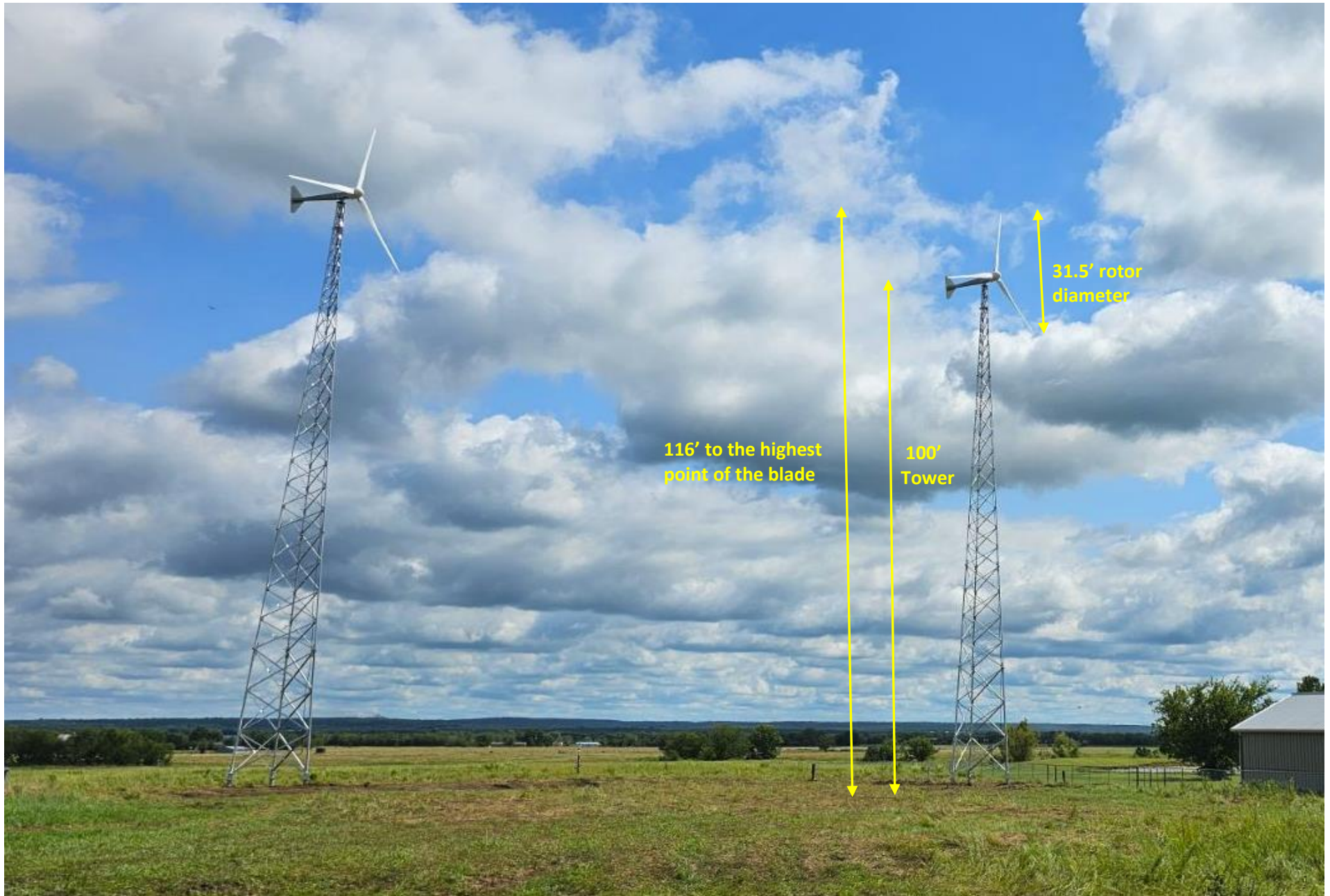
Turbine Selection	Bergey Excel 15
Nameplate Capacity [kW]	15.0
Rotor Diameter [m]	9.6
Site Location:	
221 East J Street	
Hastings, Nebraska	
40.569° latitude	
-98.379° longitude	
Average Wind Speed [mph]	12.44
Tower Height [ft]	60.0
Altitude [ft]	100.0
Weibull K	2.0
Wind Shear	0.18
Turbulence Factor [%]	10.0
Average Output Power [kW]	3.9
Daily Energy Output [kWh]	93.2
Monthly Energy Output [kWh]	2,835.2
Annual Energy Output [kWh]	34,022.2
Hub Average Wind Speed [mph]	12.4
Air Density Coefficient	1.0
Operating Time [%]	99.5

Industrial Irrigation Wind Turbine Locations

221 East J Street Hastings, NE



Turbine location #1 is approximately 120' from the electric utility line and 140' from the West property line and 30' from the North property line and 300' from the South property line. Turbine location #2 is 120' East of Turbine #1 in a slight angle East-West. Turbine 2 is 150' from the East property line and 60' from the North property line.



The 15 kW wind turbines utilize a 100' tower and the rotor diameter is 31.5. The highest point of the blade tip is 116'. Wind turbines benefit greatly by placed higher, allowing them to take advantage the higher winds aloft but more importantly avoiding turbulence created by nearby structures and even the ground itself. By avoiding this turbulence the turbines last longer and more safely due to reducing the aerodynamic stresses on the turbine and tower.



Introducing the Excel 15: The World's Most Technologically Advanced Wind Turbine

Bergey Windpower: The Industry Leader since 1977 with over 10,000 Turbines Installed in over 120 Countries and every U.S. State



(5) Bergey Excel's on 100' Towers in Drummond, OK



Bergey Excel near Juniata, NE



(2) Bergey Excel's powering the Alvis Ranch near Blanchard, Oklahoma



1 Fairholm Avenue
Peoria, IL 61603 USA
Phone: (309)-566-3000
Fax: (309)-566-3079

DATE: AUGUST 03, 2023

PURCHASER: BERGEY WINDPOWER

PROJECT: 100FT SSV SELF SUPPORT TOWER
HASTINGS, NE

FILE NUMBER: 243880

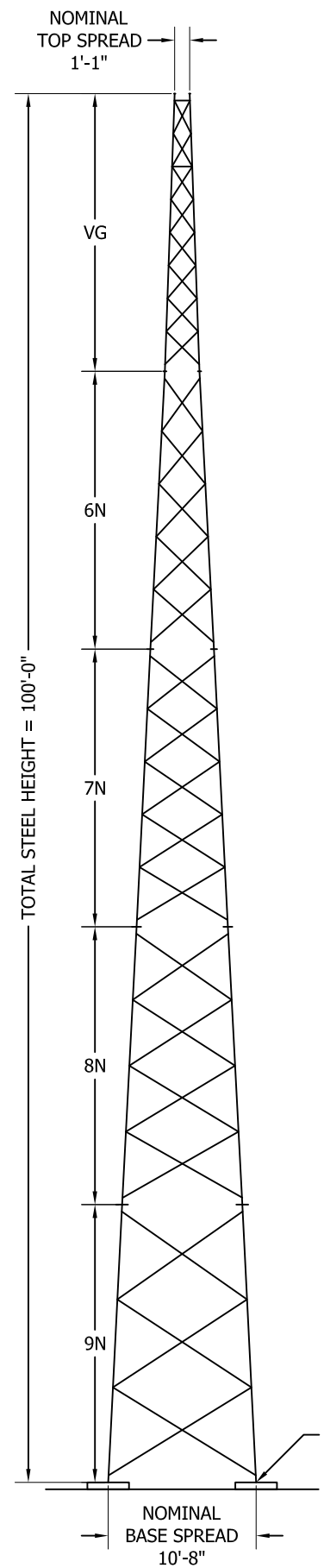
I CERTIFY THAT THE ATTACHED DRAWINGS WERE PREPARED UNDER MY SUPERVISION IN ACCORDANCE WITH THE DESIGN AND LOADING CRITERIA SPECIFIED BY THE PURCHASER AND THAT I AM A REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF NEBRASKA.

Allen Schneider

08/03/2023



Products for a Growing World of Technology®

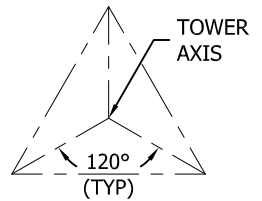


(4) ANCHOR BOLTS (12 TOTAL)
1" DIA. X 48" LONG
ASTM F1554 Gr. 105

GENERAL NOTES

- ROHN PRODUCTS, LLC TOWER DESIGNS CONFORM TO ANSI/TIA-222-H UNLESS OTHERWISE SPECIFIED UNDER TOWER DESIGN LOADING.
- THE DESIGN LOADING CRITERIA INDICATED HAS BEEN PROVIDED TO ROHN. THE DESIGN LOADING CRITERIA HAS BEEN ASSUMED TO BE BASED ON SITE-SPECIFIC DATA IN ACCORDANCE WITH ANSI/TIA-222-H AND MUST BE VERIFIED BY OTHERS PRIOR TO INSTALLATION.
- TURBINES, APPURTENANCES, AND LINES LISTED IN TOWER DESIGN LOADING TABLE ARE PROVIDED BY OTHERS UNLESS OTHERWISE SPECIFIED.
- STEP BOLTS WITH SAFETY CLIMB SYSTEM ARE PROVIDED AS A CLIMBING FACILITY FOR THE INSTALLATION OF THE STRUCTURE.
- TOWER MEMBER DESIGN DOES NOT INCLUDE STRESSES DUE TO ERECTION SINCE ERECTION EQUIPMENT AND CONDITIONS ARE UNKNOWN. DESIGN ASSUMES COMPETENT AND QUALIFIED PERSONNEL WILL ERECT THE TOWER.
- WORK SHALL BE IN ACCORDANCE WITH ANSI/TIA-222-H, "STRUCTURAL STANDARD FOR ANTENNA SUPPORTING STRUCTURES AND ANTENNAS AND SMALL WIND TURBINE SUPPORT STRUCTURES".
- THE MINIMUM YIELD STRENGTH OF STRUCTURAL STEEL MEMBERS SHALL BE 50 KSI.
- FIELD CONNECTIONS SHALL BE BOLTED. NO FIELD WELDS SHALL BE ALLOWED.
- STRUCTURAL BOLTS SHALL CONFORM TO GRADE A325 PER ASTM F3125, EXCEPT WHERE NOTED.
- PAL NUTS ARE PROVIDED FOR ALL TOWER BOLTS.
- STRUCTURAL STEEL AND CONNECTION BOLTS SHALL BE HOT-DIPPED GALVANIZED AFTER FABRICATION, IN ACCORDANCE WITH ANSI/TIA-222-H.
- ALL HIGH STRENGTH BOLTS, UNLESS OTHERWISE NOTED FOR DOUBLE ANGLE MEMBERS, ARE TO BE TIGHTENED TO A "SNUG TIGHT" CONDITION AS DEFINED IN THE RCSC "SPECIFICATION FOR STRUCTURAL JOINTS USING HIGH-STRENGTH BOLTS". NO OTHER MINIMUM BOLT TENSION OR TORQUE VALUES ARE REQUIRED.
- PURCHASER SHALL VERIFY THE INSTALLATION IS IN CONFORMANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS FOR OBSTRUCTION MARKING AND LIGHTING.
- TOLERANCE ON TOWER STEEL HEIGHT IS EQUAL TO PLUS 1% OR MINUS 1/2%.
- DESIGN ASSUMES THAT, AS A MINIMUM, MAINTENANCE AND INSPECTION WILL BE PERFORMED OVER THE LIFE OF THE STRUCTURE IN ACCORDANCE WITH ANSI/TIA-222-H.
- DESIGN ASSUMES LEVEL GRADE AT TOWER SITE.
- FOUNDATIONS SHALL BE DESIGNED TO SUPPORT THE REACTIONS SHOWN FOR THE CONDITIONS EXISTING AT THE SITE.
- THE DESIGN OF REFERENCED STRUCTURE HAS BEEN BASED ON EQUIVALENT STATIC LOADING CONDITIONS PROVIDED BY THE TURBINE MANUFACTURER. THE TURBINE MANUFACTURER MUST APPROVE THE DESIGN FOR PROPER PERFORMANCE WITH THE INTENDED TURBINE CONSIDERING AS A MINIMUM, FATIGUE, HARMONICS, AND DYNAMIC LOADING. ROHN DOES NOT ACCEPT RESPONSIBILITY AND PROVIDES NO WARRANTY FOR FATIGUE, HARMONICS, OR DYNAMIC LOADING RELATED ISSUE.
- LATERAL THRUST AND DEFLECTION CRITERIA PROVIDED BY BERGEY WINDPOWER INC. FOR USE AS A COMPONENT OF A 15KW WIND SYSTEM.
- STRUCTURE HAS BEEN DESIGNED TO DEFLECT NO MORE THAN 12.0" AT 60 MPH WIND AND 30" AT 140 MPH. TOWER DESIGN IS BASED ON STATIC LOADING ONLY. DYNAMIC AND HARMONIC CONDITIONS HAVE NOT BEEN CONSIDERED.

MAXIMUM FACTORED REACTIONS	
COMPRESSION PER LEG =	88.6 KIPS
TENSION PER LEG =	77.6 KIPS
SHEAR PER LEG =	7.8 KIPS
TOTAL SHEAR =	12.7 KIPS
TOTAL O.T.M =	788.7 FT-KIPS



TOWER CONFIGURATION
N.T.S.

TOWER DESIGN LOADING		
DESIGN WIND LOAD PER ANSI/TIA-222-H USING THE FOLLOWING DESIGN CRITERIA: RISK CATEGORY: II BASIC WIND SPEED (NO ICE): 140 MPH PER ASCE 7-16 BASIC WIND SPEED (W/ICE): 40 MPH PER ASCE 7-16 DESIGN ICE THICKNESS: 2.00 INCHES PER ASCE 7-16 EXPOSURE CATEGORY: C TOPOGRAPHIC METHOD: 1 , CATEGORY: 1		
THIS STRUCTURE HAS BEEN DESIGNED TO SUPPORT THE FOLLOWING LOADS:		
ELEVATION (FT)	ANTENNA LOADING	LINE SIZE (NOM)
TOP	BERGEY 15 KW TURBINE ROTOR DIAMETER: 31.54 FT MAX TURBINE THRUST: 2.5 K EPA: 67.82 SQFT WEIGHT OF ROTOR & TURBINE: 2.75 K	(2) 1"
95	INVERTER	

SECTION MAIN MEMBER SCHEDULE			
SECTION	LEGS	DIAGONALS	HORIZONTALS
VG	PIPE 2.875x0.203	L1 1/2x1 1/2x3/16 (8)	L1 3/4x1 3/4x3/16 (1)
6N	PIPE 2.875x0.203	L1 1/2x1 1/2x1/8 (5)	N/A
7N	PIPE 2.875x0.276	L1 1/2x1 1/2x1/8 (5)	N/A
8N	PIPE 3.500x0.300	L1 3/4x1 3/4x1/8 (4)	N/A
9N	PIPE 4x0.318	L2 1/2x2 1/2x3/16 (3)	N/A

NOTE:
SECTION NUMBERS ARE FOR REFERENCE ONLY.
FOR NOMINAL FACE WIDTH DIMENSIONS, REFER TO THE STRESS ANALYSIS.
THE NUMBERS SHOWN IN PARENTHESES INDICATE THE NUMBER OF BAYS FROM TOP TO BOTTOM.

FILE NO. 15KW100			
REVISIONS			
REV.	DESCRIPTION	DWN	CHK APP
 PO BOX 5999 PEORIA, IL 61601-5999 TOLL FREE 800-727-ROHN			
THIS DRAWING IS THE PROPERTY OF ROHN. IT IS NOT TO BE REPRODUCED, COPIED OR TRACED IN WHOLE OR IN PART WITHOUT OUR WRITTEN CONSENT.			
BERGEY WINDPOWER DESIGN PROFILE 100 FT SSV TOWER GENERIC			
DWN: AS	CHK'D: AS	DATE: 10/25/2022	
ENG'R:	SHEET #: 1 OF 1		
PRJ. ENGR: AS	PRJ. MANG'R:		
DRAWING NO: 15KW100-01-D1			REV: 0

September 3, 2019

To Whom it May Concern,

This statement will certify that all components of the Bergey Windpower Excel 15 wind turbine have been designed in conformance with AWEA 9.1-2009, AWEA Small Wind Turbine Performance and Safety Standard. Towers sold by Bergey Windpower for use with the Excel 15 turbine meet the requirements of ANSI/TIA 222-H, as referenced in the International Building Code IBC 2018. The Rohn Self-Supporting Lattice tower has been used successfully in hundreds of sites over the last four decades with an earlier BWC turbine model which produces similar tower loads. With proper installation and maintenance, the risk of tower failure is extremely minimal.

Sincerely,

Kenneth Craig PhD, PE



Kenneth J. Craig
03 September 2019
20017

<i>tnxTower</i> Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 1 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Tower Input Data

The main tower is a 3x free standing tower with an overall height of 94.70 ft above the ground line.

The base of the tower is set at an elevation of 0.00 ft above the ground line.

The face width of the tower is 1.00 ft at the top and 14.00 ft at the base.

This tower is designed using the TIA-222-G standard.

The following design criteria apply:

Basic wind speed of 120.00 mph.

Structure Class II.

Exposure Category C.

Topographic Category 1.

Crest Height 0.00 ft.

Nominal ice thickness of 0.75 in.

Ice thickness is considered to increase with height.

Ice density of 56 pcf.

A wind speed of 50.00 mph is used in combination with ice.

Temperature drop of 90 °F.

Deflections calculated using a wind speed of 60.00 mph.

Weld together tower sections have flange connections..

Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications..

Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards..

Welds are fabricated with ER-70S-6 electrodes..

A non-linear (P-delta) analysis was used.

Pressures are calculated at each section.

Stress ratio used in tower member design is 1.

Local bending stresses due to climbing loads, feed line supports, and appurtenance mounts are not considered.

Section	T1	T2	T3	T4	T5
Legs	P2.5x.401	P2.5x.203	A572-50	P3x.216	
Leg Grade	L1 1/2x1 1/2x3/16	L1 1/2x1 1/2x1/8	A36	L1 3/4x1 3/4x1/4	
Diagonals					
Diagonal Grade					
Top Girts	3x3/4				
Face Width (ft)	3.6	6.2	8.8	11.4	13.66.0
# Panels @ (ft)	7 @ 2.65817	5 @ 3.72144	4 @ 4.6518	6 @ 6.20241	
Weight (lb)	1181.5	717.6	758.8	1284.4	

96.7 ft

94.7 ft

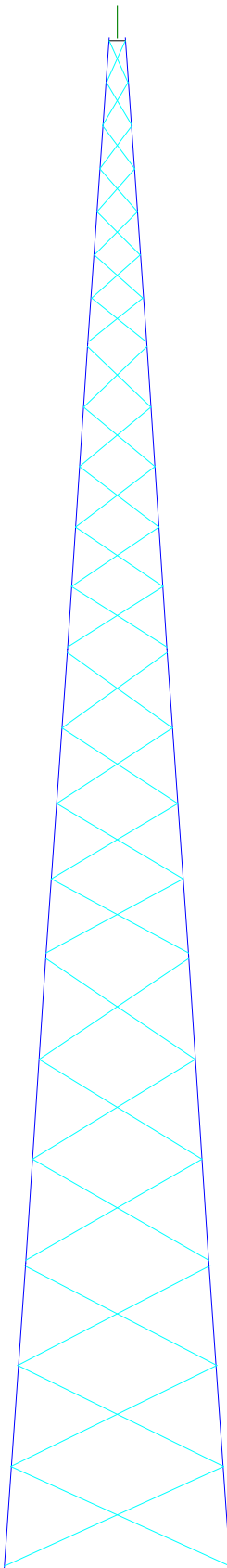
75.8 ft

56.8 ft

37.9 ft

18.9 ft

0.0 ft



MATERIAL STRENGTH

GRADE	Fy	Fu	GRADE	Fy	Fu
A572-50	50000 psi	65000 psi	A36	36000 psi	58000 psi

TOWER DESIGN NOTES

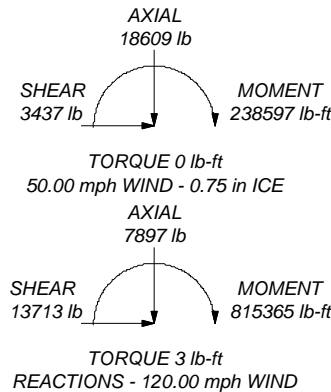
1. Tower designed for Exposure C to the TIA-222-G Standard.
2. Tower designed for a 120.00 mph basic wind in accordance with the TIA-222-G Standard.
3. Tower is also designed for a 50.00 mph basic wind with 0.75 in ice. Ice is considered to increase in thickness with height.
4. Deflections are based upon a 60.00 mph wind.
5. Tower Structure Class II.
6. Topographic Category 1 with Crest Height of 0.00 ft
7. Force Couples (top of tower)
EXCEL Wind Turbine
A: 1200.00 lb, H: 2400.00 lb, M: 4800.00 lb-ft
Ice-A: 1850.00 lb, H: 1500.00 lb, M: 3000.00 lb-ft
Service-A: 1200.00 lb, H: 2400.00 lb, M: 4800.00 lb-ft
8. Weld together tower sections have flange connections.
9. Connections use galvanized A325 bolts, nuts and locking devices. Installation per TIA/EIA-222 and AISC Specifications.
10. Tower members are "hot dipped" galvanized in accordance with ASTM A123 and ASTM A153 Standards.
11. Welds are fabricated with ER-70S-6 electrodes.

ALL REACTIONS
ARE FACTORED

MAX. CORNER REACTIONS AT BASE:

DOWN: 69883 lb
SHEAR: 8626 lb

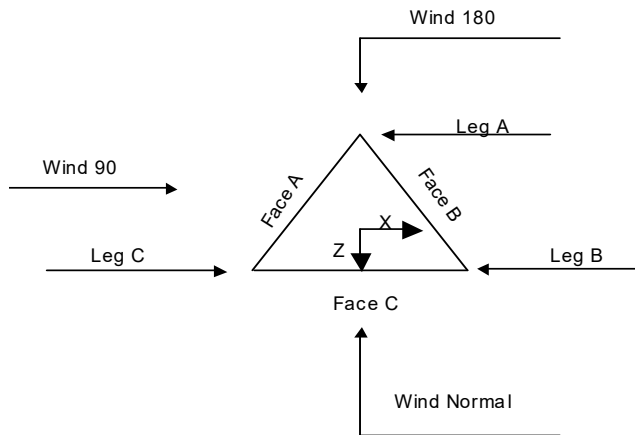
UPLIFT: -60847 lb
SHEAR: 7446 lb



Ken Craig, P.E.
417 NW 41st St.
Okla. City, OK
Phone: 405-615-8748
FAX: 405-364-2078

Job: Structural Analysis - SSL Helical Anchor Tower 100			
Project: TIA 222-G Standard (120 mph basic; 3/4" ice)			
Client: Stock Analysis for Exposure C, Topo 1, 2400 thrust	Drawn by: Ken Craig	App'd:	
Code: TIA-222-G	Date: 10/22/17	Scale: NTS	
Path: E:\BWCFiles\Towers\NREL-Helical Anchors\Helical-SSL-100-222G-120.ari	Dwg No. E-1		

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 2 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig



Triangular Tower

Tower Section Geometry

Tower Section	Tower Elevation	Assembly Database	Description	Section Width	Number of Sections	Section Length
	<i>ft</i>			<i>ft</i>		<i>ft</i>
T1	94.70-75.76	rohn	Helical-SSL-T1	1.00	1	18.94
T2	75.76-56.82	rohn	Helical-SSL-T2	3.60	1	18.94
T3	56.82-37.88	rohn	Helical-SSL-T3	6.20	1	18.94
T4	37.88-18.94	rohn	Helical-SSL-T4	8.80	1	18.94
T5	18.94-0.00	rohn	Helical-SSL-T5	11.40	1	18.94

Tower Section Geometry (cont'd)

Tower Section	Tower Elevation	Diagonal Spacing	Bracing Type	Has K Brace End Panels	Has Horizontals	Top Girt Offset	Bottom Girt Offset
	<i>ft</i>	<i>ft</i>				<i>in</i>	<i>in</i>
T1	94.70-75.76	2.66	X Brace	No	No	2.00	2.00
T2	75.76-56.82	3.72	X Brace	No	No	2.00	2.00
T3	56.82-37.88	4.65	X Brace	No	No	2.00	2.00
T4	37.88-18.94	6.20	X Brace	No	No	2.00	2.00
T5	18.94-0.00	6.20	X Brace	No	No	2.00	2.00

Tower Section Geometry (cont'd)

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 3 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Tower Elevation ft	Leg Type	Leg Size	Leg Grade	Diagonal Type	Diagonal Size	Diagonal Grade
T1 94.70-75.76	Pipe	P2.5x.401	A572-50 (50000 psi)	Single Angle	L1 1/2x1 1/2x3/16	A36 (36000 psi)
T2 75.76-56.82	Pipe	P2.5x.203	A572-50 (50000 psi)	Single Angle	L1 1/2x1 1/2x1/8	A36 (36000 psi)
T3 56.82-37.88	Pipe	P2.5x.203	A572-50 (50000 psi)	Single Angle	L1 1/2x1 1/2x1/8	A36 (36000 psi)
T4 37.88-18.94	Pipe	P3x.216	A572-50 (50000 psi)	Single Angle	L1 3/4x1 3/4x1/4	A36 (36000 psi)
T5 18.94-0.00	Pipe	P3x.216	A572-50 (50000 psi)	Single Angle	L1 3/4x1 3/4x1/4	A36 (36000 psi)

Tower Section Geometry (cont'd)

Tower Elevation ft	Top Girt Type	Top Girt Size	Top Girt Grade	Bottom Girt Type	Bottom Girt Size	Bottom Girt Grade
T1 94.70-75.76	Flat Bar	3x3/4	A36 (36000 psi)	Flat Bar		A36 (36000 psi)

Tower Section Geometry (cont'd)

Tower Elevation ft	Gusset Area (per face) ft ²	Gusset Thickness in	Gusset Grade	Adjust. Factor A _f	Adjust. Factor A _r	Weight Mult.	Double Angle Stitch Bolt Spacing Diagonals in	Double Angle Stitch Bolt Spacing Horizontals in
T1 94.70-75.76	1.88	0.19	A36 (36000 psi)	1.05	1	1.27	Mid-Pt	Mid-Pt
T2 75.76-56.82	0.94	0.19	A36 (36000 psi)	1.05	1	1.25	Mid-Pt	Mid-Pt
T3 56.82-37.88	0.94	0.19	A36 (36000 psi)	1.05	1	1.25	Mid-Pt	Mid-Pt
T4 37.88-18.94	0.71	0.19	A36 (36000 psi)	1.05	1	1.25	Mid-Pt	Mid-Pt
T5 18.94-0.00	0.63	0.19	A36 (36000 psi)	1.05	1	1.19	Mid-Pt	Mid-Pt

Tower Section Geometry (cont'd)

Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	Legs	K Factors ¹						
				X Brace Diags	K Brace Diags	Single Diags	Girts	Horiz.	Sec. Horiz.	Inner Brace
				X Y	X Y	X Y	X Y	X Y	X Y	X Y
T1 94.70-75.76	No	No	1	1 1	1 1	1 1	1 1	1 1	1 1	1 1

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	4 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Tower Elevation ft	Calc K Single Angles	Calc K Solid Rounds	Legs	K Factors ¹								
				X Diags	K Brace Diags	Single Diags	Girts	Horiz.	Sec. Horiz.	Inner Brace		
											X Y	X Y
T2 75.76-56.82	No	No	1	1	1	1	1	1	1	1	1	1
T3 56.82-37.88	No	No	1	1	1	1	1	1	1	1	1	1
T4 37.88-18.94	No	No	1	1	1	1	1	1	1	1	1	1
T5 18.94-0.00	No	No	1	1	1	1	1	1	1	1	1	1

¹Note: K factors are applied to member segment lengths. K-braces without inner supporting members will have the K factor in the out-of-plane direction applied to the overall length.

Tower Section Geometry (cont'd)

Tower Elevation ft	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U	Net Width Deduct in	U
T1 94.70-75.76	0.00	1	0.00	0.75	0.00	0.75	0.00	0	0.00	0	0.00	0	0.00	0
T2 75.76-56.82	0.00	1	0.00	0.75	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
T3 56.82-37.88	0.00	1	0.00	0.75	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
T4 37.88-18.94	0.00	1	0.00	0.75	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
T5 18.94-0.00	0.00	1	0.00	0.75	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0

Tower Section Geometry (cont'd)

Tower Elevation ft	Leg Connection Type	Leg		Diagonal		Top Girt		Bottom Girt		Mid Girt		Long Horizontal		Short Horizontal	
		Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.	Bolt Size in	No.
T1 94.70-75.76	Flange	0.63	4	0.50	1	0.63	3	0.00	0	0.00	0	0.00	0	0.00	0
		A325N		A325N		A325N		A325N		A325N		A325N		A325N	
T2 75.76-56.82	Flange	0.63	4	0.50	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
		A325N		A325N		A325N		A325N		A325N		A325N		A325N	
T3 56.82-37.88	Flange	0.75	4	0.50	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
		A325N		A325N		A325N		A325N		A325N		A325N		A325N	
T4 37.88-18.94	Flange	0.88	4	0.50	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
		A325N		A325N		A325N		A325N		A325N		A325N		A325N	
T5 18.94-0.00	Flange	1.00	4	0.50	1	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
		F1554-105		A325N		A325N		A325N		A325N		A325N		A325N	

Feed Line/Linear Appurtenances - Entered As Area

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	5 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Description	Face or Leg	Allow Shield	Component Type	Placement ft	Total Number	C _{AA}	Weight plf
3 x #6 Armored	C	No	CaAa (In Face)	94.70 - 0.00	1	No Ice	0.08
						1/2" Ice	0.17
						1" Ice	0.25

Feed Line/Linear Appurtenances Section Areas

Tower Section	Tower Elevation ft	Face	A _R ft ²	A _F ft ²	C _{AA} In Face ft ²	C _{AA} Out Face ft ²	Weight lb
T1	94.70-75.76	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.572	0.000	12.50
T2	75.76-56.82	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.572	0.000	12.50
T3	56.82-37.88	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.572	0.000	12.50
T4	37.88-18.94	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.572	0.000	12.50
T5	18.94-0.00	A	0.000	0.000	0.000	0.000	0.00
		B	0.000	0.000	0.000	0.000	0.00
		C	0.000	0.000	1.572	0.000	12.50

Feed Line/Linear Appurtenances Section Areas - With Ice

Tower Section	Tower Elevation ft	Face or Leg	Ice Thickness in	A _R ft ²	A _F ft ²	C _{AA} In Face ft ²	C _{AA} Out Face ft ²	Weight lb
T1	94.70-75.76	A	1.649	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	6.820	0.000	69.73
T2	75.76-56.82	A	1.608	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	6.690	0.000	68.31
T3	56.82-37.88	A	1.555	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	6.521	0.000	66.46
T4	37.88-18.94	A	1.478	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	6.274	0.000	63.78
T5	18.94-0.00	A	1.324	0.000	0.000	0.000	0.000	0.00
		B		0.000	0.000	0.000	0.000	0.00
		C		0.000	0.000	5.785	0.000	58.44

Shielding Factor Ka

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K _a No Ice	K _a Ice

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 6 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Tower Section	Feed Line Record No.	Description	Feed Line Segment Elev.	K_a No Ice	K_a Ice
T1	1	3 x #6 Armored	75.76 - 94.70	1.0000	1.0000
T2	1	3 x #6 Armored	56.82 - 75.76	1.0000	1.0000
T3	1	3 x #6 Armored	37.88 - 56.82	1.0000	1.0000
T4	1	3 x #6 Armored	18.94 - 37.88	1.0000	1.0000
T5	1	3 x #6 Armored	0.00 - 18.94	1.0000	1.0000

Force Couples At Top Of Tower **EXCEL Wind Turbine**

Description	Shear	Vertical	Moment	Torque
	lb	lb	lb-ft	lb-ft
No Ice	2400.00	1200.00	4800.00	0.00
With Ice	1500.00	1850.00	3000.00	0.00

Tower Forces - No Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C_F	q_z	D_F	D_R	A_E	F	w	Ctrl. Face
ft	lb	lb	e			psf			ft ²	lb	plf	
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	38.35	1	1	13.513	1004.33	53.03	C
			B	0.353	2.164	1	1	13.513				
			C	0.353	2.164	1	1	13.513				
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	36.37	1	1	13.841	1185.24	62.58	C
			B	0.182	2.656	1	1	13.841				
			C	0.182	2.656	1	1	13.841				
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	33.88	1	1	15.069	1280.99	67.63	C
			B	0.13	2.847	1	1	15.069				
			C	0.13	2.847	1	1	15.069				
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	30.43	1	1	17.412	1351.00	71.33	C
			B	0.114	2.91	1	1	17.412				
			C	0.114	2.91	1	1	17.412				
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	26.63	1	1	19.556	1349.34	71.24	C
			B	0.099	2.967	1	1	19.556				
			C	0.099	2.967	1	1	19.556				
Sum Weight:	179.33	5318.40						OTM	275991.36 lb-ft	6170.89		

Tower Forces - No Ice - Wind 60 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C_F	q_z	D_F	D_R	A_E	F	w	Ctrl. Face
ft	lb	lb	e			psf			ft ²	lb	plf	
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	38.35	0.8	1	11.935	892.98	47.15	C
			B	0.353	2.164	0.8	1	11.935				
			C	0.353	2.164	0.8	1	11.935				

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	7 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	q _z	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb	e			psf			ft ²	lb	plf	
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	36.37	0.8	1	12.114	1043.38	55.09	C
			B	0.182	2.656		0.8	1	12.114			
			C	0.182	2.656		0.8	1	12.114			
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	33.88	0.8	1	13.085	1118.33	59.04	C
			B	0.13	2.847		0.8	1	13.085			
			C	0.13	2.847		0.8	1	13.085			
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	30.43	0.8	1	15.154	1181.03	62.35	C
			B	0.114	2.91		0.8	1	15.154			
			C	0.114	2.91		0.8	1	15.154			
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	26.63	0.8	1	16.892	1170.41	61.79	C
			B	0.099	2.967		0.8	1	16.892			
			C	0.099	2.967		0.8	1	16.892			
Sum Weight:	179.33	5318.40						OTM	242871.58 lb-ft	5406.14		

Tower Forces - No Ice - Wind 90 To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	q _z	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb	e			psf			ft ²	lb	plf	
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	38.35	0.85	1	12.329	920.82	48.62	C
			B	0.353	2.164		0.85	1	12.329			
			C	0.353	2.164		0.85	1	12.329			
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	36.37	0.85	1	12.545	1078.84	56.96	C
			B	0.182	2.656		0.85	1	12.545			
			C	0.182	2.656		0.85	1	12.545			
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	33.88	0.85	1	13.581	1159.00	61.19	C
			B	0.13	2.847		0.85	1	13.581			
			C	0.13	2.847		0.85	1	13.581			
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	30.43	0.85	1	15.718	1223.52	64.60	C
			B	0.114	2.91		0.85	1	15.718			
			C	0.114	2.91		0.85	1	15.718			
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	26.63	0.85	1	17.558	1215.14	64.16	C
			B	0.099	2.967		0.85	1	17.558			
			C	0.099	2.967		0.85	1	17.558			
Sum Weight:	179.33	5318.40						OTM	251151.52 lb-ft	5597.33		

Tower Forces - With Ice - Wind Normal To Face

Section Elevation	Add Weight	Self Weight	F a c e	e	C _F	q _z	D _F	D _R	A _E	F	w	Ctrl. Face
ft	lb	lb	e			psf			ft ²	lb	plf	
T1 94.70-75.76	207.41	2823.66	A	0.761	1.792	6.66	1	1	35.225	395.85	20.90	C
			B	0.761	1.792		1	1	35.225			
			C	0.761	1.792		1	1	35.225			
T2	137.50	2554.93	A	0.431	2.006	6.31	1	1	31.407	373.97	19.74	C

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 8 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
75.76-56.82			B	0.431	2.006		1	1	31.407			
			C	0.431	2.006		1	1	31.407			
T3 56.82-37.88	133.96	2698.29	A	0.311	2.267	5.88	1	1	32.018	395.59	20.89	C
			B	0.311	2.267		1	1	32.018			
			C	0.311	2.267		1	1	32.018			
T4 37.88-18.94	113.65	3313.76	A	0.244	2.456	5.28	1	1	33.154	393.74	20.79	C
			B	0.244	2.456		1	1	33.154			
			C	0.244	2.456		1	1	33.154			
T5 18.94-0.00	99.20	3360.30	A	0.205	2.578	4.62	1	1	35.045	377.81	19.95	C
			B	0.205	2.578		1	1	35.045			
			C	0.205	2.578		1	1	35.045			
Sum Weight:	691.72	14867.78						OTM	92026.70 lb-ft	1936.96		

Tower Forces - With Ice - Wind 60 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T1 94.70-75.76	207.41	2823.66	A	0.761	1.792	6.66	0.8	1	33.646	379.84	20.05	C
			B	0.761	1.792		0.8	1	33.646			
			C	0.761	1.792		0.8	1	33.646			
T2 75.76-56.82	137.50	2554.93	A	0.431	2.006	6.31	0.8	1	29.680	355.38	18.76	C
			B	0.431	2.006		0.8	1	29.680			
			C	0.431	2.006		0.8	1	29.680			
T3 56.82-37.88	133.96	2698.29	A	0.311	2.267	5.88	0.8	1	30.034	373.11	19.70	C
			B	0.311	2.267		0.8	1	30.034			
			C	0.311	2.267		0.8	1	30.034			
T4 37.88-18.94	113.65	3313.76	A	0.244	2.456	5.28	0.8	1	30.896	368.83	19.47	C
			B	0.244	2.456		0.8	1	30.896			
			C	0.244	2.456		0.8	1	30.896			
T5 18.94-0.00	99.20	3360.30	A	0.205	2.578	4.62	0.8	1	32.382	350.82	18.52	C
			B	0.205	2.578		0.8	1	32.382			
			C	0.205	2.578		0.8	1	32.382			
Sum Weight:	691.72	14867.78						OTM	87401.49 lb-ft	1827.98		

Tower Forces - With Ice - Wind 90 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T1 94.70-75.76	207.41	2823.66	A	0.761	1.792	6.66	0.85	1	34.041	383.84	20.27	C
			B	0.761	1.792		0.85	1	34.041			
			C	0.761	1.792		0.85	1	34.041			
T2 75.76-56.82	137.50	2554.93	A	0.431	2.006	6.31	0.85	1	30.112	360.03	19.01	C
			B	0.431	2.006		0.85	1	30.112			

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 9 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T3 56.82-37.88	133.96	2698.29	C	0.431	2.006	5.88	0.85	1	30.112	378.73	20.00	C
			A	0.311	2.267		0.85	1	30.530			
			B	0.311	2.267		0.85	1	30.530			
T4 37.88-18.94	113.65	3313.76	C	0.311	2.267	5.28	0.85	1	30.530	375.06	19.80	C
			A	0.244	2.456		0.85	1	31.460			
			B	0.244	2.456		0.85	1	31.460			
T5 18.94-0.00	99.20	3360.30	C	0.244	2.456	4.62	0.85	1	31.460	357.57	18.88	C
			A	0.205	2.578		0.85	1	33.047			
			B	0.205	2.578		0.85	1	33.047			
Sum Weight:	691.72	14867.78	C	0.205	2.578			1	33.047	1855.22		
								OTM	88557.79 lb-ft			

Tower Forces - Service - Wind Normal To Face

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	9.59	1	1	13.513	251.08	13.26	C
			B	0.353	2.164		1	1	13.513			
			C	0.353	2.164		1	1	13.513			
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	9.09	1	1	13.841	296.31	15.64	C
			B	0.182	2.656		1	1	13.841			
			C	0.182	2.656		1	1	13.841			
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	8.47	1	1	15.069	320.25	16.91	C
			B	0.13	2.847		1	1	15.069			
			C	0.13	2.847		1	1	15.069			
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	7.61	1	1	17.412	337.75	17.83	C
			B	0.114	2.91		1	1	17.412			
			C	0.114	2.91		1	1	17.412			
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	6.66	1	1	19.556	337.33	17.81	C
			B	0.099	2.967		1	1	19.556			
			C	0.099	2.967		1	1	19.556			
Sum Weight:	179.33	5318.40						OTM	68997.84 lb-ft	1542.72		

Tower Forces - Service - Wind 60 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	9.59	0.8	1	11.935	223.25	11.79	C
			B	0.353	2.164		0.8	1	11.935			
			C	0.353	2.164		0.8	1	11.935			
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	9.09	0.8	1	12.114	260.84	13.77	C
			B	0.182	2.656		0.8	1	12.114			
			C	0.182	2.656		0.8	1	12.114			

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	10 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	8.47	0.8	1	13.085	279.58	14.76	C
			B	0.13	2.847		0.8	1	13.085			
			C	0.13	2.847		0.8	1	13.085			
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	7.61	0.8	1	15.154	295.26	15.59	C
			B	0.114	2.91		0.8	1	15.154			
			C	0.114	2.91		0.8	1	15.154			
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	6.66	0.8	1	16.892	292.60	15.45	C
			B	0.099	2.967		0.8	1	16.892			
			C	0.099	2.967		0.8	1	16.892			
Sum Weight:	179.33	5318.40						OTM	60717.89 lb-ft	1351.53		

Tower Forces - Service - Wind 90 To Face

Section Elevation ft	Add Weight lb	Self Weight lb	F a c e	e	C _F	q _z psf	D _F	D _R	A _E ft ²	F lb	w plf	Ctrl. Face
T1 94.70-75.76	55.57	1138.40	A	0.353	2.164	9.59	0.85	1	12.329	230.21	12.15	C
			B	0.353	2.164		0.85	1	12.329			
			C	0.353	2.164		0.85	1	12.329			
T2 75.76-56.82	34.03	696.11	A	0.182	2.656	9.09	0.85	1	12.545	269.71	14.24	C
			B	0.182	2.656		0.85	1	12.545			
			C	0.182	2.656		0.85	1	12.545			
T3 56.82-37.88	34.03	737.28	A	0.13	2.847	8.47	0.85	1	13.581	289.75	15.30	C
			B	0.13	2.847		0.85	1	13.581			
			C	0.13	2.847		0.85	1	13.581			
T4 37.88-18.94	28.84	1278.10	A	0.114	2.91	7.61	0.85	1	15.718	305.88	16.15	C
			B	0.114	2.91		0.85	1	15.718			
			C	0.114	2.91		0.85	1	15.718			
T5 18.94-0.00	26.86	1351.69	A	0.099	2.967	6.66	0.85	1	17.558	303.79	16.04	C
			B	0.099	2.967		0.85	1	17.558			
			C	0.099	2.967		0.85	1	17.558			
Sum Weight:	179.33	5318.40						OTM	62787.88 lb-ft	1399.33		

Force Couple Vectors - No Ice

Wind Azimuth °	F lb	V _x lb	V _z lb	OTM _x lb-ft	OTM _z lb-ft	Torque lb-ft
0	2400.00	0.00	-2400.00	-232086.62	0.00	0.00
30	2400.00	1200.00	-2078.46	-200992.91	-116043.31	0.00
60	2400.00	2078.46	-1200.00	-116043.31	-200992.91	0.00
90	2400.00	2400.00	0.00	0.00	-232086.62	0.00
120	2400.00	2078.46	1200.00	116043.31	-200992.91	0.00
150	2400.00	1200.00	2078.46	200992.91	-116043.31	0.00
180	2400.00	0.00	2400.00	232086.62	0.00	0.00
210	2400.00	-1200.00	2078.46	200992.91	116043.31	0.00

tnxTower Ken Craig, P.E. 417 NW 41st St. Oklahoma City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	11 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Wind Azimuth °	F lb	V _x lb	V _z lb	OTM _x lb-ft	OTM _z lb-ft	Torque lb-ft
240	2400.00	-2078.46	1200.00	116043.31	200992.91	0.00
270	2400.00	-2400.00	0.00	0.00	232086.62	0.00
300	2400.00	-2078.46	-1200.00	-116043.31	200992.91	0.00
330	2400.00	-1200.00	-2078.46	-200992.91	116043.31	0.00

Force Couple Vectors - With Ice

Wind Azimuth °	F lb	V _x lb	V _z lb	OTM _x lb-ft	OTM _z lb-ft	Torque lb-ft
0	1500.00	0.00	-1500.00	-145054.14	0.00	0.00
30	1500.00	750.00	-1299.04	-125620.57	-72527.07	0.00
60	1500.00	1299.04	-750.00	-72527.07	-125620.57	0.00
90	1500.00	1500.00	0.00	0.00	-145054.14	0.00
120	1500.00	1299.04	750.00	72527.07	-125620.57	0.00
150	1500.00	750.00	1299.04	125620.57	-72527.07	0.00
180	1500.00	0.00	1500.00	145054.14	0.00	0.00
210	1500.00	-750.00	1299.04	125620.57	72527.07	0.00
240	1500.00	-1299.04	750.00	72527.07	125620.57	0.00
270	1500.00	-1500.00	0.00	0.00	145054.14	0.00
300	1500.00	-1299.04	-750.00	-72527.07	125620.57	0.00
330	1500.00	-750.00	-1299.04	-125620.57	72527.07	0.00

Force Couple Vectors - Service

Wind Azimuth °	F lb	V _x lb	V _z lb	OTM _x lb-ft	OTM _z lb-ft	Torque lb-ft
0	2400.00	0.00	-2400.00	-232086.62	0.00	0.00
30	2400.00	1200.00	-2078.46	-200992.91	-116043.31	0.00
60	2400.00	2078.46	-1200.00	-116043.31	-200992.91	0.00
90	2400.00	2400.00	0.00	0.00	-232086.62	0.00
120	2400.00	2078.46	1200.00	116043.31	-200992.91	0.00
150	2400.00	1200.00	2078.46	200992.91	-116043.31	0.00
180	2400.00	0.00	2400.00	232086.62	0.00	0.00
210	2400.00	-1200.00	2078.46	200992.91	116043.31	0.00
240	2400.00	-2078.46	1200.00	116043.31	200992.91	0.00
270	2400.00	-2400.00	0.00	0.00	232086.62	0.00
300	2400.00	-2078.46	-1200.00	-116043.31	200992.91	0.00
330	2400.00	-1200.00	-2078.46	-200992.91	116043.31	0.00

Force Totals

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M _x lb-ft	Sum of Overturning Moments, M _z lb-ft	Sum of Torques lb-ft
Leg Weight	2648.66					

<p>tnxTower</p> <p>Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078</p>	<p>Job</p> <p>Structural Analysis - SSL Helical Anchor Tower 100</p>	<p>Page</p> <p>12 of 22</p>
	<p>Project</p> <p>TIA 222-G Standard (120 mph basic; 3/4" ice)</p>	<p>Date</p> <p>15:38:42 10/22/17</p>
	<p>Client</p> <p>Stock Analysis for Exposure C, Topo 1, 2400 thrust</p>	<p>Designed by</p> <p>Ken Craig</p>

Load Case	Vertical Forces lb	Sum of Forces X lb	Sum of Forces Z lb	Sum of Overturning Moments, M _x lb-ft	Sum of Overturning Moments, M _z lb-ft	Sum of Torques lb-ft
Bracing Weight	2552.92					
Total Member Self-Weight	5201.57			0.00	0.00	
Gusset Weight	116.82					
Total Weight	6580.90			0.00	0.00	
Wind 0 deg - No Ice		0.00	-8570.89	-508077.99	0.00	0.00
Wind 30 deg - No Ice		3998.66	-6925.89	-418496.51	-241619.07	0.00
Wind 60 deg - No Ice		6760.31	-3903.07	-237479.10	-411325.87	0.00
Wind 90 deg - No Ice		7997.33	0.00	0.00	-483238.15	0.00
Wind 120 deg - No Ice		7422.61	4285.45	254038.99	-440008.45	0.00
Wind 150 deg - No Ice		3998.66	6925.89	418496.51	-241619.07	0.00
Wind 180 deg - No Ice		0.00	7806.14	474958.20	0.00	0.00
Wind 210 deg - No Ice		-3998.66	6925.89	418496.51	241619.07	0.00
Wind 240 deg - No Ice		-7422.61	4285.45	254038.99	440008.45	0.00
Wind 270 deg - No Ice		-7997.33	0.00	0.00	483238.15	0.00
Wind 300 deg - No Ice		-6760.31	-3903.07	-237479.10	411325.87	0.00
Wind 330 deg - No Ice		-3998.66	-6925.89	-418496.51	241619.07	0.00
Member Ice	9549.38					
Gusset Ice	248.17					
Total Weight Ice	17292.67			0.00	0.00	
Wind 0 deg - Ice		0.00	-3436.96	-237080.84	0.00	0.00
Wind 30 deg - Ice		1677.61	-2905.71	-202313.87	-116805.96	0.00
Wind 60 deg - Ice		2882.11	-1663.99	-116227.81	-201312.48	0.00
Wind 90 deg - Ice		3355.22	0.00	0.00	-233611.93	0.00
Wind 120 deg - Ice		2976.49	1718.48	118540.42	-205318.03	0.00
Wind 150 deg - Ice		1677.61	2905.71	202313.87	-116805.96	0.00
Wind 180 deg - Ice		0.00	3327.98	232455.63	0.00	0.00
Wind 210 deg - Ice		-1677.61	2905.71	202313.87	116805.96	0.00
Wind 240 deg - Ice		-2976.49	1718.48	118540.42	205318.03	0.00
Wind 270 deg - Ice		-3355.22	0.00	0.00	233611.93	0.00
Wind 300 deg - Ice		-2882.11	-1663.99	-116227.81	201312.48	0.00
Wind 330 deg - Ice		-1677.61	-2905.71	-202313.87	116805.96	0.00
Total Weight	6580.90			0.00	0.00	
Wind 0 deg - Service		0.00	-3942.72	-301084.47	0.00	0.00
Wind 30 deg - Service		1899.67	-3290.32	-255368.81	-147437.25	0.00
Wind 60 deg - Service		3248.92	-1875.77	-146402.26	-253576.15	0.00
Wind 90 deg - Service		3799.33	0.00	0.00	-294874.50	0.00
Wind 120 deg - Service		3414.50	1971.36	150542.23	-260746.80	0.00
Wind 150 deg - Service		1899.67	3290.32	255368.81	-147437.25	0.00
Wind 180 deg - Service		0.00	3751.53	292804.52	0.00	0.00
Wind 210 deg - Service		-1899.67	3290.32	255368.81	147437.25	0.00
Wind 240 deg - Service		-3414.50	1971.36	150542.23	260746.80	0.00
Wind 270 deg - Service		-3799.33	0.00	0.00	294874.50	0.00
Wind 300 deg - Service		-3248.92	-1875.77	-146402.26	253576.15	0.00
Wind 330 deg - Service		-1899.67	-3290.32	-255368.81	147437.25	0.00

Load Combinations

Comb. No.	Description
1	Dead Only
2	1.2 Dead+1.6 Wind 0 deg - No Ice
3	0.9 Dead+1.6 Wind 0 deg - No Ice
4	1.2 Dead+1.6 Wind 30 deg - No Ice
5	0.9 Dead+1.6 Wind 30 deg - No Ice
6	1.2 Dead+1.6 Wind 60 deg - No Ice
7	0.9 Dead+1.6 Wind 60 deg - No Ice

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 13 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Comb. No.	Description
8	1.2 Dead+1.6 Wind 90 deg - No Ice
9	0.9 Dead+1.6 Wind 90 deg - No Ice
10	1.2 Dead+1.6 Wind 120 deg - No Ice
11	0.9 Dead+1.6 Wind 120 deg - No Ice
12	1.2 Dead+1.6 Wind 150 deg - No Ice
13	0.9 Dead+1.6 Wind 150 deg - No Ice
14	1.2 Dead+1.6 Wind 180 deg - No Ice
15	0.9 Dead+1.6 Wind 180 deg - No Ice
16	1.2 Dead+1.6 Wind 210 deg - No Ice
17	0.9 Dead+1.6 Wind 210 deg - No Ice
18	1.2 Dead+1.6 Wind 240 deg - No Ice
19	0.9 Dead+1.6 Wind 240 deg - No Ice
20	1.2 Dead+1.6 Wind 270 deg - No Ice
21	0.9 Dead+1.6 Wind 270 deg - No Ice
22	1.2 Dead+1.6 Wind 300 deg - No Ice
23	0.9 Dead+1.6 Wind 300 deg - No Ice
24	1.2 Dead+1.6 Wind 330 deg - No Ice
25	0.9 Dead+1.6 Wind 330 deg - No Ice
26	1.2 Dead+1.0 Ice+1.0 Temp
27	1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp
28	1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp
29	1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp
30	1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp
31	1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp
32	1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp
33	1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp
34	1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp
35	1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp
36	1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp
37	1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp
38	1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp
39	Dead+Wind 0 deg - Service
40	Dead+Wind 30 deg - Service
41	Dead+Wind 60 deg - Service
42	Dead+Wind 90 deg - Service
43	Dead+Wind 120 deg - Service
44	Dead+Wind 150 deg - Service
45	Dead+Wind 180 deg - Service
46	Dead+Wind 210 deg - Service
47	Dead+Wind 240 deg - Service
48	Dead+Wind 270 deg - Service
49	Dead+Wind 300 deg - Service
50	Dead+Wind 330 deg - Service

Maximum Member Forces

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
T1	94.7028 - 75.7622	Leg	Max Tension	23	29684.15	65.55	-0.00
			Max. Compression	2	-31904.07	54.22	0.00
			Max. Mx	10	-28934.72	160.65	-0.00
			Max. My	4	-458.34	-6.35	-215.58
			Max. Vy	2	-789.65	54.22	0.00
			Max. Vx	4	1290.53	-6.35	-215.58
		Diagonal	Max Tension	21	2041.40	9.18	3.60
			Max. Compression	8	-2124.95	0.00	0.00
			Max. Mx	13	-772.34	-16.54	0.85

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	14 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Section No.	Elevation ft	Component Type	Condition	Gov. Load Comb.	Axial lb	Major Axis Moment lb-ft	Minor Axis Moment lb-ft
T2	75.7622 - 56.8217	Top Girt	Max. My	24	-2120.74	-8.98	-4.31
			Max. Vy	16	12.85	0.00	0.00
			Max. Vx	24	3.54	0.00	0.00
			Max Tension	19	755.62	0.00	0.00
			Max. Compression	22	-873.38	0.00	0.00
			Max. Mx	26	-21.04	2.77	0.00
			Max. My	26	-21.04	0.00	-0.11
		Leg	Max. Vy	26	-10.85	0.00	0.00
			Max. Vx	26	-0.43	0.00	0.00
			Max Tension	23	38459.54	114.22	-0.00
			Max. Compression	2	-42017.78	66.52	0.00
			Max. Mx	2	-31905.72	186.30	0.00
			Max. My	20	-981.00	-3.34	-138.28
			Max. Vy	2	-1261.92	66.52	0.00
T3	56.8217 - 37.8811	Diagonal	Max. Vx	4	443.28	-1.09	-89.01
			Max Tension	4	949.91	0.00	0.00
			Max. Compression	12	-983.43	0.00	0.00
			Max. Mx	29	140.77	13.86	-2.17
			Max. My	37	-198.04	10.30	2.47
			Max. Vy	37	17.94	13.80	2.12
			Max. Vx	28	1.35	0.00	0.00
		Leg	Max Tension	23	46200.76	74.66	-0.00
			Max. Compression	2	-51252.13	200.90	0.00
			Max. Mx	2	-42019.47	277.45	0.00
			Max. My	4	-1242.24	1.18	-163.32
			Max. Vy	2	-1789.60	200.90	0.00
			Max. Vx	5	576.07	4.08	-123.65
			Max Tension	12	1216.65	0.00	0.00
T4	37.8811 - 18.9406	Diagonal	Max. Compression	16	-1262.00	0.00	0.00
			Max. Mx	29	62.37	24.67	-3.99
			Max. My	27	-151.82	23.67	-4.08
			Max. Vy	37	23.87	22.64	3.73
			Max. Vx	27	1.70	0.00	0.00
			Max Tension	23	53709.17	211.13	0.00
			Max. Compression	2	-60714.05	103.17	0.00
		Leg	Max. Mx	2	-51254.37	499.74	0.00
			Max. My	25	-1167.35	7.83	220.18
			Max. Vy	2	-2371.33	103.17	0.00
			Max. Vx	25	-761.29	-9.22	195.70
			Max Tension	16	1617.14	0.00	0.00
			Max. Compression	12	-1676.58	0.00	0.00
			Max. Mx	37	-179.73	65.32	10.18
T5	18.9406 - 0	Diagonal	Max. My	28	-656.59	62.08	-10.59
			Max. Vy	37	42.06	65.32	10.18
			Max. Vx	28	3.10	0.00	0.00
			Max Tension	23	61250.78	418.01	0.00
			Max. Compression	2	-70338.28	0.00	0.00
			Max. Mx	27	-23060.54	575.84	0.00
			Max. My	4	-2092.84	-3.20	-323.42
		Leg	Max. Vy	2	-3241.55	0.00	0.00
			Max. Vx	25	-763.72	-2.89	323.17
			Max Tension	12	1957.03	0.00	0.00
			Max. Compression	2	-2071.38	0.00	0.00
			Max. Mx	29	-471.88	78.31	-13.83
			Max. My	28	-806.17	67.75	-14.41
			Max. Vy	29	43.80	78.31	-13.83
Diagonal	Max. Vx	28	3.46	0.00	0.00		

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job	Structural Analysis - SSL Helical Anchor Tower 100	Page	15 of 22
	Project	TIA 222-G Standard (120 mph basic; 3/4" ice)	Date	15:38:42 10/22/17
	Client	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by	Ken Craig

Maximum Reactions

Location	Condition	Gov. Load Comb.	Vertical lb	Horizontal, X lb	Horizontal, Z lb
Leg C	Max. Vert	18	69882.54	7470.52	-4313.11
	Max. H _x	18	69882.54	7470.52	-4313.11
	Max. H _z	7	-60846.73	-6448.81	3723.22
	Min. Vert	7	-60846.73	-6448.81	3723.22
	Min. H _x	7	-60846.73	-6448.81	3723.22
	Min. H _z	18	69882.54	7470.52	-4313.11
Leg B	Max. Vert	10	69882.54	-7470.52	-4313.11
	Max. H _x	23	-60846.73	6448.81	3723.22
	Max. H _z	23	-60846.73	6448.81	3723.22
	Min. Vert	23	-60846.73	6448.81	3723.22
	Min. H _x	10	69882.54	-7470.52	-4313.11
	Min. H _z	10	69882.54	-7470.52	-4313.11
Leg A	Max. Vert	2	69882.54	0.00	8626.21
	Max. H _x	21	1974.06	705.94	187.63
	Max. H _z	2	69882.54	0.00	8626.21
	Min. Vert	15	-60846.73	0.00	-7446.44
	Min. H _x	9	1974.06	-705.94	187.63
	Min. H _z	15	-60846.73	0.00	-7446.44

Tower Mast Reaction Summary

Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
Dead Only	6580.90	0.00	0.00	0.00	0.00	0.00
1.2 Dead+1.6 Wind 0 deg - No Ice	7897.08	0.00	-13712.93	-815364.83	0.00	0.00
0.9 Dead+1.6 Wind 0 deg - No Ice	5922.81	-0.00	-13713.07	-814747.32	0.00	-0.00
1.2 Dead+1.6 Wind 30 deg - No Ice	7897.08	6397.51	-11080.97	-671630.58	-387763.55	2.09
0.9 Dead+1.6 Wind 30 deg - No Ice	5922.81	6397.59	-11081.09	-671115.66	-387465.89	2.68
1.2 Dead+1.6 Wind 60 deg - No Ice	7897.08	10815.96	-6244.60	-381125.78	-660129.22	-0.00
0.9 Dead+1.6 Wind 60 deg - No Ice	5922.81	10816.08	-6244.67	-380831.92	-659620.24	-0.00
1.2 Dead+1.6 Wind 90 deg - No Ice	7897.08	12795.16	0.07	2.21	-775530.92	-2.09
0.9 Dead+1.6 Wind 90 deg - No Ice	5922.81	12795.30	0.07	2.52	-774936.15	-2.68
1.2 Dead+1.6 Wind 120 deg - No Ice	7897.08	11875.74	6856.46	407682.41	-706126.66	-0.00
0.9 Dead+1.6 Wind 120 deg - No Ice	5922.81	11875.86	6856.53	407373.66	-705591.87	-0.00
1.2 Dead+1.6 Wind 150 deg - No Ice	7897.08	6397.64	11080.89	671628.37	-387767.37	2.09
0.9 Dead+1.6 Wind 150 deg - No Ice	5922.81	6397.71	11081.02	671113.14	-387470.26	2.68
1.2 Dead+1.6 Wind 180 deg - No Ice	7897.08	0.00	12489.19	762251.57	0.00	-0.00

<p style="text-align: center;">tnxTower</p> <p style="text-align: center;">Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078</p>	Job	Page
	Project	Date
	Client	Designed by
	Structural Analysis - SSL Helical Anchor Tower 100	16 of 22
	TIA 222-G Standard (120 mph basic; 3/4" ice)	15:38:42 10/22/17
	Stock Analysis for Exposure C, Topo 1, 2400 thrust	Ken Craig

Load Combination	Vertical lb	Shear _x lb	Shear _z lb	Overturning Moment, M _x lb-ft	Overturning Moment, M _z lb-ft	Torque lb-ft
0.9 Dead+1.6 Wind 180 deg - No Ice	5922.81	0.00	12489.34	761663.85	0.00	0.00
1.2 Dead+1.6 Wind 210 deg - No Ice	7897.08	-6397.64	11080.89	671628.37	387767.37	-2.09
0.9 Dead+1.6 Wind 210 deg - No Ice	5922.81	-6397.71	11081.02	671113.14	387470.26	-2.68
1.2 Dead+1.6 Wind 240 deg - No Ice	7897.08	-11875.74	6856.46	407682.41	706126.66	0.00
0.9 Dead+1.6 Wind 240 deg - No Ice	5922.81	-11875.86	6856.53	407373.66	705591.87	0.00
1.2 Dead+1.6 Wind 270 deg - No Ice	7897.08	-12795.16	0.07	2.21	775530.92	2.09
0.9 Dead+1.6 Wind 270 deg - No Ice	5922.81	-12795.30	0.07	2.52	774936.15	2.68
1.2 Dead+1.6 Wind 300 deg - No Ice	7897.08	-10815.96	-6244.60	-381125.78	660129.22	0.00
0.9 Dead+1.6 Wind 300 deg - No Ice	5922.81	-10816.08	-6244.67	-380831.92	659620.24	0.00
1.2 Dead+1.6 Wind 330 deg - No Ice	7897.08	-6397.51	-11080.97	-671630.58	387763.55	-2.09
0.9 Dead+1.6 Wind 330 deg - No Ice	5922.81	-6397.59	-11081.09	-671115.66	387465.89	-2.68
1.2 Dead+1.0 Ice+1.0 Temp	18608.84	0.00	-0.00	0.00	0.00	0.00
1.2 Dead+1.0 Wind 0 deg+1.0 Ice+1.0 Temp	18608.85	0.00	-3436.85	-238596.79	0.00	-0.00
1.2 Dead+1.0 Wind 30 deg+1.0 Ice+1.0 Temp	18608.85	1677.55	-2905.61	-203613.86	-117556.74	0.10
1.2 Dead+1.0 Wind 60 deg+1.0 Ice+1.0 Temp	18608.85	2882.01	-1663.93	-116976.03	-202608.43	-0.00
1.2 Dead+1.0 Wind 90 deg+1.0 Ice+1.0 Temp	18608.85	3355.11	0.00	-0.20	-235113.15	-0.10
1.2 Dead+1.0 Wind 120 deg+1.0 Ice+1.0 Temp	18608.85	2976.40	1718.42	119298.39	-206630.88	-0.00
1.2 Dead+1.0 Wind 150 deg+1.0 Ice+1.0 Temp	18608.85	1677.56	2905.61	203614.06	-117556.41	0.10
1.2 Dead+1.0 Wind 180 deg+1.0 Ice+1.0 Temp	18608.85	0.00	3327.86	233952.06	-0.00	0.00
1.2 Dead+1.0 Wind 210 deg+1.0 Ice+1.0 Temp	18608.85	-1677.56	2905.61	203614.06	117556.41	-0.10
1.2 Dead+1.0 Wind 240 deg+1.0 Ice+1.0 Temp	18608.85	-2976.40	1718.42	119298.39	206630.88	0.00
1.2 Dead+1.0 Wind 270 deg+1.0 Ice+1.0 Temp	18608.85	-3355.11	0.00	-0.20	235113.15	0.10
1.2 Dead+1.0 Wind 300 deg+1.0 Ice+1.0 Temp	18608.85	-2882.01	-1663.93	-116976.03	202608.43	0.00
1.2 Dead+1.0 Wind 330 deg+1.0 Ice+1.0 Temp	18608.85	-1677.55	-2905.61	-203613.86	117556.74	-0.10
Dead+Wind 0 deg - Service	6580.90	0.00	-3942.52	-301965.07	0.00	-0.00
Dead+Wind 30 deg - Service	6580.90	1899.55	-3290.14	-256120.37	-147870.53	0.32
Dead+Wind 60 deg - Service	6580.90	3248.73	-1875.65	-146834.38	-254324.61	-0.00
Dead+Wind 90 deg - Service	6580.90	3799.12	0.01	0.55	-295742.01	-0.32
Dead+Wind 120 deg - Service	6580.90	3414.32	1971.26	150982.53	-261509.42	-0.00
Dead+Wind 150 deg - Service	6580.90	1899.57	3290.12	256119.82	-147871.48	0.32
Dead+Wind 180 deg - Service	6580.90	0.00	3751.31	293668.76	-0.00	0.00
Dead+Wind 210 deg - Service	6580.90	-1899.57	3290.12	256119.82	147871.48	-0.32
Dead+Wind 240 deg - Service	6580.90	-3414.32	1971.26	150982.53	261509.42	0.00
Dead+Wind 270 deg - Service	6580.90	-3799.12	0.01	0.55	295742.01	0.32
Dead+Wind 300 deg - Service	6580.90	-3248.73	-1875.65	-146834.38	254324.61	0.00
Dead+Wind 330 deg - Service	6580.90	-1899.55	-3290.14	-256120.37	147870.53	-0.32

Solution Summary

Load Comb.	Sum of Applied Forces			Sum of Reactions			% Error
	PX lb	PY lb	PZ lb	PX lb	PY lb	PZ lb	
1	0.00	-6580.90	0.00	0.00	6580.90	-0.00	0.000%
2	0.00	-7897.08	-13713.43	-0.00	7897.08	13712.93	0.003%
3	0.00	-5922.81	-13713.43	0.00	5922.81	13713.07	0.002%
4	6397.86	-7897.08	-11081.42	-6397.51	7897.08	11080.97	0.004%
5	6397.86	-5922.81	-11081.42	-6397.59	5922.81	11081.09	0.003%
6	10816.50	-7897.08	-6244.91	-10815.96	7897.08	6244.60	0.004%
7	10816.50	-5922.81	-6244.91	-10816.08	5922.81	6244.67	0.003%
8	12795.72	-7897.08	-0.00	-12795.16	7897.08	-0.07	0.004%
9	12795.72	-5922.81	-0.00	-12795.30	5922.81	-0.07	0.003%
10	11876.18	-7897.08	6856.71	-11875.74	7897.08	-6856.46	0.003%
11	11876.18	-5922.81	6856.71	-11875.86	5922.81	-6856.53	0.002%
12	6397.86	-7897.08	11081.42	-6397.64	7897.08	-11080.89	0.004%
13	6397.86	-5922.81	11081.42	-6397.71	5922.81	-11081.02	0.003%
14	0.00	-7897.08	12489.82	0.00	7897.08	-12489.19	0.004%
15	0.00	-5922.81	12489.82	-0.00	5922.81	-12489.34	0.003%
16	-6397.86	-7897.08	11081.42	6397.64	7897.08	-11080.89	0.004%
17	-6397.86	-5922.81	11081.42	6397.71	5922.81	-11081.02	0.003%
18	-11876.18	-7897.08	6856.71	11875.74	7897.08	-6856.46	0.003%
19	-11876.18	-5922.81	6856.71	11875.86	5922.81	-6856.53	0.002%
20	-12795.72	-7897.08	-0.00	12795.16	7897.08	-0.07	0.004%
21	-12795.72	-5922.81	-0.00	12795.30	5922.81	-0.07	0.003%
22	-10816.50	-7897.08	-6244.91	10815.96	7897.08	6244.60	0.004%
23	-10816.50	-5922.81	-6244.91	10816.08	5922.81	6244.67	0.003%
24	-6397.86	-7897.08	-11081.42	6397.51	7897.08	11080.97	0.004%
25	-6397.86	-5922.81	-11081.42	6397.59	5922.81	11081.09	0.003%
26	0.00	-18608.85	0.00	-0.00	18608.84	0.00	0.000%
27	0.00	-18608.85	-3436.96	-0.00	18608.85	3436.85	0.001%
28	1677.61	-18608.85	-2905.71	-1677.55	18608.85	2905.61	0.001%
29	2882.11	-18608.85	-1663.99	-2882.01	18608.85	1663.93	0.001%
30	3355.22	-18608.85	-0.00	-3355.11	18608.85	-0.00	0.001%
31	2976.49	-18608.85	1718.48	-2976.40	18608.85	-1718.42	0.001%
32	1677.61	-18608.85	2905.71	-1677.56	18608.85	-2905.61	0.001%
33	0.00	-18608.85	3327.98	0.00	18608.85	-3327.86	0.001%
34	-1677.61	-18608.85	2905.71	1677.56	18608.85	-2905.61	0.001%
35	-2976.49	-18608.85	1718.48	2976.40	18608.85	-1718.42	0.001%
36	-3355.22	-18608.85	-0.00	3355.11	18608.85	-0.00	0.001%
37	-2882.11	-18608.85	-1663.99	2882.01	18608.85	1663.93	0.001%
38	-1677.61	-18608.85	-2905.71	1677.55	18608.85	2905.61	0.001%
39	0.00	-6580.90	-3942.72	0.00	6580.90	3942.52	0.003%
40	1899.67	-6580.90	-3290.32	-1899.55	6580.90	3290.14	0.003%
41	3248.92	-6580.90	-1875.77	-3248.73	6580.90	1875.65	0.003%
42	3799.33	-6580.90	0.00	-3799.12	6580.90	-0.01	0.003%
43	3414.50	-6580.90	1971.36	-3414.32	6580.90	-1971.26	0.003%
44	1899.67	-6580.90	3290.32	-1899.57	6580.90	-3290.12	0.003%
45	0.00	-6580.90	3751.53	0.00	6580.90	-3751.31	0.003%
46	-1899.67	-6580.90	3290.32	1899.57	6580.90	-3290.12	0.003%
47	-3414.50	-6580.90	1971.36	3414.32	6580.90	-1971.26	0.003%
48	-3799.33	-6580.90	0.00	3799.12	6580.90	-0.01	0.003%
49	-3248.92	-6580.90	-1875.77	3248.73	6580.90	1875.65	0.003%
50	-1899.67	-6580.90	-3290.32	1899.55	6580.90	3290.14	0.003%

Non-Linear Convergence Results

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 19 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	94.7028 - 75.7622	4	43	0.49	0.00
T2	75.7622 - 56.8217	2	43	0.37	0.00
T3	56.8217 - 37.8811	1	43	0.23	0.00
T4	37.8811 - 18.9406	0	43	0.12	0.00
T5	18.9406 - 0	0	43	0.06	0.00

Maximum Tower Deflections - Design Wind

Section No.	Elevation ft	Horz. Deflection in	Gov. Load Comb.	Tilt °	Twist °
T1	94.7028 - 75.7622	9	10	1.00	0.00
T2	75.7622 - 56.8217	6	10	0.80	0.00
T3	56.8217 - 37.8811	3	10	0.52	0.00
T4	37.8811 - 18.9406	1	10	0.30	0.00
T5	18.9406 - 0	0	10	0.14	0.00

Bolt Design Data

Section No.	Elevation ft	Component Type	Bolt Grade	Bolt Size in	Number Of Bolts	Maximum Load per Bolt lb	Allowable Load lb	Ratio Load Allowable	Allowable Ratio	Criteria	
T1	94.7028	Leg	A325N	0.63	4	7421.04	20708.70	0.358	✓	1	Bolt Tension
		Diagonal	A325N	0.50	1	2041.40	5572.35	0.366	✓	1	Member Bearing
		Top Girt	A325N	0.63	3	291.13	12425.20	0.023	✓	1	Bolt Shear
T2	75.7622	Leg	A325N	0.63	4	9614.88	20708.70	0.464	✓	1	Bolt Tension
		Diagonal	A325N	0.50	1	949.91	3714.90	0.256	✓	1	Member Bearing
T3	56.8217	Leg	A325N	0.75	4	11550.20	29820.60	0.387	✓	1	Bolt Tension
		Diagonal	A325N	0.50	1	1216.65	3714.90	0.328	✓	1	Member Bearing
T4	37.8811	Leg	A325N	0.88	4	13427.30	40589.10	0.331	✓	1	Bolt Tension
		Diagonal	A325N	0.50	1	1617.14	6198.75	0.261	✓	1	Gusset Bearing
T5	18.9406	Leg	F1554-10 5	1.00	4	15312.70	55223.30	0.277	✓	1	Bolt Tension
		Diagonal	A325N	0.50	1	1957.03	6198.75	0.316	✓	1	Gusset Bearing

Compression Checks

Leg Design Data (Compression)

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 20 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Section No.	Elevation ft	Size	L ft	L _u ft	KL/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	P2.5x.401	19.00	2.67	36.1 K=1.00	3.12	-31904.10	127497.00	0.250 ¹ ✓
T2	75.7622 - 56.8217	P2.5x.203	19.00	3.73	47.3 K=1.00	1.70	-42017.80	65117.90	0.645 ¹ ✓
T3	56.8217 - 37.8811	P2.5x.203	19.00	4.67	59.1 K=1.00	1.70	-51252.10	59397.10	0.863 ¹ ✓
T4	37.8811 - 18.9406	P3x.216	19.00	6.22	64.2 K=1.00	2.23	-60714.10	74212.50	0.818 ¹ ✓
T5	18.9406 - 0	P3x.216	19.00	6.22	64.2 K=1.00	2.23	-70338.30	74212.50	0.948 ¹ ✓

¹ P_u / φP_n controls

Diagonal Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L _u ft	KL/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	L1 1/2x1 1/2x3/16	2.92	1.53	62.6 K=1.00	0.53	-2124.95	13905.10	0.153 ¹ ✓
T2	75.7622 - 56.8217	L1 1/2x1 1/2x1/8	7.00	3.51	142.1 K=1.00	0.36	-983.43	4021.11	0.245 ¹ ✓
T3	56.8217 - 37.8811	L1 1/2x1 1/2x1/8	9.65	4.87	197.4 K=1.00	0.36	-1262.00	2083.11	0.606 ¹ ✓
T4	37.8811 - 18.9406	L1 3/4x1 3/4x1/4	12.59	6.37	224.0 K=1.00	0.81	-1676.58	3659.13	0.458 ¹ ✓
T5	18.9406 - 0	KL/R > 200 (C) - 112 L1 3/4x1 3/4x1/4	14.91	7.53	264.6 K=1.00	0.81	-2071.38	2622.04	0.790 ¹ ✓
		KL/R > 200 (C) - 133							

¹ P_u / φP_n controls

Top Girt Design Data (Compression)

Section No.	Elevation ft	Size	L ft	L _u ft	KL/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	3x3/4	1.02	0.78	43.4 K=1.00	2.25	-873.38	66013.70	0.013 ¹ ✓

¹ P_u / φP_n controls

Tension Checks

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 21 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Leg Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	P2.5x.401	19.00	2.67	36.1	3.12	29684.20	140251.00	0.212 ¹ ✓
T2	75.7622 - 56.8217	P2.5x.203	19.00	3.73	47.3	1.70	38459.50	76682.30	0.502 ¹ ✓
T3	56.8217 - 37.8811	P2.5x.203	19.00	4.67	59.1	1.70	46200.80	76682.30	0.602 ¹ ✓
T4	37.8811 - 18.9406	P3x.216	19.00	6.22	64.2	2.23	53709.20	100281.00	0.536 ¹ ✓
T5	18.9406 - 0	P3x.216	19.00	6.22	64.2	2.23	61250.80	100281.00	0.611 ¹ ✓

¹ P_u / φP_n controls

Diagonal Design Data (Tension)

Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	L1 1/2x1 1/2x3/16	2.92	1.53	40.2	0.31	2041.40	13381.30	0.153 ¹ ✓
T2	75.7622 - 56.8217	L1 1/2x1 1/2x1/8	7.00	3.51	90.5	0.21	949.91	9175.78	0.104 ¹ ✓
T3	56.8217 - 37.8811	L1 1/2x1 1/2x1/8	9.65	4.87	125.7	0.21	1216.65	9175.78	0.133 ¹ ✓
T4	37.8811 - 18.9406	L1 3/4x1 3/4x1/4	12.59	6.37	144.6	0.49	1617.14	21410.20	0.076 ¹ ✓
T5	18.9406 - 0	L1 3/4x1 3/4x1/4	14.91	7.53	170.8	0.49	1957.03	21410.20	0.091 ¹ ✓

¹ P_u / φP_n controls

Top Girt Design Data (Tension)

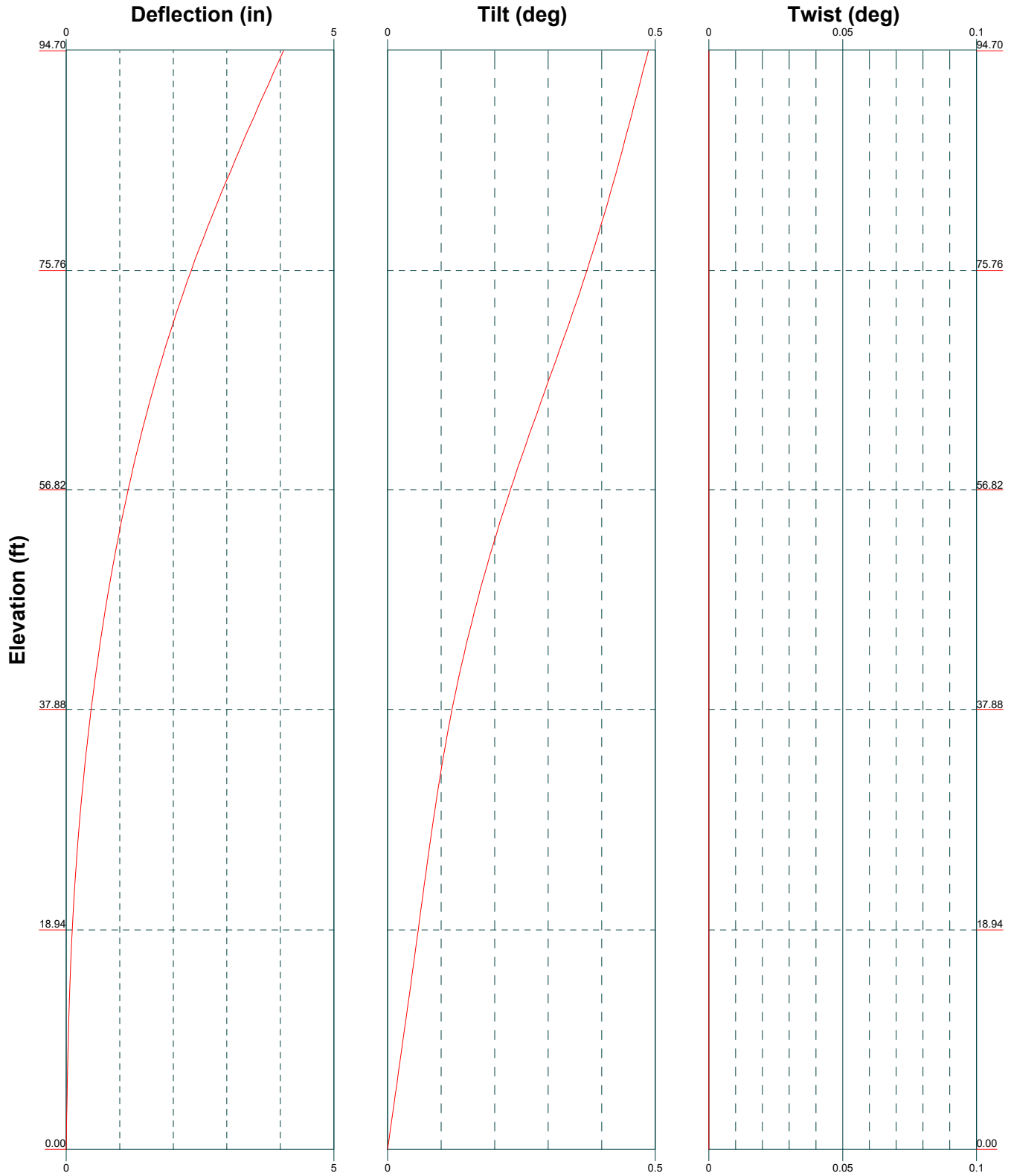
Section No.	Elevation ft	Size	L ft	L _u ft	Kl/r	A in ²	P _u lb	φP _n lb	Ratio $\frac{P_u}{\phi P_n}$
T1	94.7028 - 75.7622	3x3/4	1.02	0.78	43.4	1.27	755.62	55054.70	0.014 ¹ ✓

¹ P_u / φP_n controls

tnxTower Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job Structural Analysis - SSL Helical Anchor Tower 100	Page 22 of 22
	Project TIA 222-G Standard (120 mph basic; 3/4" ice)	Date 15:38:42 10/22/17
	Client Stock Analysis for Exposure C, Topo 1, 2400 thrust	Designed by Ken Craig

Section Capacity Table

Section No.	Elevation ft	Component Type	Size	Critical Element	P lb	ϕP_{allow} lb	% Capacity	Pass Fail
T1	94.7028 - 75.7622	Leg	P2.5x.401	1	-31904.10	127497.00	25.0	Pass
		Diagonal	L1 1/2x1 1/2x3/16	43	-2124.95	13905.10	35.8 (b)	Pass
		Top Girt	3x3/4	4	755.62	55054.70	1.4	Pass
T2	75.7622 - 56.8217	Leg	P2.5x.203	49	-42017.80	65117.90	2.3 (b)	Pass
		Diagonal	L1 1/2x1 1/2x1/8	54	-983.43	4021.11	64.5	Pass
T3	56.8217 - 37.8811	Leg	P2.5x.203	84	-51252.10	59397.10	25.6 (b)	Pass
T4	37.8811 - 18.9406	Diagonal	L1 1/2x1 1/2x1/8	88	-1262.00	2083.11	86.3	Pass
		Leg	P3x.216	109	-60714.10	74212.50	60.6	Pass
T5	18.9406 - 0	Diagonal	L1 3/4x1 3/4x1/4	114	-1676.58	3659.13	81.8	Pass
		Leg	P3x.216	130	-70338.30	74212.50	45.8	Pass
		Diagonal	L1 3/4x1 3/4x1/4	135	-2071.38	2622.04	94.8	Pass
Summary								
Leg (T5)							94.8	Pass
Diagonal (T5)							79.0	Pass
Top Girt (T1)							2.3	Pass
Bolt Checks							46.4	Pass
RATING =							94.8	Pass

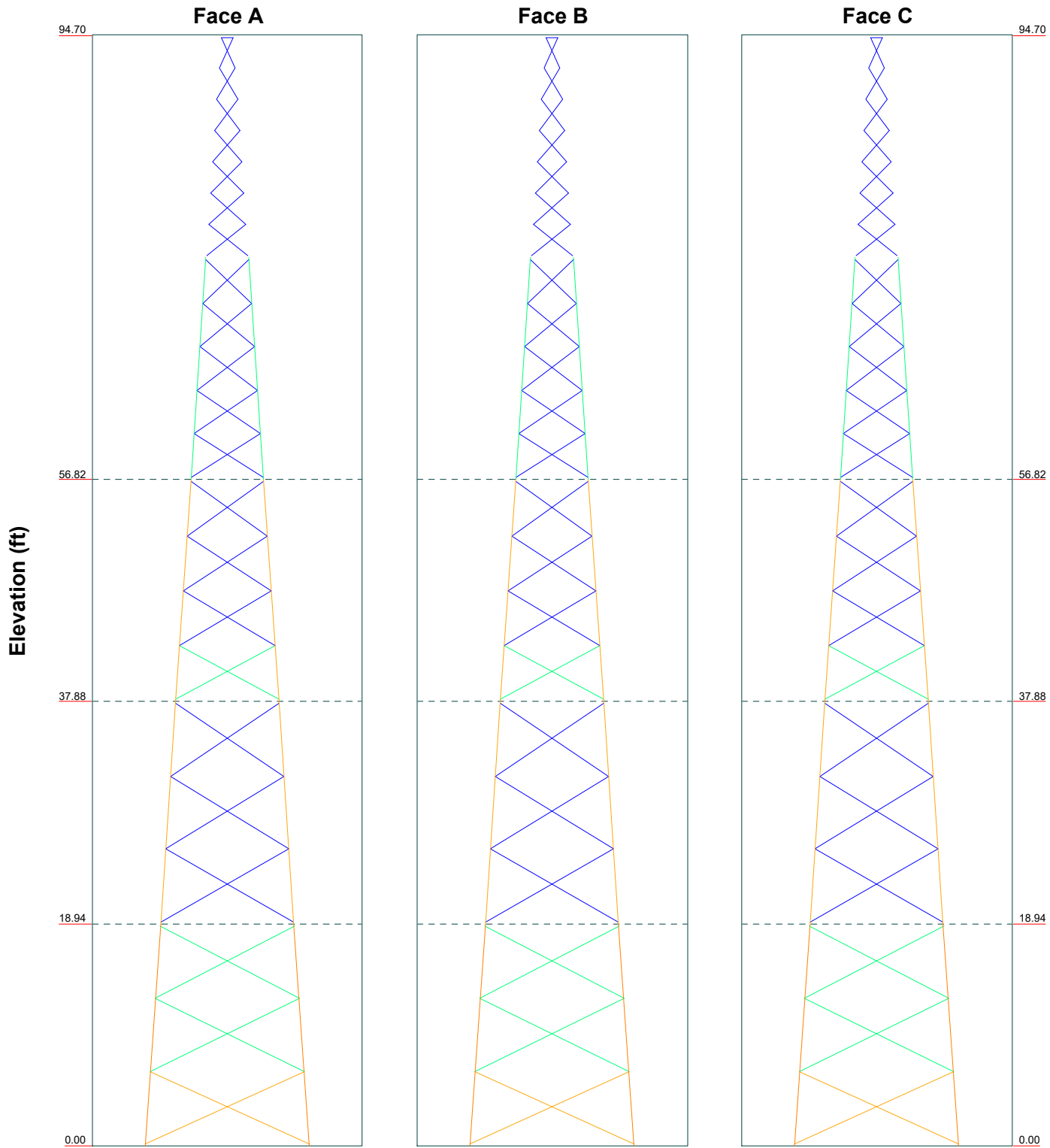


Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job: Structural Analysis - SSL Helical Anchor Tower 100		
	Project: TIA 222-G Standard (120 mph basic; 3/4" ice)		
	Client: Stock Analysis for Exposure C, Topo 1, 2400 thrust	Drawn by: Ken Craig	App'd:
	Code: TIA-222-G	Date: 10/22/17	Scale: NTS
	Path: E:\BWCFiles\Towers\NREL-Helical Anchors\Helical-SSL-100-222G-120.eri		Dwg No. E-5

Stress Distribution Chart

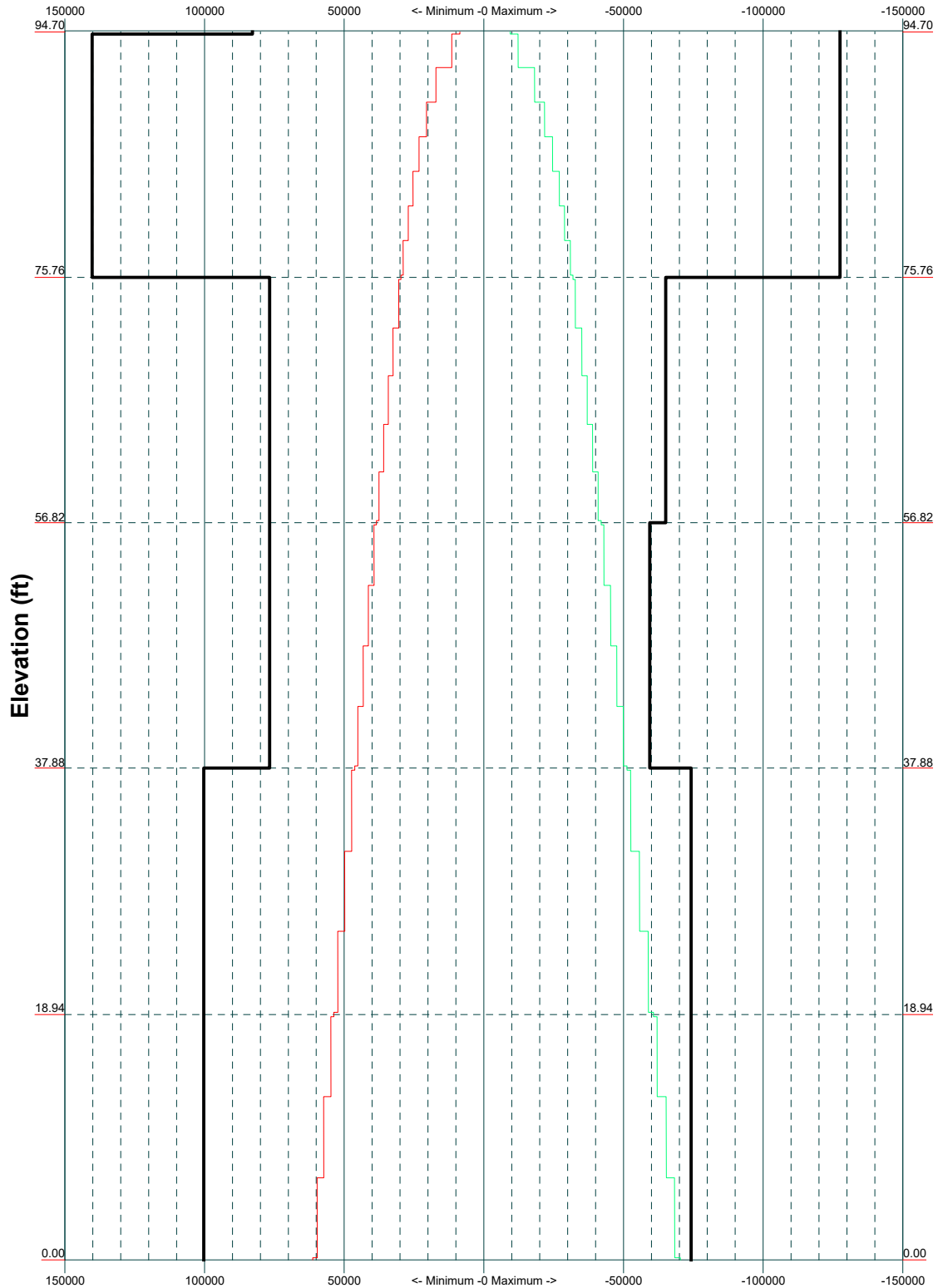
0' - 94'8-13/32"

■ > 100%
 ■ 90%-100%
 ■ 75%-90%
 ■ 50%-75%
 ■ < 50% Overstress



Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job: Structural Analysis - SSL Helical Anchor Tower 100		
	Project: TIA 222-G Standard (120 mph basic; 3/4" ice)		
	Client: Stock Analysis for Exposure C, Topo 1, 2400 thrust	Drawn by: Ken Craig	App'd:
	Code: TIA-222-G	Date: 10/22/17	Scale: NTS
	Path: E:\BWCFiles\Towers\NREL-Helical Anchors\Helical-SSL-100-222G-120.ari		Dwg No. E-8

TIA-222-G - 120.00 mph/50.00 mph 0.75 in Ice Exposure C
Leg Capacity ——— Leg Compression (lb)



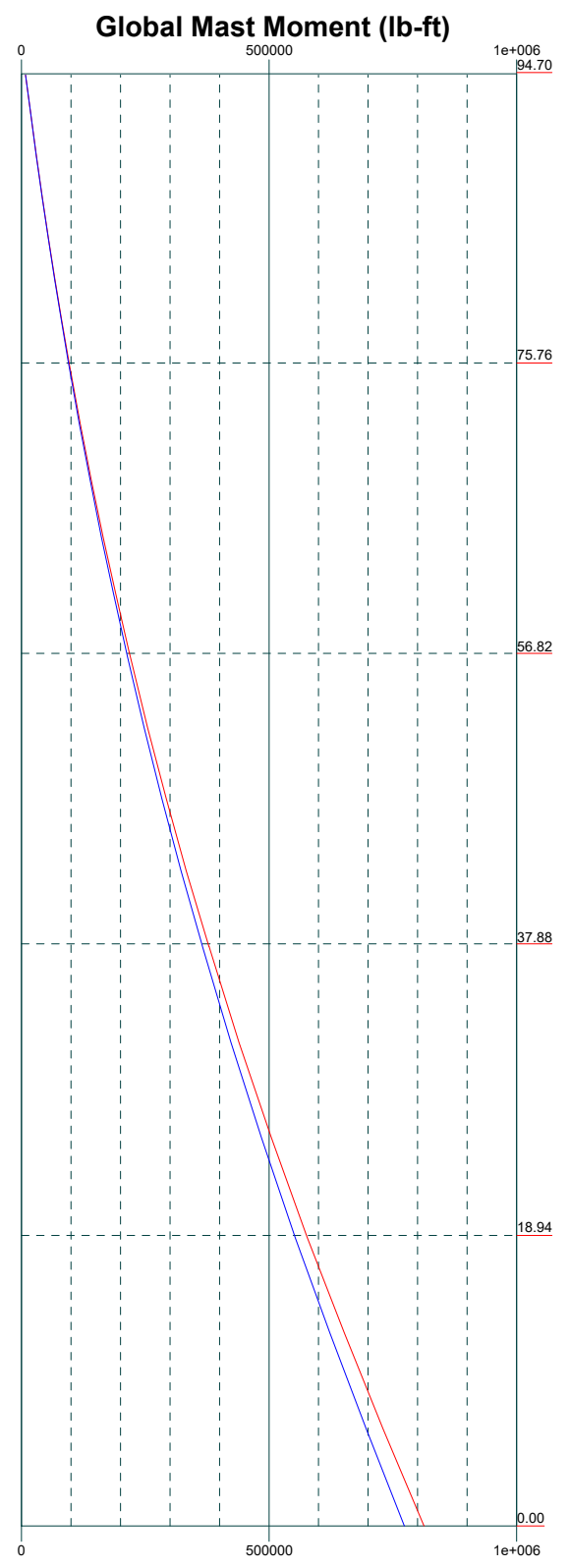
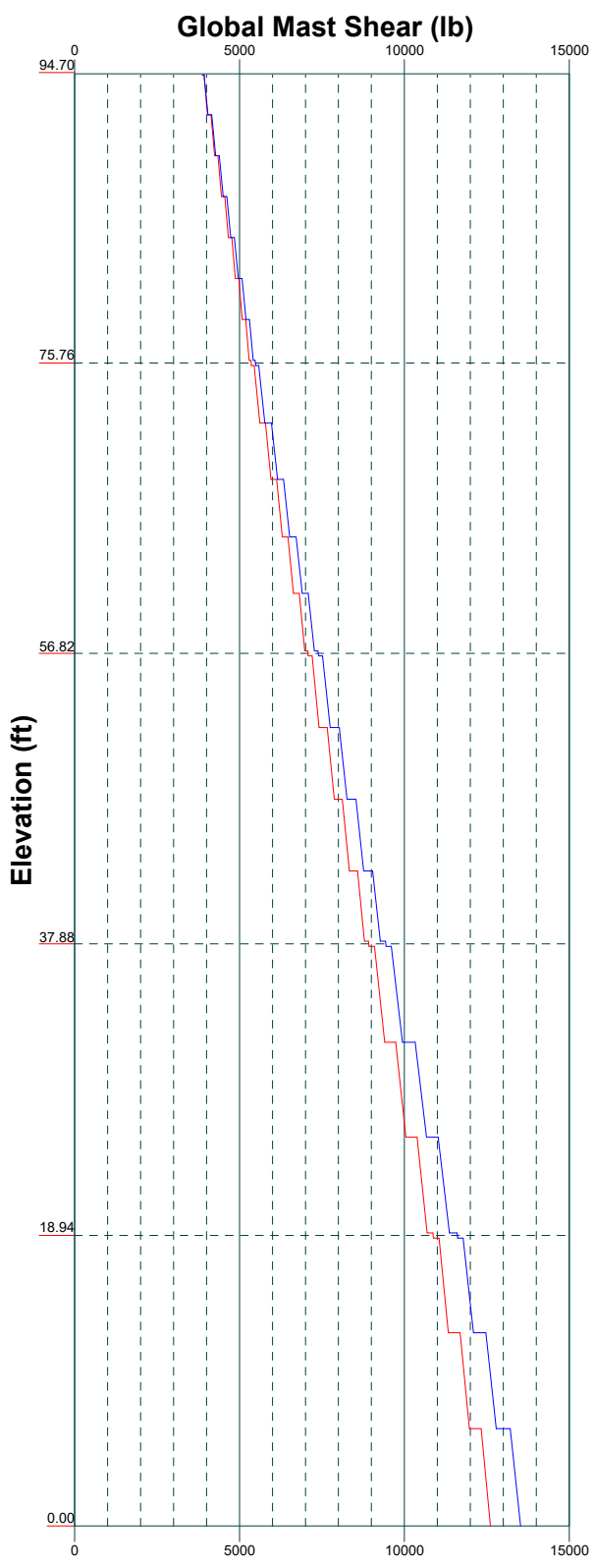
Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job: Structural Analysis - SSL Helical Anchor Tower 100		
	Project: TIA 222-G Standard (120 mph basic; 3/4" ice)		
	Client: Stock Analysis for Exposure C, Topo 1, 2400 thrust	Drawn by: Ken Craig	App'd:
	Code: TIA-222-G	Date: 10/22/17	Scale: NTS
	Path: E:\BWCFiles\Towers\NREL-Helical Anchors\Helical-SSL-100-222G-120.eri		Dwg No. E-3

Vx

Vz

Mx

Mz



Ken Craig, P.E. 417 NW 41st St. Okla. City, OK Phone: 405-615-8748 FAX: 405-364-2078	Job: Structural Analysis - SSL Helical Anchor Tower 100		
	Project: TIA 222-G Standard (120 mph basic; 3/4" ice)		
	Client: Stock Analysis for Exposure C, Topo 1, 2400 thrust	Drawn by: Ken Craig	App'd:
	Code: TIA-222-G	Date: 10/22/17	Scale: NTS
	Path: E:\BWCFiles\Towers\NREL-Helical Anchors\Helical-SSL-100-222G-120.eri		Dwg No. E-4

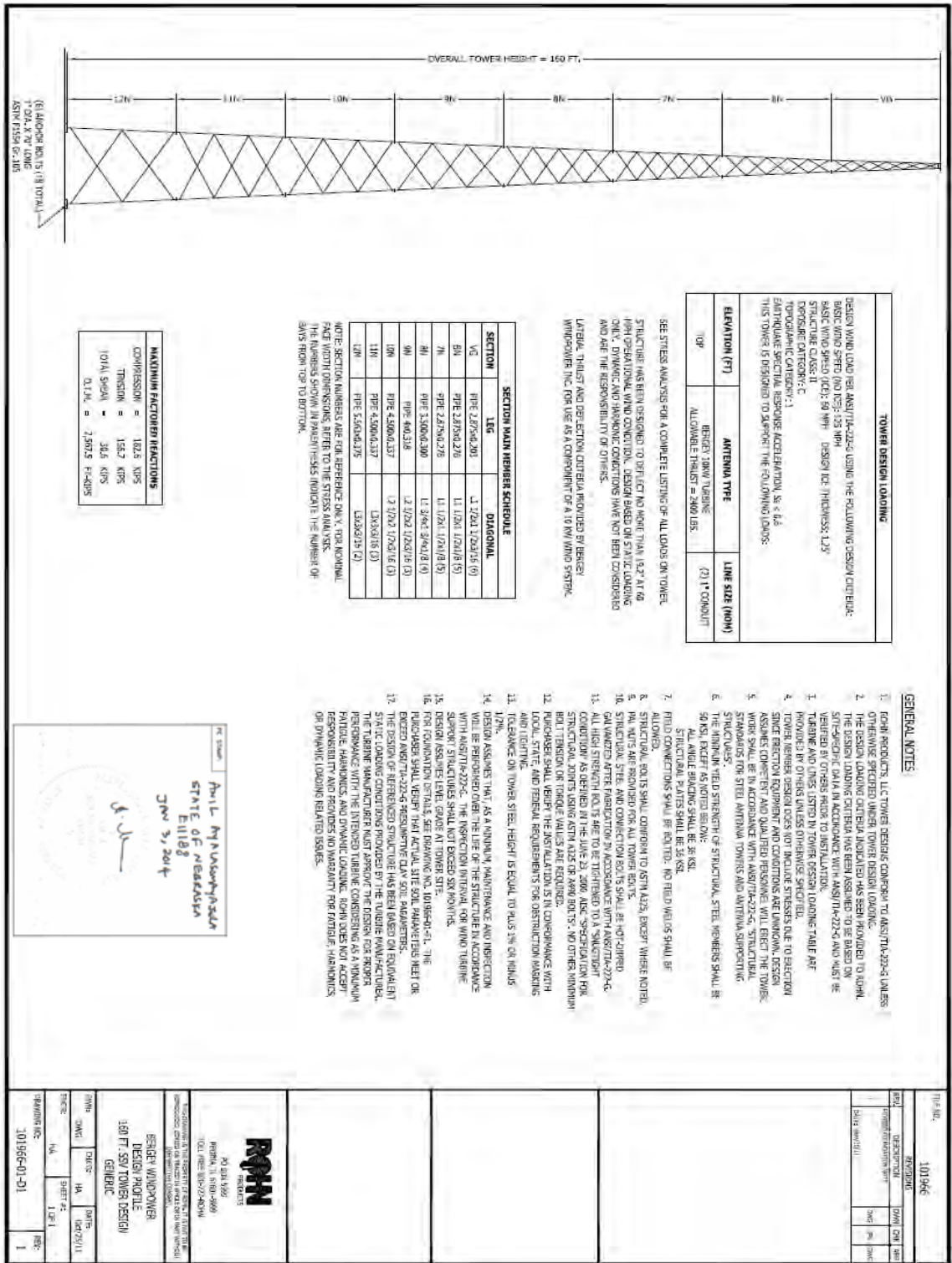
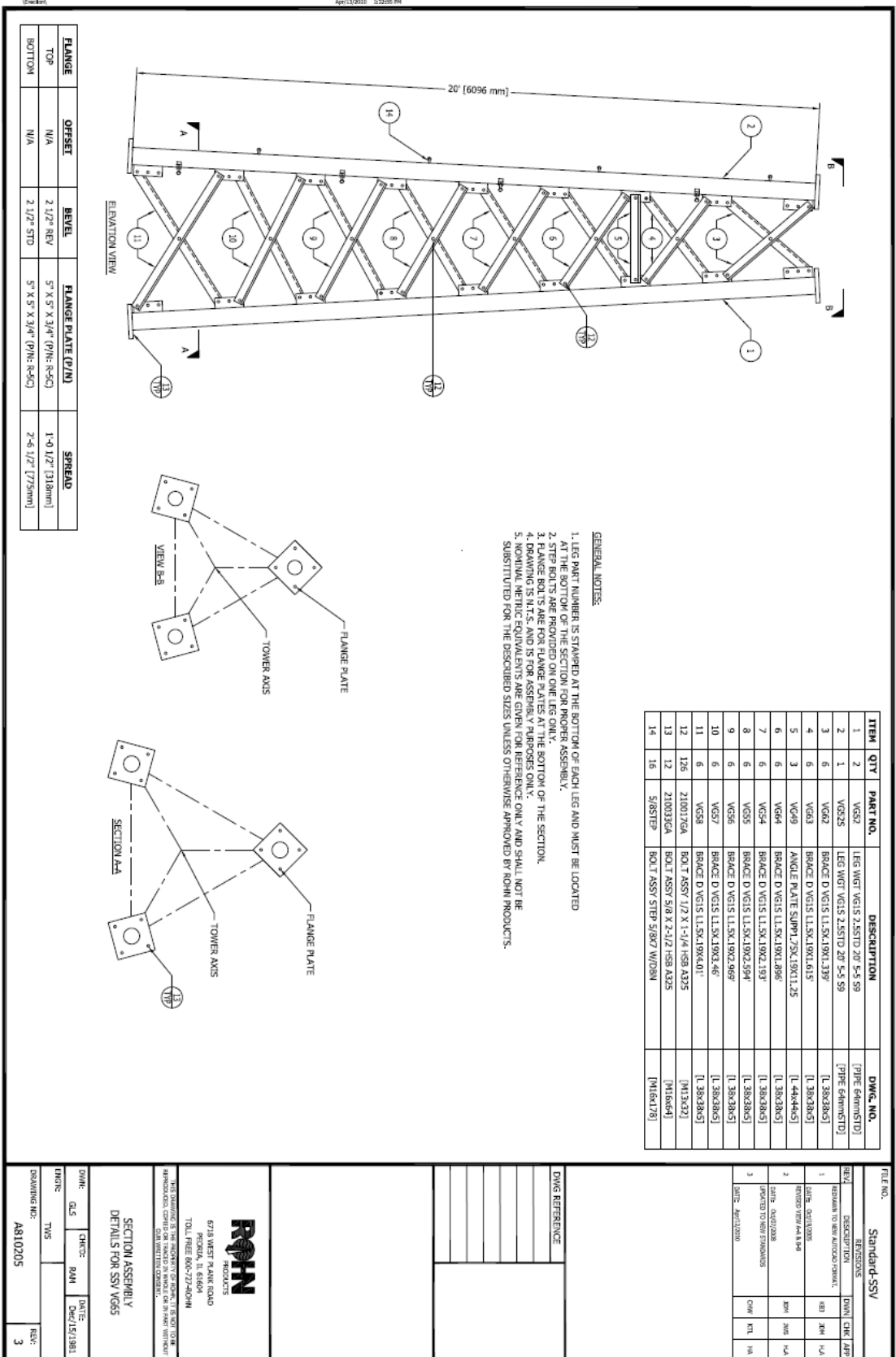


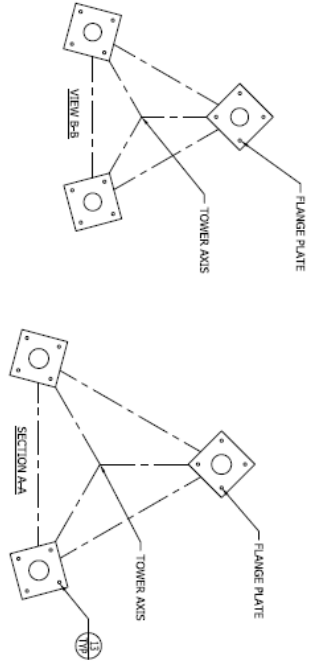
Figure 20: Tower Elevation and Schedule



FLANGE	OFFSET	BEVEL	FLANGE PLATE (F/L)	SPREAD
TOP	N/A	2-1/2" BEV	5" X 5" X 3/4" (P/N: R-5C)	1'-0" 1/2" [318mm]
BOTTOM	N/A	2-1/2" STD	5" X 5" X 3/4" (P/N: R-5C)	2'-6" 1/2" [775mm]

ITEM	QTY	PART NO.	DESCRIPTION	DWG. NO.
1	2	VG52	LEG WGT VGIS 2.5STD 20' 5-5 59	[PIPE ELEMSTD]
2	1	VG52S	LEG WGT VGIS 2.5STD 20' 5-5 59	[PIPE ELEMSTD]
3	6	VG62	BRACE D VGIS L1.5X1.19X1.319'	[L 38x38x5]
4	6	VG63	BRACE D VGIS L1.5X1.19X1.615'	[L 38x38x5]
5	3	VG69	ANGLE PLATE SUPP 7.5X1.19X1.25'	[L 44x44x5]
6	6	VG64	BRACE D VGIS L1.5X1.19X1.896'	[L 38x38x5]
7	6	VG54	BRACE D VGIS L1.5X1.19X2.183'	[L 38x38x5]
8	6	VG55	BRACE D VGIS L1.5X1.19X2.594'	[L 38x38x5]
9	6	VG56	BRACE D VGIS L1.5X1.19X2.969'	[L 38x38x5]
10	6	VG57	BRACE D VGIS L1.5X1.19X3.46'	[L 38x38x5]
11	6	VG58	BRACE D VGIS L1.5X1.19X3.401'	[L 38x38x5]
12	126	210017GA	BOIT ASSY 1/2" X 1-1/4" H58 A225	[M13x2]
13	12	210033GA	BOIT ASSY 5/8" X 2-1/2" H58 A225	[M16x4]
14	16	5/8STEP	BOIT ASSY STEP 5/8X7 WIDEN	[M16x178]

- GENERAL NOTES:**
1. LEG PART NUMBER IS STAMPED AT THE BOTTOM OF EACH LEG AND MUST BE LOCATED AT THE BOTTOM OF THE SECTION FOR PROPER ASSEMBLY.
 2. STEP BOLTS ARE PROVIDED ON ONE LEG ONLY.
 3. FLANGE BOLTS ARE FOR FLANGE PLATES AT THE BOTTOM OF THE SECTION.
 4. DIMENSIONS ARE GIVEN IN FEET AND INCHES UNLESS OTHERWISE NOTED.
 5. NOMINAL METRIC EQUIVALENTS ARE GIVEN FOR REFERENCE ONLY AND SHALL NOT BE SUBSTITUTED FOR THE DESCRIBED SIZES UNLESS OTHERWISE APPROVED BY ROHN PRODUCTS.



DWG. NO.	DATE	CHK'D	APP'D
AS10205	08/15/1983	TWS	RAM

**SECTION ASSEMBLY
DETAILS FOR SSV VG65**

ROHN PRODUCTS
8718 WEST PARK ROAD
PROVO, UT 84601
TOLL FREE 800-774-ROHN

THIS DRAWING IS THE PROPERTY OF ROHN. IT IS NOT TO BE REPRODUCED OR TRANSMITTED IN ANY FORM OR BY ANY MEANS, ELECTRONIC OR MECHANICAL, INCLUDING PHOTOCOPYING, RECORDING, OR BY ANY INFORMATION STORAGE AND RETRIEVAL SYSTEM.

Figure 21: Top Section - VG65

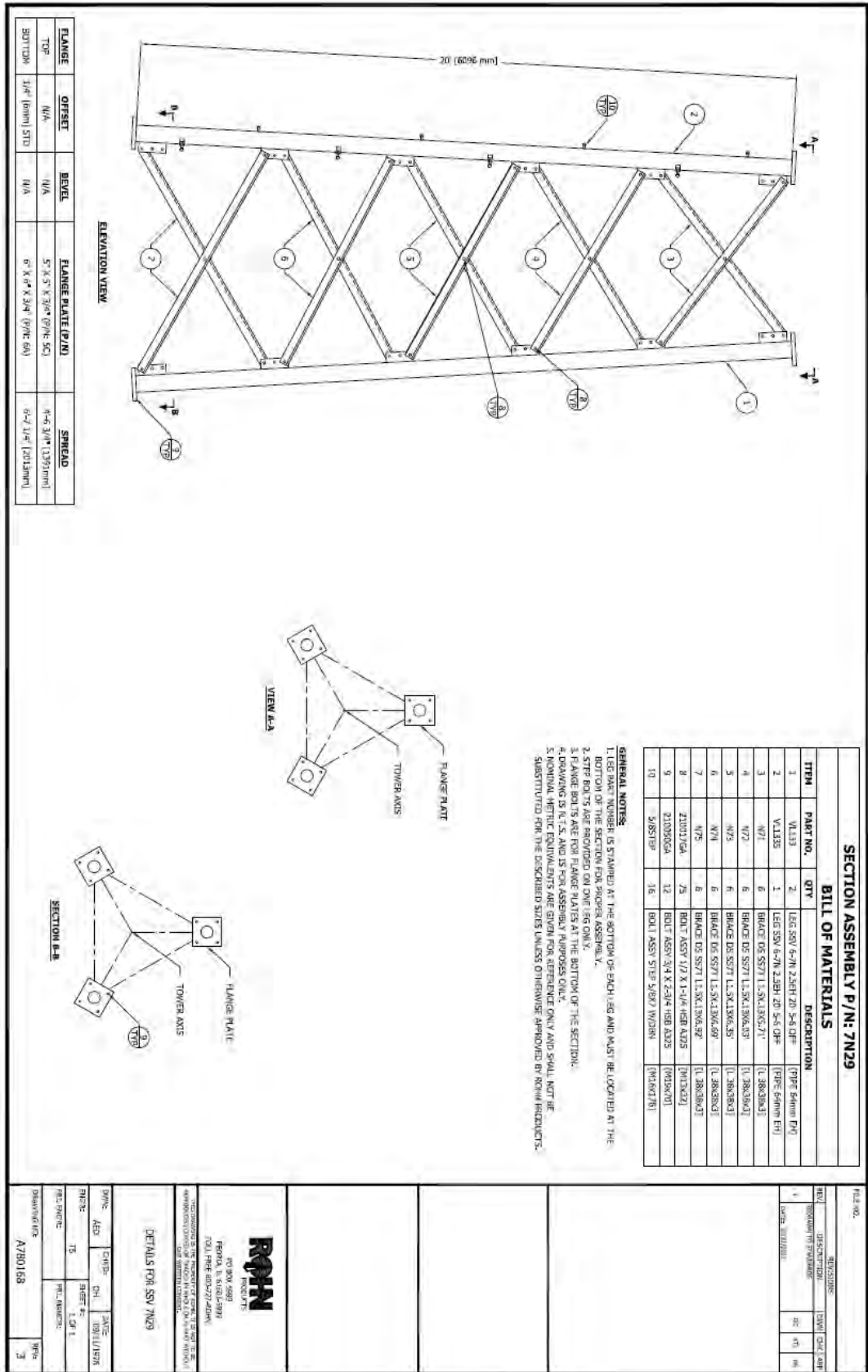


Figure 24: Third Section – 7N29

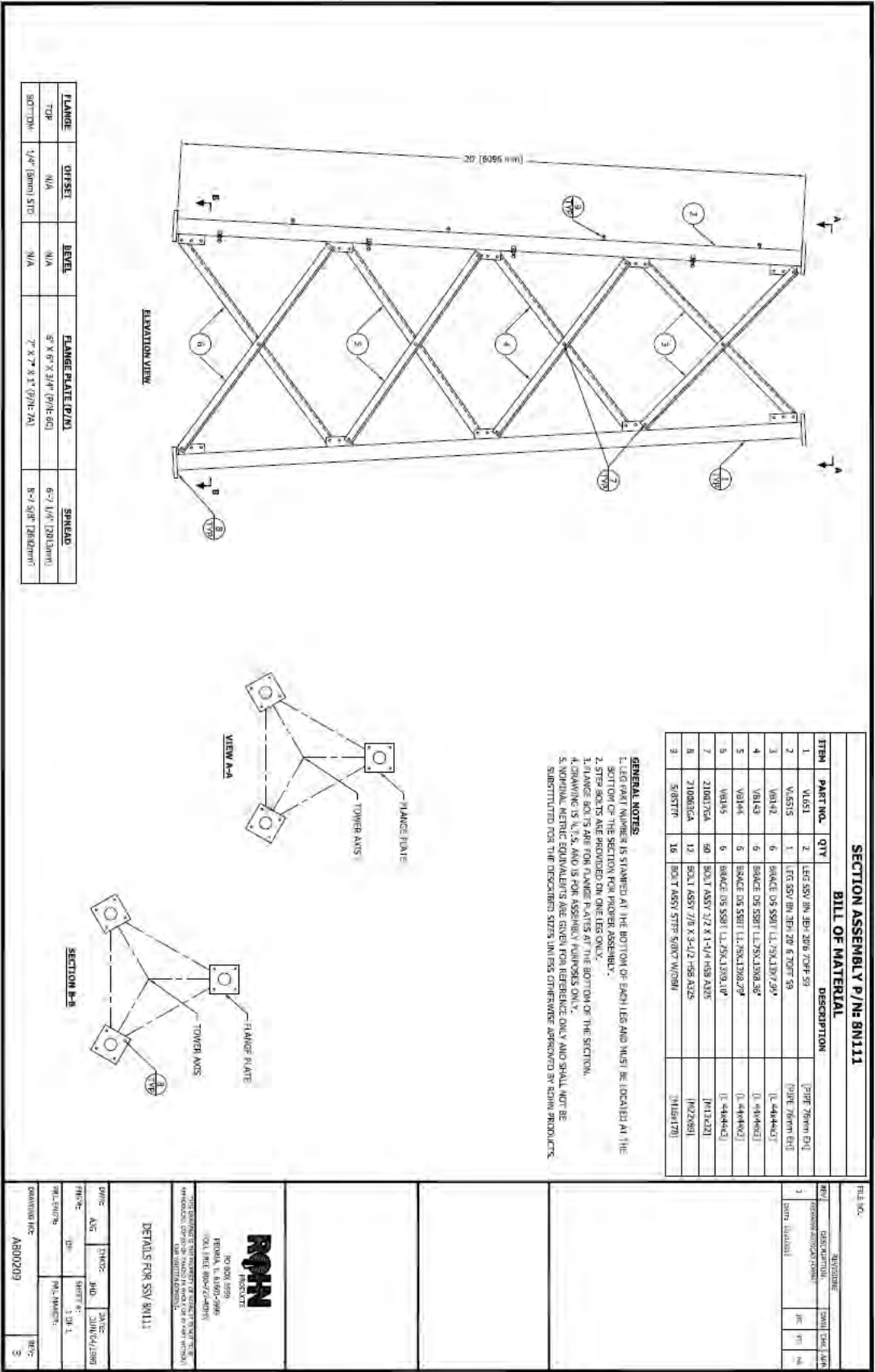


Figure 26: Fourth Section - 8N111

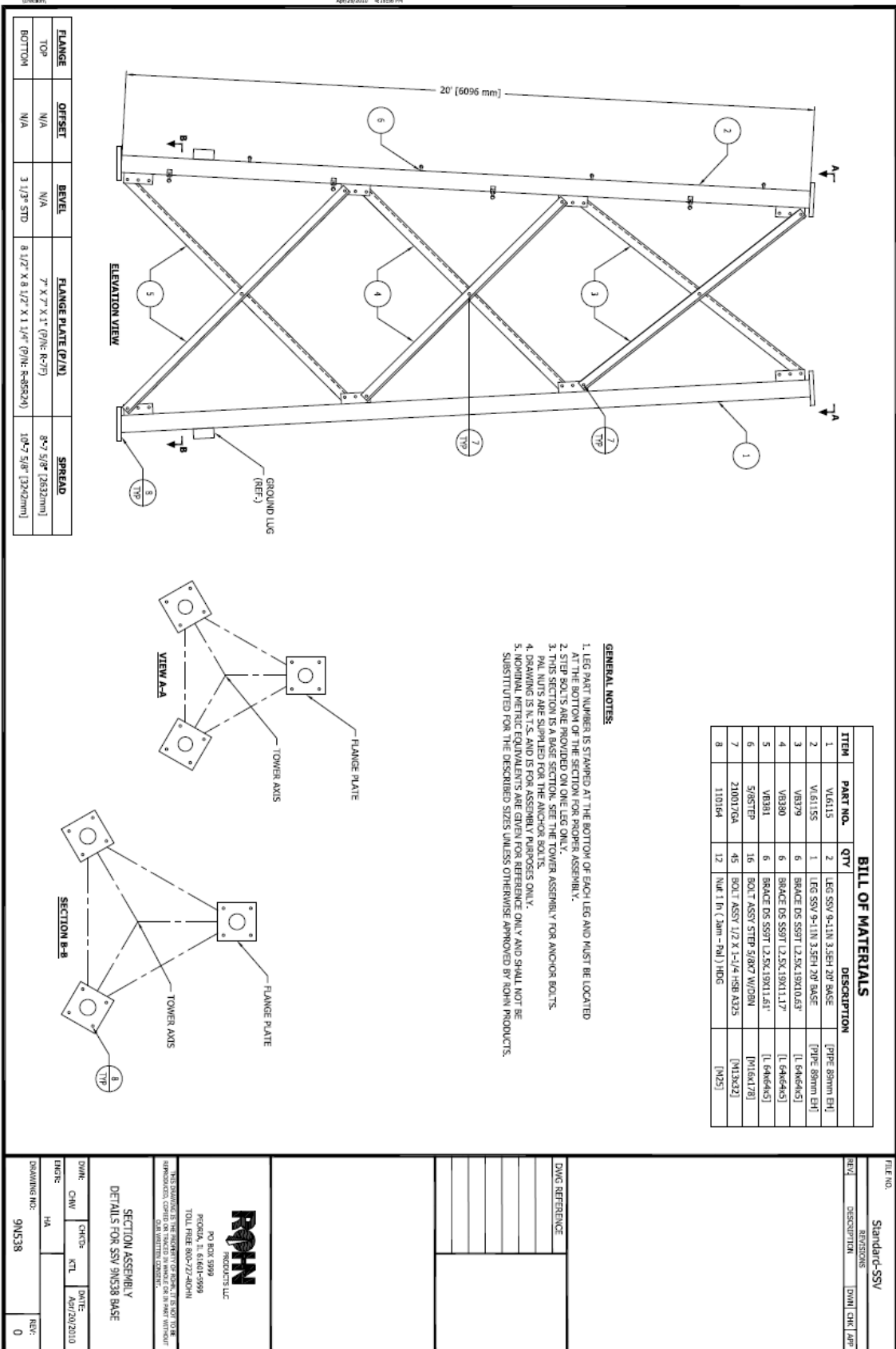
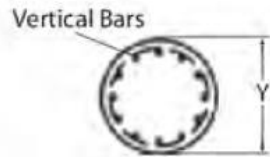


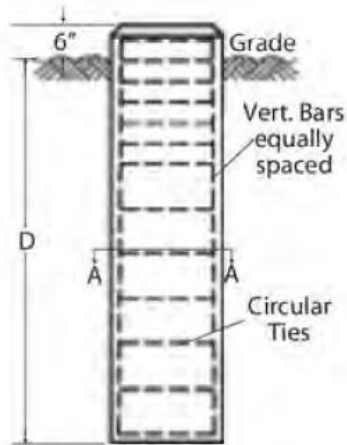
Figure 30: Fifth Section - 9N538 (Base of 100 ft. Tower)

FILE NO:	Standard-SSV			
REV:	DESCRIPTION	DATE	CHK	APP
<p>Rohn PRODUCTS, LLC PO BOX 8989 PROCTOR, IL 61601-8989 TOLL FREE 800-272-4000 FAX 815-231-1111 WWW.ROHN.COM</p>				
<p>THIS DRAWING IS THE INCLUSIVE PROPERTY OF Rohn PRODUCTS, LLC. NO PARTS, MATERIALS, OR SERVICES SHALL BE USED IN THE CONSTRUCTION OF THIS TOWER WITHOUT THE WRITTEN PERMISSION OF Rohn PRODUCTS, LLC.</p>				
<p>SECTION ASSEMBLY DETAILS FOR SSV 9N538 BASE</p>				
DATE:	CHW	KTJ	DATE:	AS/20/2010
TIME:	HA		REV:	0
DRAWING NO:	9N538			

SELF-SUPPORTING
ANSI/TIA-222-G STANDARD FOUNDATIONS



Section A-A

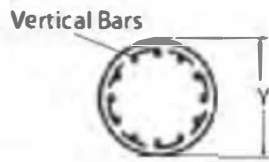


**Drilled Pier
Elevation View**

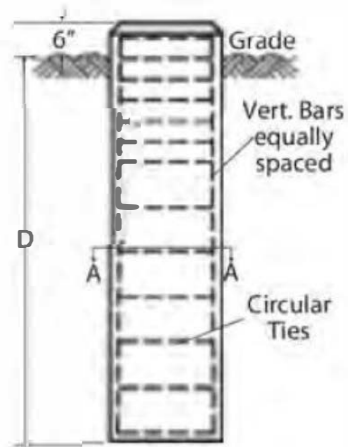
PE STAMP: ANIL AYALASOMYAJULA
STATE OF NEBRASKA
E11188
JAN 3, 2014

Tower Base Sect. No.	Drilled Pier		
	D	Y	Req'd Conc (cu. yds.)
3WN	-	-	-
4N	-	-	-
5N	-	-	-
6N62	-	-	-
7N165	10' - 0"	3' - 0"	8.4

**SELF-SUPPORTING
ANSI/TIA-222-G STANDARD FOUNDATIONS**



Section A-A



**Drilled Pier
Elevation View**



Tower Base Sect. No.	Drilled Pier		
	D	Y	Req'd Conc (cu.yds)
3WN	-	-	-
4N	-	-	-
5N	-	-	-
6N62	-	-	-
7N165	10' - 0"	3' - 0"	8.4



HASTINGS

Nebraska



File No. 2021-12

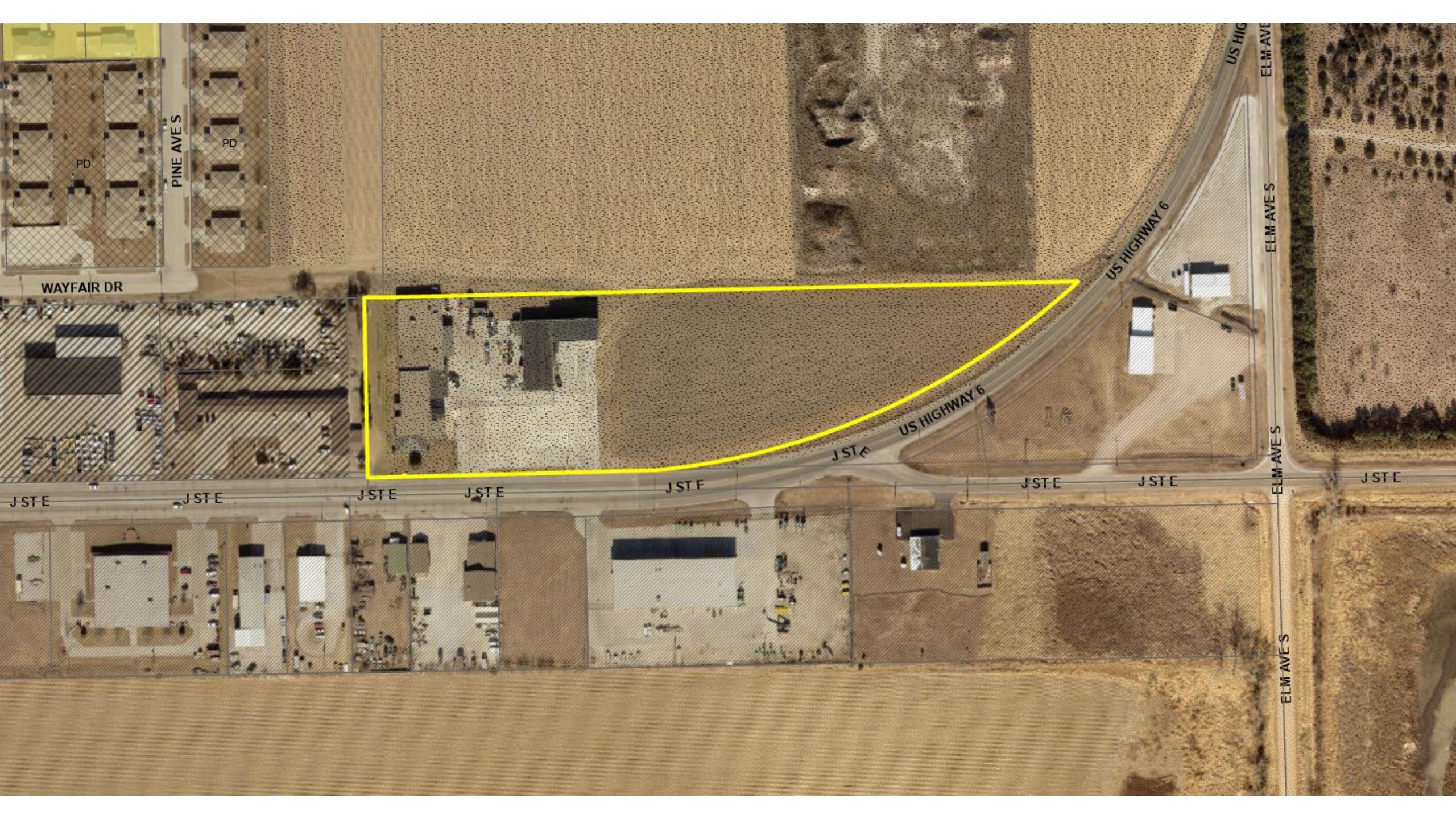
Project Variances to reduce the setback of and to increase the maximum height a small wind energy system

Applicant/
Property Owner Industrial Irrigation Services

Details:

- 6.75-acre site
- Relatively flat
- Devoted to a manufacturing business for industrial and agricultural use
- Eastern 2/3 undeveloped





WAYFAIR DR

PINE AVE S

PD

PD

US HIGHWAY 6

ELM AVES

US HIGHWAY 6

ELM AVES

JST E

US HIGHWAY 6

JST E

JST E

JST E

JST E

JST E

JST E

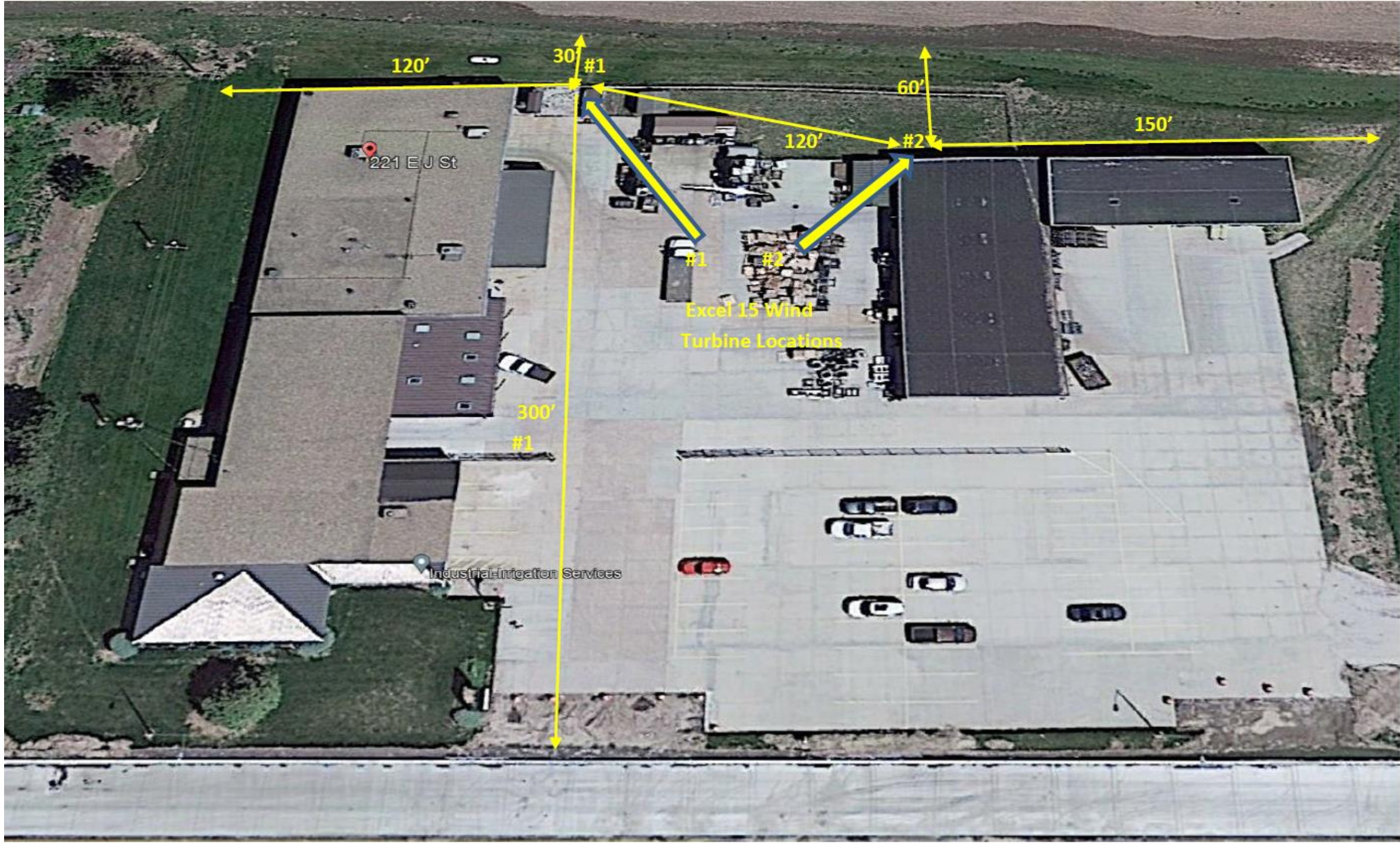
JST E

JST F

ELM AVES

Proposal

- Construct two wind turbines (small wind energy systems)
- Both towers will be on a 100-foot tall, lattice-type tower
- Total height will be 116 feet.
- Each turbine should produce 15 kilowatts
- Turbine #1 will be approximately 30 feet from the north property line
- Turbine #2 will be approximately 60 feet from the north property line
- The location of the turbine conforms to the required setbacks, except for the north property line



120'

30'

#1

60'

#2

150'

120'

#1

#2

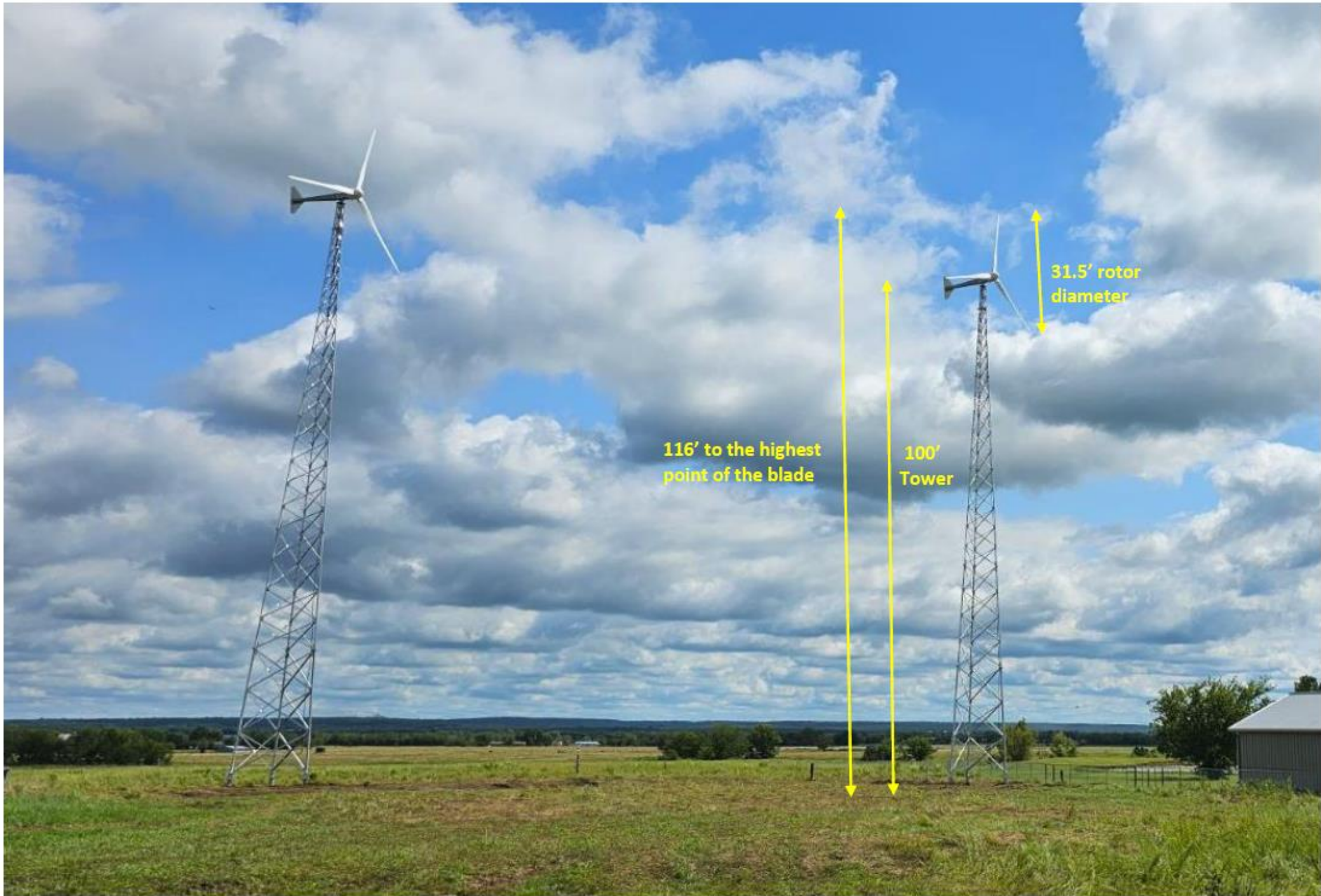
Excel 15 Wind
Turbine Locations

221 E J St

300'

#1

Industrial Irrigator Services



116' to the highest
point of the blade

100'
Tower

31.5' rotor
diameter



Findings Summary

Sec. 34-706(4). No such variance shall be authorized by the Board unless it finds that all four of the following conditions have been found to exist and the merits of the situation support such authorization

(a) The strict application of the zoning regulations would produce undue hardship.

Structure Height

- Not allowing the increased height of the proposed turbine would diminish the efficiency of the energy generation

Structure Setback

- The location is designed to minimize the costs
- Currently, the most impacted property is undeveloped
- This property is zoned I-2 District, which is intended to be developed, with the potential for buildings to be 0-3 feet close to the property line.
- Alternatives exist to locate the towers that comply with the regulations

Staff Findings Summary (continued)

(b) Such hardship is not shared generally by other properties in the same zoning district and the same vicinity.

Structure height

- Appropriate height is needed to efficiently generate energy
- The height limitation creates a hardship for all properties in the district and vicinity.
- This issue should be addressed with upcoming zoning updates

Structure setback

- The setback issue is not unique to this property.
- Other properties in the District would face similar issues if they choose to site the turbines in similar areas.
- Alternatives exist to site the towers to meet the requirements.

Staff Findings Summary (continued)

- (c) The authorization of such variance will not be of substantial detriment to adjacent property and the character of the district will not be changed by the granting of the variance.

Structure height

- Allowing the increase in height should not be detrimental
- The I-2 District does not have a height restriction for buildings

Structure setback

- Reducing the setback may impact adjacent properties, particularly the one to the north
- Although the land is undeveloped, the potential exists for development in the future that could be impacted by a failure of the tower

Staff Findings Summary (continued)

- (d) The granting of such variance is based upon reason of demonstrable and exceptional hardship as distinguished from variations for purposes of convenience, profit or caprice. In no instance, shall a variance be granted which would allow the use of land or a building which is not permitted within the zoning use district in which the property is located. No variance shall be authorized unless the Board finds that the condition or situation of the property concerned is not of so general or recurring a nature as to make reasonably practicable the formulation of a general regulation to be adopted as an amendment to the zoning regulations.

Structure height

- The variance is technically a purpose of convenience and/or profit
- This limitation would create recurring variance requests
- The regulations need to be updated to address the inconsistency

Structure setback

- The variance does appear to be a purpose of convenience and/or profit
- Alternatives exist to site the turbines in a location that meets the requirements

Staff Recommendations

Structure Height: Staff recommends the Board of Adjustment **APPROVE** the **VARIANCE** request to allow the maximum height of the two proposed wind turbines to increase from 80 feet to 116 feet tall, as present, for the property at 221 East J Street, in the I-2, Heavy Industrial District, with the following condition of approval:

1. All applicable permits shall be applied for and issued, including any electrical permits for the connection of the wind turbines to the building(s).

Possible Motion

Approve the Variance to increase the maximum height for a wind turbine from 80 feet to 116 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Note: If the Board of Adjustment is inclined to not take the recommendations of City staff, and/or add conditions of approval, they should clearly and specifically articulate the findings of their decision and any conditions of approval.



Staff Recommendations

Structure Setback: Staff recommends the Board of Adjustment **DENY** the **VARIANCE** request to reduce the required setback for the proposed wind turbines from 116 feet to 30 feet, for the property at 221 East J Street, in the I-2, Heavy Industrial District.

Possible Motion

Deny the Variance to decrease the minimum setback for a wind turbine from 116 feet to 30 feet for the two proposed wind turbines for the property at 221 East J Street, in the I-2, Heavy Industrial District as recommended in the staff report.

Note: If the Board of Adjustment is inclined to not take the recommendations of City staff, and/or add conditions of approval, they should clearly and specifically articulate the findings of their decision and any conditions of approval.





HASTINGS

Nebraska