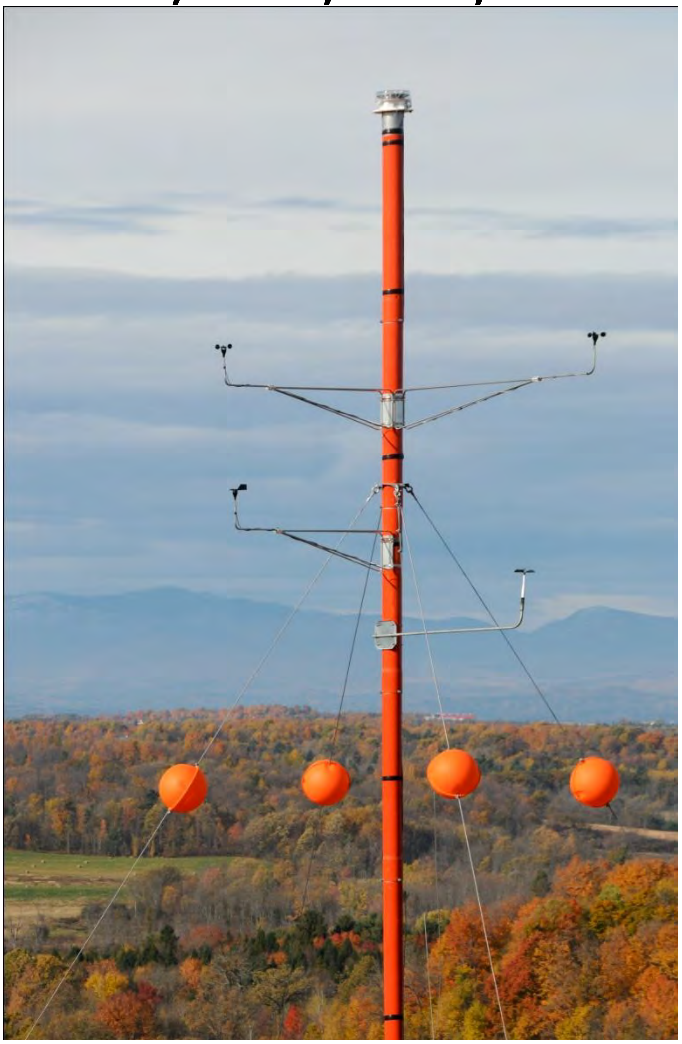
NRG Super 60 meter XHD TallTower™
Installation Manual
& Specifications

For NRG Tower Kit #'s
7675, 7677, 7724, 7725
&
NRG-NOW System Kit #'s
7676, 7678, 7728, 7729



SEE THE POTENTIAL

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Specifications are subject to change without notice.

Installation of guyed towers is inherently dangerous. To minimize risks, read and follow the tower installation instructions explicitly. Do not install during an electrical storm. Installation in agricultural areas may pose a threat to low flying crop dusting aircraft. Notify appropriate parties and install warning devices as needed. NRG Systems, Inc. assumes no responsibility or liability in connection with any act, error, omission, or for any injury, loss, accident, delay, inconvenience, irregularity or damage related to any TallTower installation.

DANGER: YOU CAN BE KILLED

IF THIS TOWER COMES NEAR ELECTRIC POWER LINES or IF YOU INSTALL THIS TOWER DURING AN ELECTRICAL STORM.

FOR YOUR SAFETY, FOLLOW THESE INSTALLATION INSTRUCTIONS.

Table of Contents

WARNINGS

Do these things:

Read and follow the Tower Installation Manual!

Determine the soil type at your site and install the correct anchors.

Place tower anchors according to anchor manufacturer's recommendations.

Properly ground the tower electrically.

Stand to the side of any tensioned cables.

Thoroughly understand tower erection procedure before beginning installation. All crew members should read the manual before arriving at the installation site!

Review glossary so that you are familiar with all tower parts and terminology.

If you are NOT familiar with erecting towers of this type, seek professional guidance. NRG will gladly help answer any questions.

If you have never installed a TallTower before, DO NOT attempt to install your 80 meter XHD TallTower. Seek the assistance of a qualified installer.

If you are not thoroughly familiar with all components of the tower, including all hardware and how all components function, DO NOT attempt to install this tower yourself. Tall guyed towers are dangerous, and you or members of your crew can be injured or killed.

If installing the TallTower in an agricultural area, notify appropriate parties and install warning devices as needed. Towers can pose a threat to low-flying crop dusting aircraft.

If you are unsure of how to anchor your tower, seek professional guidance.

Do NOT do these things:

DO NOT climb this tower.

DO NOT erect tower within 1 ½ times the tower height of electric power lines.

DO NOT install this tower during an electrical storm.

DO NOT erect tower within 1 ½ times the tower height of walkways, roads, or buildings.

DO NOT permit unauthorized personnel onto the site while the tower is being installed.

DO NOT raise or lower the tower on a day with high winds or gusty winds.

DO NOT use rebar anchors.

DO NOT stand in line with, directly in front of, or behind any tensioned cable.

DO NOT install as a shorter tower (50 m or 60 m, for example) using the parts from the 80 m XHD tower. This cannot be done safely.

References

ANSI/TIA-222-G Structural Standard for Antenna Supporting Structures and Antenna
ASTM D3359 - 09e2 Standard Test Methods for Measuring Adhesion by Tape Test
Encyclopedia of Anchoring - Principles and Applications of Anchoring, Hubbell Power Systems
Federal Aviation Administration (FAA) Advisory Circular AC 70/7460-1K
Federal Specification FED-STD-595
Federal Specification Wire Rope and Strand RR-W-410F

Introduction

TallTower History

NRG TallTowers™, the original tilt-up tubular towers, were first introduced in 1982 and quickly became the industry standard to quickly and easily get sensors up and into the wind to start measurements. TallTowers are delivered in complete kits, assembled on the ground and then tilted up and secured with guy wires. The Super 60 meter XHD TallTower is ice-rated for extreme climates and meets the applicable sections of ANSI/TIA-222-G Standards.

Construction and Assembly

The NRG TallTower™ is constructed of galvanized steel tube and is guyed at eight levels in four directions. Sections slide together and are secured using fasteners. The tower is tilted up from the ground with a gin pole and winch (not included). Lifting of the tower is accomplished using eight lifting wires attached to the gin pole. The tower is stabilized using four guy wire sets. The base plate is hinged so both the tower and gin pole can pivot to the erected position.

Required Parts to Erect Tower System

NRG Super 60 meter XHD TallTowers are supplied complete with ready to assemble tubes, baseplate, guy rings, precut guy wires, grounding kit, and associated hardware. Anchors are optional. Several types of anchors, suitable for many soil types, are available from NRG. It is your responsibility to determine which type of anchor is appropriate for your specific site.

Please refer to Appendix B: Anchoring Guidelines of this manual for more information.

A winch and ginpole are also required to raise the tower. When combined, a winch and ginpole comprise an installation kit. The installation kit (winch and ginpole) can be transported from one site to another to raise and lower the Super 60 meter XHD tower. The winch and ginpole for the Super 60 m XHD TallTower are the same equipment used to raise and lower the NRG 80m XHD TallTower, and, therefore, can be used to erect and lower the NRG 80m XHD TallTower. The winch and ginpole for the Super 60m TallTower are NOT compatible with the NRG 50m XHD and 60m XHD TallTowers and SHALL NOT be used to raise and lower these towers.

Experience Required

Extensive experience installing other TallTowers is required for successful installation of the Super 60 m XHD TallTower. If you do not have extensive experience installing TallTowers, seek assistance from a qualified installer.

Using This Manual

The single configuration for the Super 60 m XHD TallTower consists of a 59.8 m height and a single guy anchor footprint. This manual provides detailed information on the installation and specifications of the Super 60 m XHD TallTower. Wind and ice loadings are included in the body of the manual along with anchor and baseplate loads, parts lists, a site layout map, and tower assembly drawings. Critical installation steps are highlighted throughout the manual as shown below.

Critical Installation Step:

> Failure to follow critical installation steps precisely may result in catastrophic failure of the ginpole or tower and endangers the lives of crew members.

Tools Supplied with Tower Kits

Metal rust-prevention compound (such as Sanchem, Inc. NO-OX-ID "A-SPECIAL")

Tools Supplied with Installation Toolkit #4832

Klein Tools, Inc. Chicago Grip (PN 1659-20) (3)
Lug-All Come-Along (Model 115-R) (3)
Loos & Co. Inc. Model PT-3 Tension Gauge (1)

Tools Required but not Supplied

- ¼ inch nut driver (for sensor installation)
- 5/16 inch nut driver (for hose clamps)
- Torque wrenches for wire rope clips (see Table 1)
- Torque wrench capable of applying 150 ft-lbs of torque (to tighten 5/8"-11 tower tube joint nuts)
- Small adjustable wrench (for opening/closing acorn clamps)
- Small pliers (for sensor cotter pins)
- Small Phillips head (+) screwdriver (for set screws)
- Flat (-) screwdriver (for antenna mounting assembly)
- Wood blocks (for tube layout and seating tower joints)
- Mallet (for seating tower joints and installing ground rods)
- Large adjustable wrench (for large bolts)
- Hand sledge (for ground rods)
- Level, preferably with a magnetic base (to straighten the tower)
- Compass (for aligning direction sensors)
- Permanent marker (for labeling lower ends of cables)
- Anti-Seize
- Gloves
- Wire cutters
- 2-way radios or walkie talkies
- Electric drill with 5/16 inch bit (for unpacking EnviroCrate)
- 9/16 inch wrench, socket or open-end (for base plate assembly and unpacking EnviroCrate)
- Band cutters (for unpacking EnviroCrate)
- 10 ft (3 m) stepladder (for reaching top of helper ginpole)
- Nylon slings (2) with minimum Working Load Limit (WLL) of 6000 lbf (basket hitch)
- For use in installing 203 mm (8.0 inch) diameter twin helix anchors (available from Hubbell Power Systems):
- Locking Dog assembly
- Drive Wrench

Tools Required but not Supplied (Continued)

Table 1: Wire Rope Clips, Socket Sizes, and Torque Requirements

Wire Rope Clip (inches)	Socket Diameter (inches)	Torque Wrench N-m (ft-lbf)
3/16	7/16	10 (7.5)
5/16	11/16	41 (30)

Table 2: Bolt Diameters and Socket Sizes

Bolt Diameter (inches)	Socket/Wrench Diameter (inches)
3/8	9/16
½	¾
5/8	1-1/16
¾	1-1/8

Tower Obstruction Marking

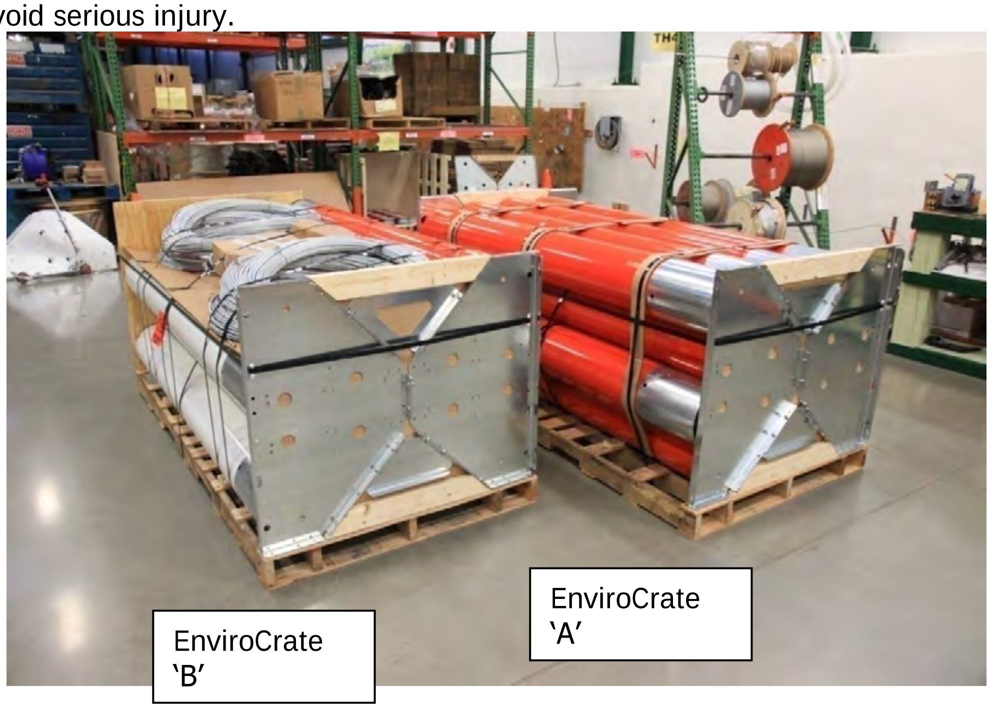
Super 60 m XHD painted towers meet the requirements of Federal Aviation Administration (FAA) Advisory Circular AC 70/7460-1K for Obstruction Marking and Lighting. The paint color used for obstruction marking complies with Federal Standard FED-STD-595 and the paint coating passes ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test. Although the paint coating passes a rigorous adhesion test and great care is taken to minimize damage, scuff marks, paint chipping, and blemishes do occur to the finish during manufacturing and transporation. Although coating damage may occur, the paint finish achieves its design objective of providing obstruction marking in accordance with the FAA Advisory Circular AC 70/7460-1K for Obstruction Marking and Lighting.

Unpack your tower

Description of the EnviroCrate packaging

NRG has developed the EnviroCrate in an effort to reduce cardboard waste, protect the tower components and allow for more economical shipment. All of the Super 60 m XHD tower components including anchors and ground kit are included on two pallets. If you purchased this tower as part of an NRG-NOW System, the ginpole, electronics, sensors and associated accessories are packaged separately.

It is very important that you understand how to unpack the contents of the EnviroCrate safely. Tower tubes and hardware are heavy and can cause injury if unpacked improperly. The recommended sequence to unpack the tower is described in this section of the manual. Please read this section carefully to avoid serious injury.



Picture 1

Tools required to unpack the EnviroCrate

- 5/16 inch nut driver or electric drill with 5/16 inch bit
- 9/16 inch socket and open-end wrench for bolts
- Band cutters
- Gloves
- Safety glasses

EnviroCrate Access and Orientation

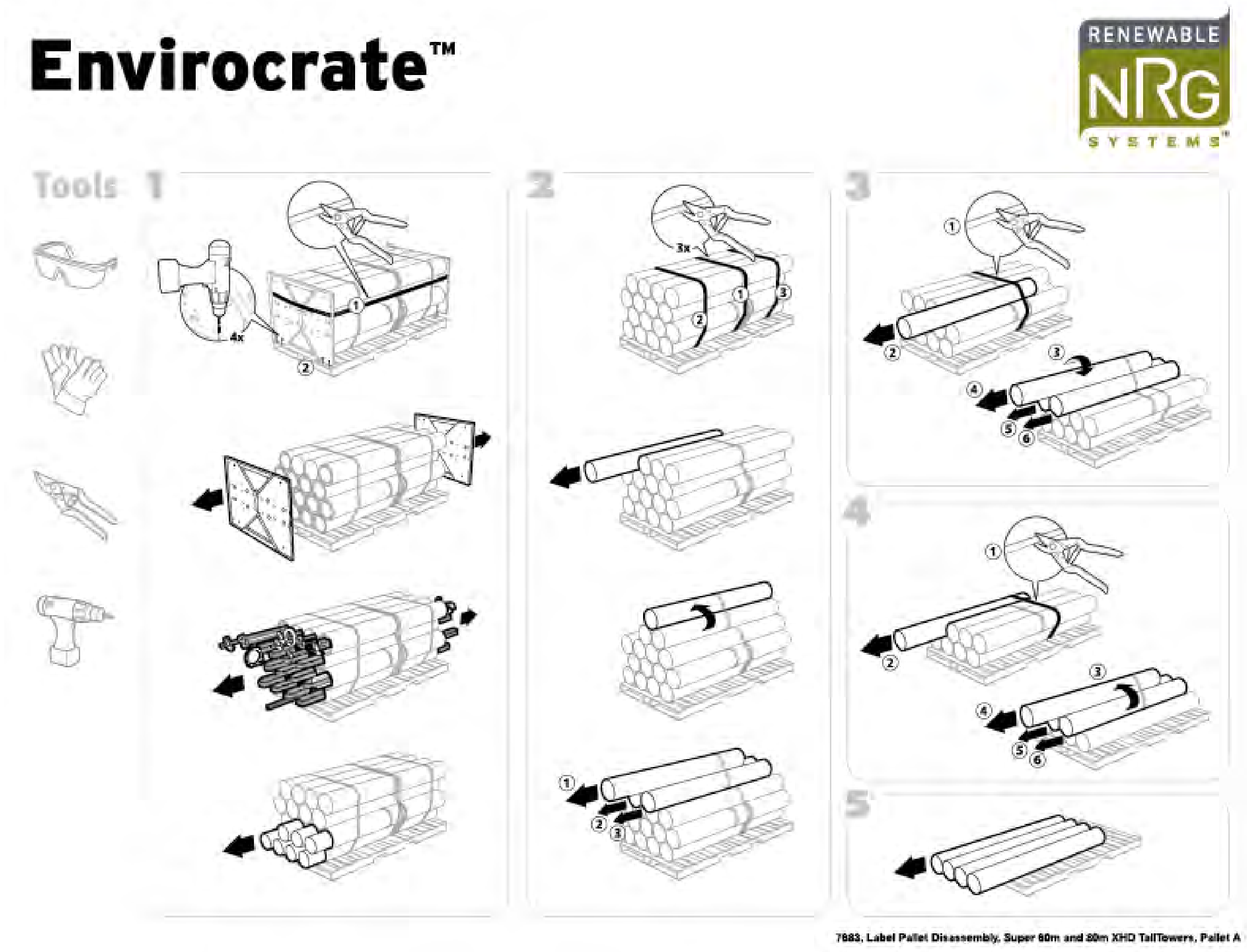
Ideally, you will want access to both ends of the EnviroCrates to unpack the contents. If a forklift is available, that is also ideal. Remove the EnviroCrates from the truck with the forklift and set them on an unobstructed flat area before unpacking.

It is also possible to unpack the contents with access to only one end of the EnviroCrates. For example, the EnviroCrate may have been placed into a truck with one end against the front wall of the truck's cargo area and no forklift available to remove the EnviroCrate from the truck. In this case, you will be able to follow instructions in this section of the manual to unpack the contents and unload from the truck by hand.

Note: You will NOT be able to unpack the contents of the EnviroCrate if the EnviroCrate has been loaded into a truck sideways. If the EnviroCrate has been loaded into a truck sideways, you will not have the required access to the ends and will need a forklift to remove the EnviroCrate.

EnviroCrate Unpack Sequence – Very Important!

The Super 60 m XHD TallTower ships in two (2) Pallets, EnviroCrate Pallet A and EnviroCrate Pallet B, as shown in Picture 1. The sequence for unpacking the EnviroCrate A and B is shown graphically in Picture 2 and Picture 3, respectively.


Envirocrate™
RENEWABLE
NRG
SYSTEMS
Tools
1
2
3
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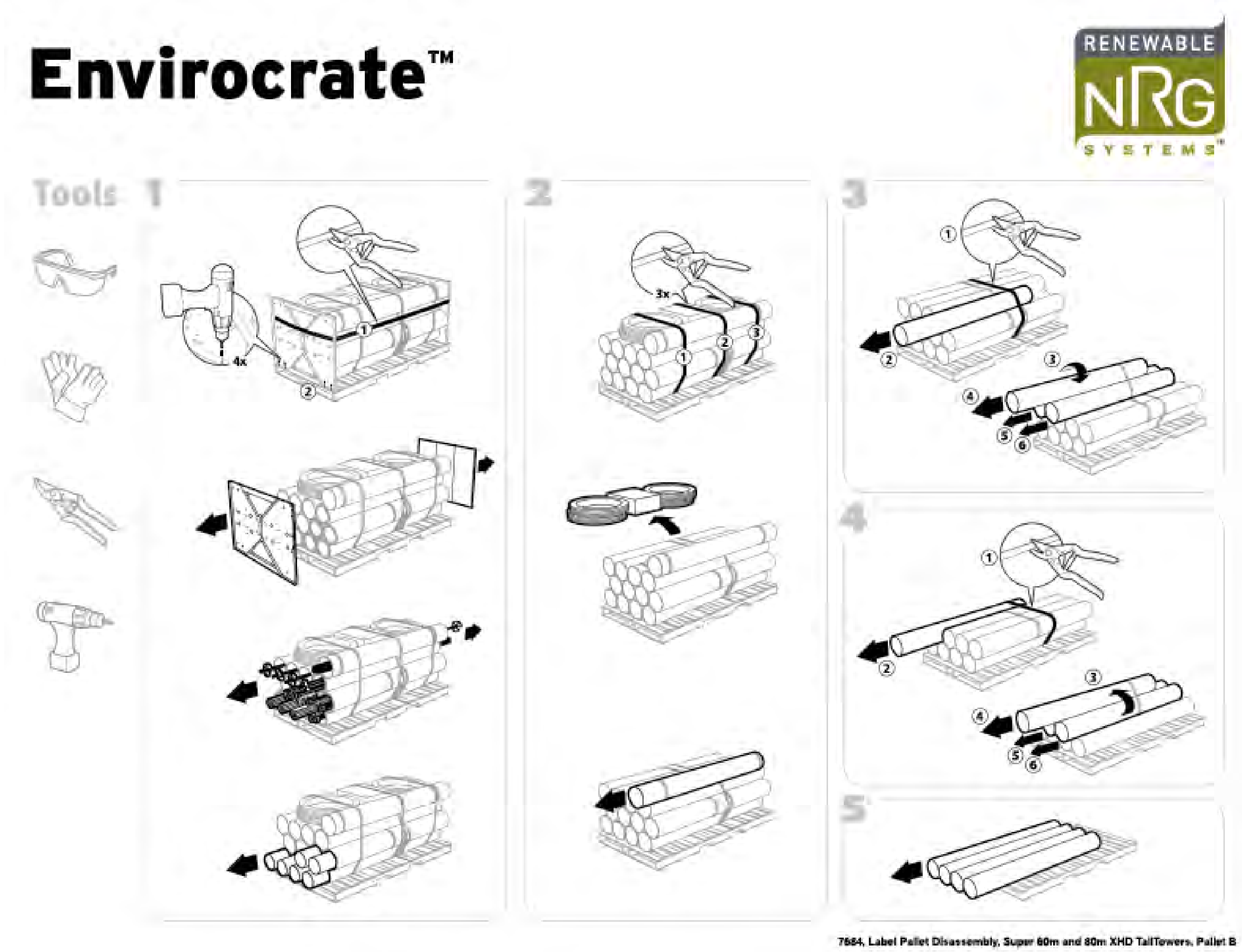
7683, Label Pallet Disassembly, Super 60m and 80m XHD TallTowers, Pallet A

Picture 2



Picture 3

The general procedure for unpacking the EnviroCrate is as follows:

1. With the banding cutters, cut the single horizontal band (#1) and discard. DO NOT CUT the remaining 5 bands at this time.
2. With the powered screwdriver, remove the 4 wood screws that fasten each end plate assembly down to the wood pallet.
3. Set aside the end plate assemblies. If you can only remove one end plate assembly, that is OK – remove the end plate and set it aside. The tube contents will now be exposed.
4. Remove the contents in the tubes as shown in the picture.
5. Remove the two (2) 203 mm (8 inch) diameter tubes from the 254 mm (10 inch) diameter tubes, one at a time. Recycle the protective cardboard strips. At this point, there should only be 254 mm (10 inch) diameter tubes remaining on the pallet.
6. With the band cutters, cut the three (3) bands as shown in the picture.
7. EnviroCrate A:

8. Note that one top layer tube is now free and can be removed. DO NOT CUT the inner 3 bands that are marked with the "DO NOT CUT" tags. These are safety bands that never need to be cut.
9. The three remaining sections of 254 mm (10 inch) diameter tubing on the top layer are restrained by a small metal safety band (marked with a "DO NOT CUT" tag). These can be safely rearranged without cutting that band by lifting the tube closest to the edge of the EnviroCrate and nesting it on the two other tubes, and the safety band will go slack. Now you may slide this top tube out from underneath the safety band and remove it from the pallet.
10. Remove the remaining two tubes from the top layer (these two tubes were within the safety band).
11. With the band cutters, cut another cross-band, and remove the next layer of tubes in the same manner described above. Repeat until the pallet is disassembled.
12. EnviroCrate B:
13. Remove the transition tube, and guy rings and tower pivot pin (boxed).
14. Reposition the top 254 mm (10 inch) diameter tube and nest it between two inside tubes. The safety band will go slack. Now you may slide this top tube out from underneath the safety band and remove it from the pallet.
15. With the band cutters, cut another cross-band, and remove the next layer of tubes in the same manner described above. Repeat until the pallet is disassembled.

Site Layout

Pre-installation Planning

The NRG Super 60 m XHD TallTower may require a site permit prior to installation. Check with local building codes or town authorities regarding site permitting.

It is a good idea to visit the site before you order your wind measurement system. You will need to make arrangements regarding how to unload your tower system. Some site preparation may also be necessary.

Soil Type and Anchors

Before ordering your tower, research the site soil and anchor type required. It is your responsibility to determine which type of anchor is appropriate for your specific site. Depending on the soil type, anchoring can take varying levels of planning, effort and time. Be sure to know what soil types you are dealing with as part of your pre-installation planning process.

The Super 60 m XHD TallTower anchors require mechanical means to install. In addition, all anchors shall be pull tested to 66.7 kN (15000 lbf) prior to tower erection.

Please refer to the anchoring guidelines in Appendix B: Anchoring Guidelines of this manual for more information.

Tip: Cellular Coverage

This is also a good opportunity to identify what type of cellular service is available at the site for those who will be using an NRG iPack to transmit data. For more information on NRG iPacks, contact NRG.

Site Layout Map

The NRG Super 60 m XHD TallTower is suitable for installation in flat or rolling terrain with slopes less than or equal to 3° (1:20). Picture 4 shows the permissible terrain/slope combinations. Do not install this tower on slopes greater than 3° (1:20) or in sites where it is greater than 3° down from the baseplate to both the tower *and* the winch anchor.

Slopes Greater than +1.5°

For slopes greater than +1.5° up from the baseplate-to-ginpole, the ginpole jumper struts will likely contact the ground before the tower reaches vertical. In this case, you will need to do one or all of the following:

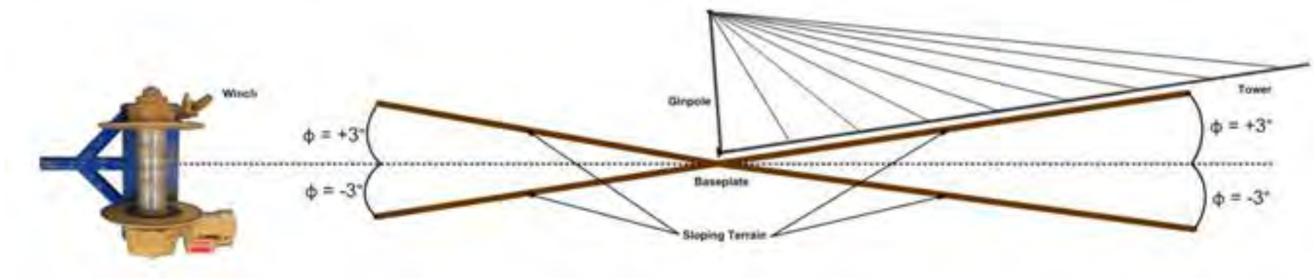
1. Proceed with the tower raising as you normally would following the instructions in this Manual. When the tower is near vertical and the lower jumper struts are nearing ground contact, de-tension all four (4) jumper strut wires by loosening each of the four (4) turnbuckles. After de-tensioning the jumper strut wires, remove one of the two jumper strut mounting bolts (from the bottom jumper struts) and swing the lower jumper struts out-of-the-way. Proceed with the tower raising.
2. Proceed with the tower raising as you normally would following the instructions in this Manual. When the tower is near vertical and the lower jumper struts are nearing ground contact, STOP the tower raising. The tower will be near-vertical but not at 90°.

Attach the front guys to their respective anchors (see Attach Front Guys for more detail). Follow the procedures outlined in Plumb and Straighten Tower to plumb the tower. Anticipate it taking longer to plumb the tower since the tower has to physically move a greater distance.

3. Perform site work before assembling the ginpole. Using an excavator or other suitable device, dig a hole 0.3 m (1 ft) in depth, approximately 9.4 m (31 ft) from the tower baseplate (in the direction of the final ginpole position) so that the ginpole jumper strut tips will not contact the ground but be below grade when the tower is vertical.

Slopes Less than -2°

For slopes less than -2° down from the baseplate-to-ginpole, the height from the ground to the top of the ginpole (when the tower is vertical) will exceed 8 feet. In this case, NRG recommends using a 12 foot step ladder to access the top of the ginpole to remove the lifters for storage. Alternatively, one could use scaffolding to access the top of the ginpole if the site permits its transport and you are willing take the necessary steps to set it up.



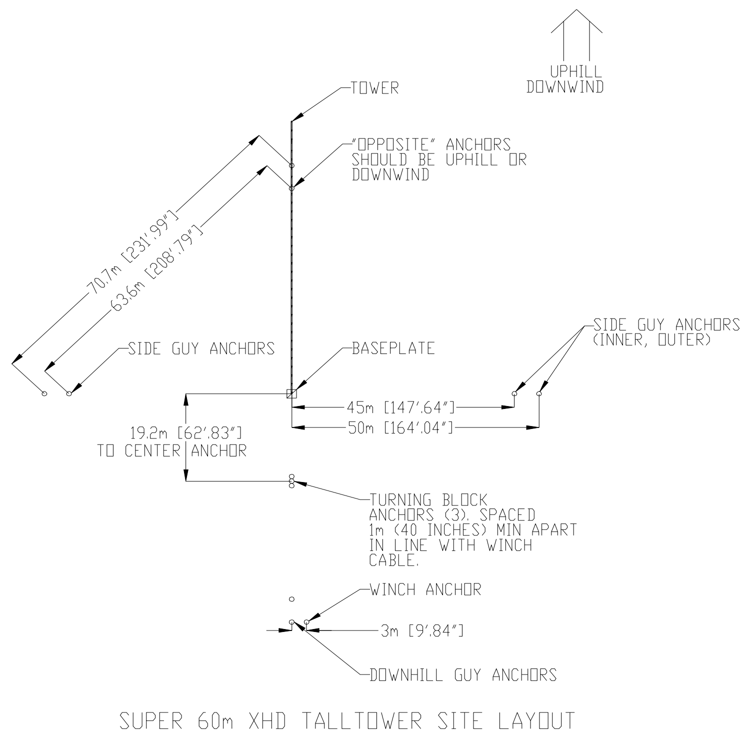
Picture 4

Lay out the site so that the tower is laid out downwind of the baseplate, to ensure that the tower will be lifted into the wind.

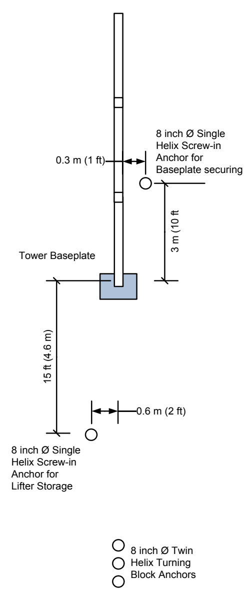
NOTE: When laying out a TallTower installation on a slope, measure the calculated distances along the ground to place the anchors. It is not necessary to compensate for the slope. TallTower guy wires are long enough to allow for installation on slopes up to 3° while maintaining the ideal angle between the tower and the guys.

Measure carefully to place the anchor points, paying extra attention to the placement of the winch anchors. Verify that the anchor radii and the diagonal distances between anchors are correct (reference Picture 5 for Site Layout Map).

Picture 6 shows a magnified plan-view of the tower baseplate and tower showing the placement of two (2) 8-inch diameter single helix anchors. One of these 8-inch diameter single helix anchor is used to secure the tower baseplate; the other is used for storing the lifters.



Picture 5: Super 60 m XHD Site Layout Map (plan view)



Picture 6: Placement of 8 inch Single Helix Screw-in Anchors (2)

NOTE: The side guy anchors and the base plate should be on a straight line. If it is not possible to place them in the locations shown, it is better to move them in or out along the line to the baseplate than to move them off the line. Do not move them more than 1.5 m (5 feet) off the line.

NOTE: Extra care will have to be taken while raising the tower if:

Anchor placement is not perpendicular to the tower as it lays on the ground.

Anchors are not at the same elevation.

Side anchors and base plate are not in a straight line.

NOTE: Any of these conditions will affect the side guy wire tension and the ginpole safety wire rope tension as the tower is raised. Tension will have to be continuously monitored and periodically adjusted as the tower is lifted.

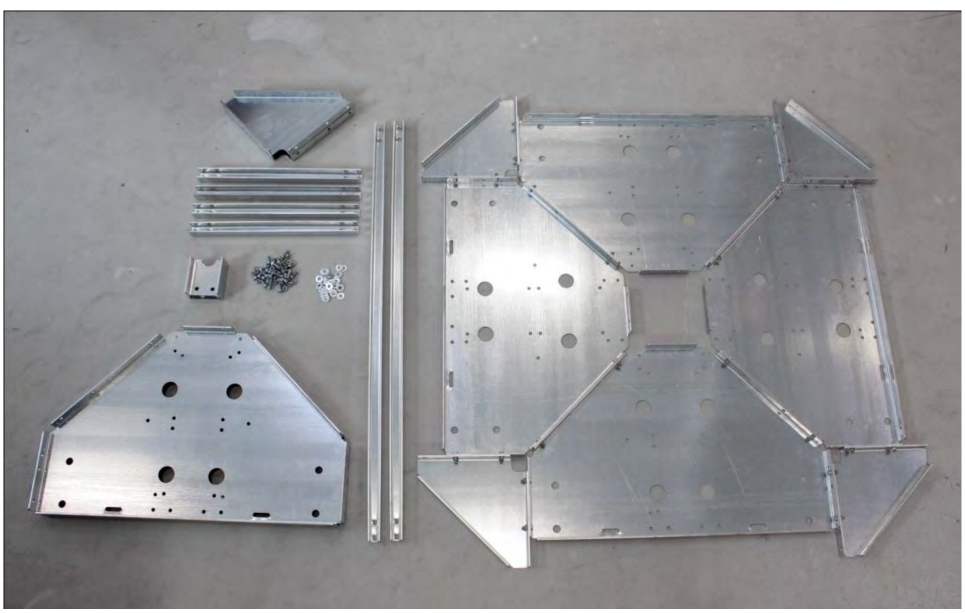
Placement of the winch anchors is critical. Make sure that you measure carefully and set the anchor heads close to ground level. Angle all three anchors towards the tower at 45 degrees.

All of these factors are important for proper distribution of forces and for clearance and proper operation of the ginpole.

Tower Assembly

Assemble the Baseplate

The baseplate will be located according to the site layout map described in the Section entitled Site Layout. It is often easiest to assemble the baseplate on-site where the tower will be installed. Assemble 4 of the 6 large triangular baseplate sections as shown in Picture 7.

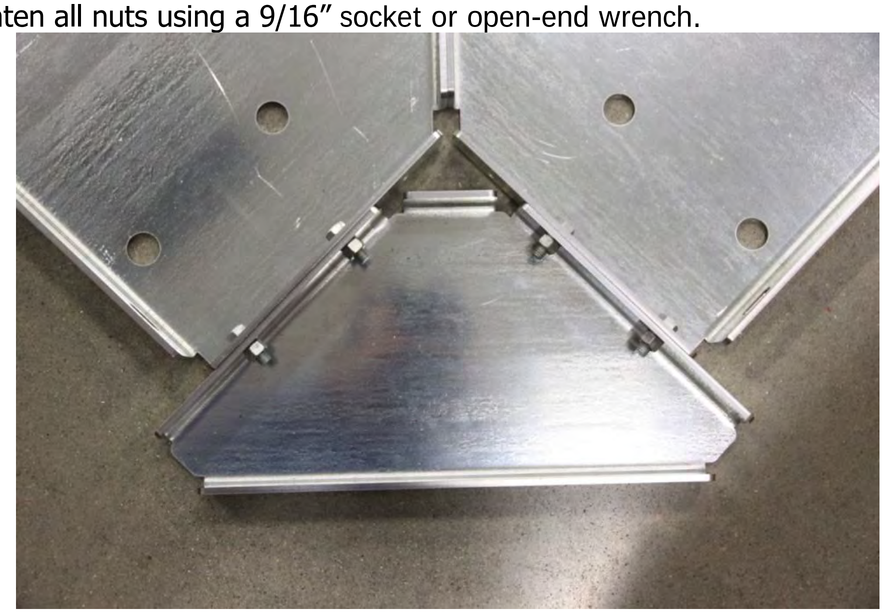


Picture 7

Insert eight (8) 3/8"-16X1" bolts in the outer holes of each mating flange. Leave nuts somewhat loose; tighten by hand only.

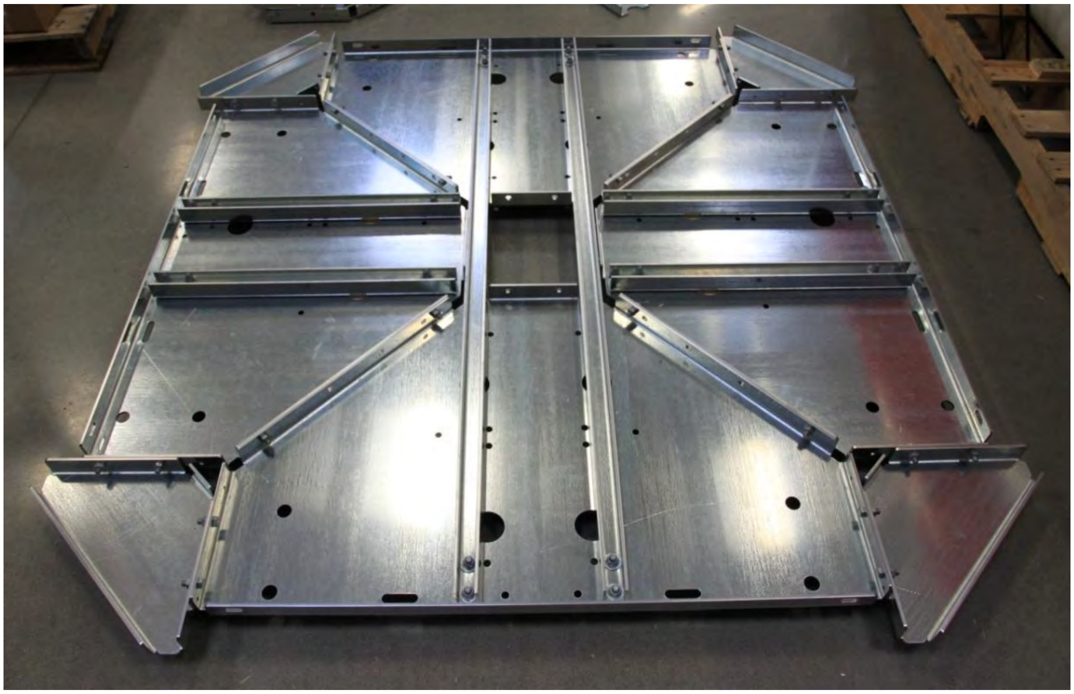
Picture 8

Bolt the corner pieces to the triangular baseplate section using sixteen (16) 3/8″-16X1″ bolts, as shown in Picture 9. Tighten all nuts using a 9/16″ socket or open-end wrench.



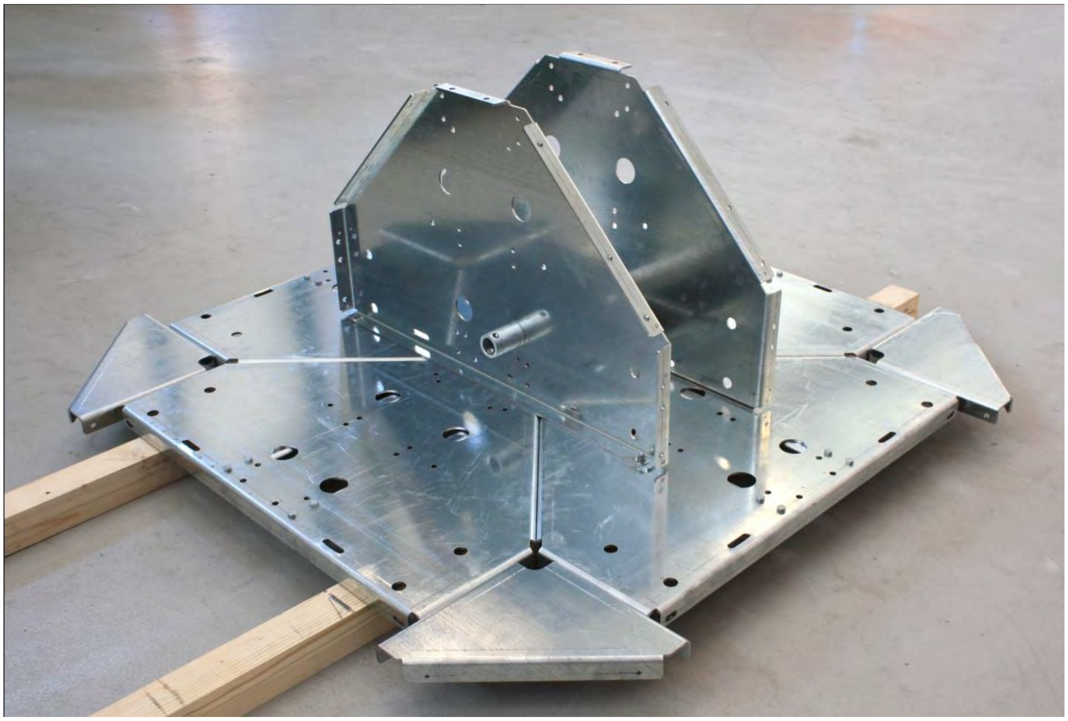
Picture 9

While the baseplate is upside down, attach the six (6) stiffeners as shown. Note two (2) of the stiffeners are long and extend the full dimension of the baseplate. The other four (4) stiffeners are short and extend from the edge of the baseplate to the center square hole. Use washers under the 3/8″-16 nuts of the slotted holes in the channels.

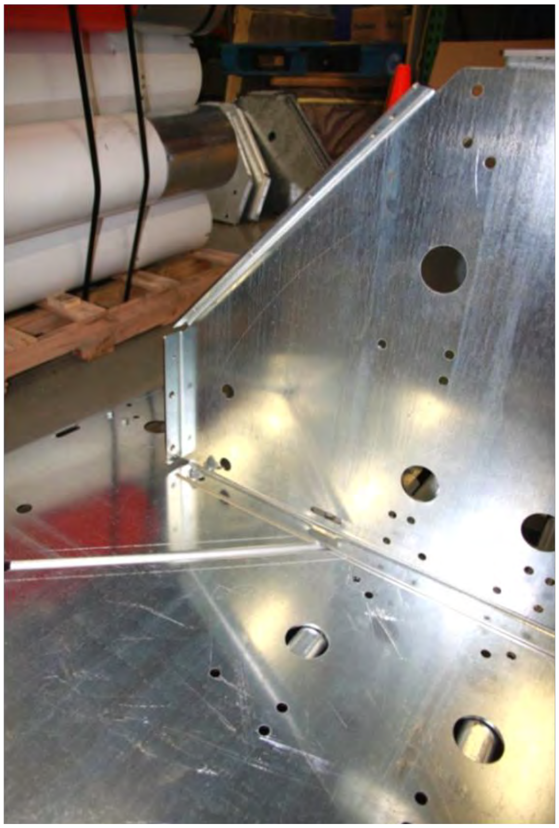


Picture 10

Flip over the baseplate assembly, and prop up on one edge to allow access to underside of baseplate. Attach the vertical uprights to the center of the baseplate as shown in Picture 11, with flanges facing outward, and with the vertical pieces perpendicular to the two (2) long stiffeners (visible through center hole). Use washers under the nuts to cover the slotted holes.



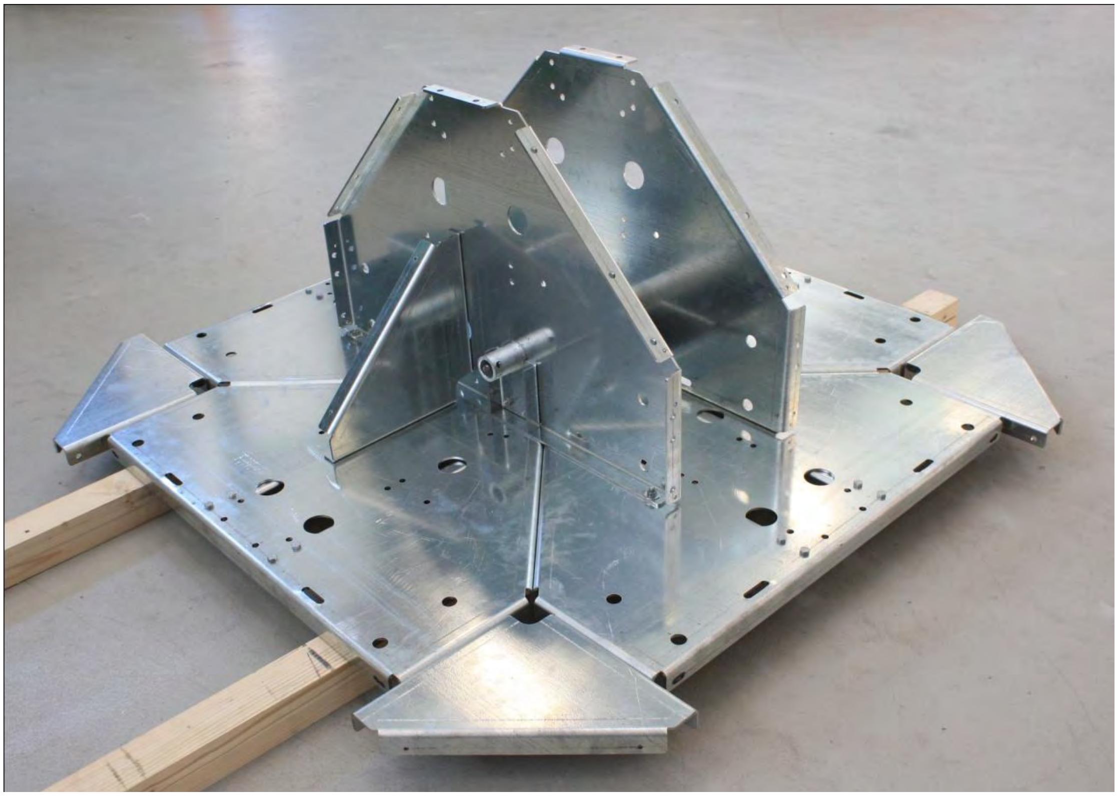
Picture 11



Picture 12

Picture 13

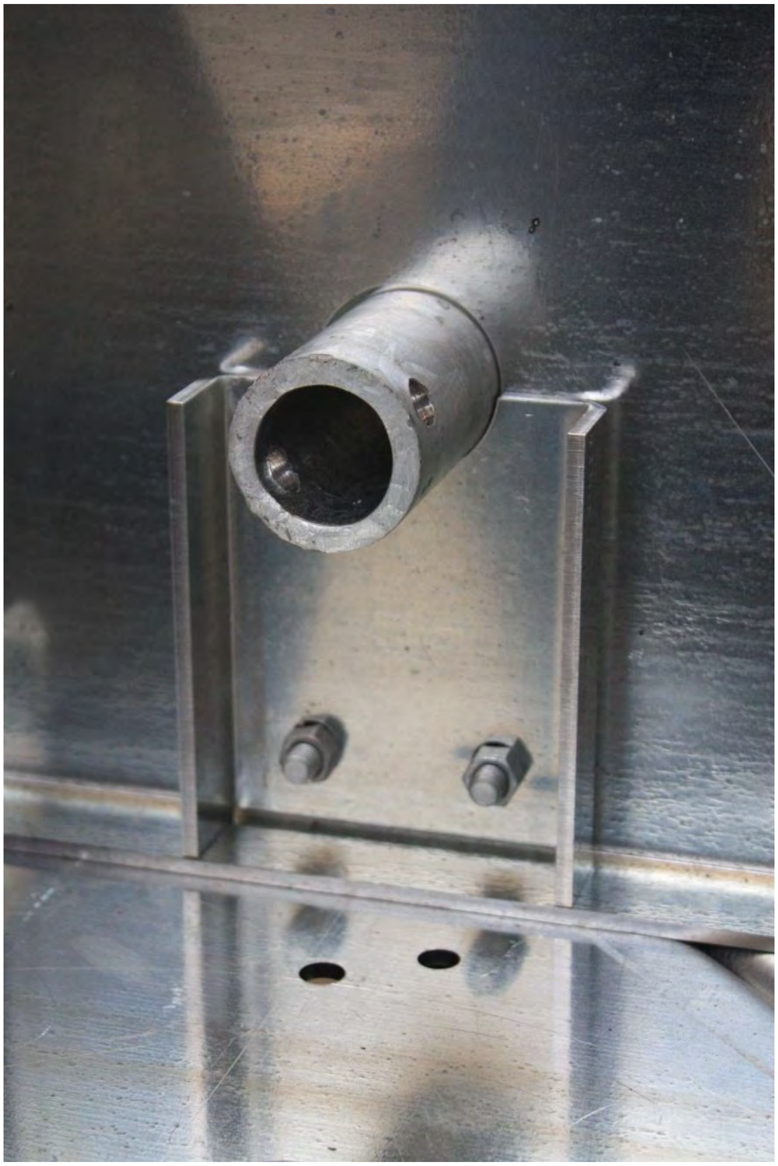
Install gussets directly across from each other, attaching them perpendicular to the vertical uprights as shown in Picture 14. Be sure to install the gusset bolts with the nuts toward the gusset. Tighten all bolts in the baseplate.



Picture 14

Picture 15

Install the doublers on the vertical pieces as shown in Picture 165. Carefully align the "saddle" cutouts with the large holes in the vertical pieces so that the pivot tube can pass through (inserting the pivot pipe as shown in the photo will aide in the correct placement of the doublers). Make sure the bolt and nut are oriented as shown, nut on the outside.



Picture 16

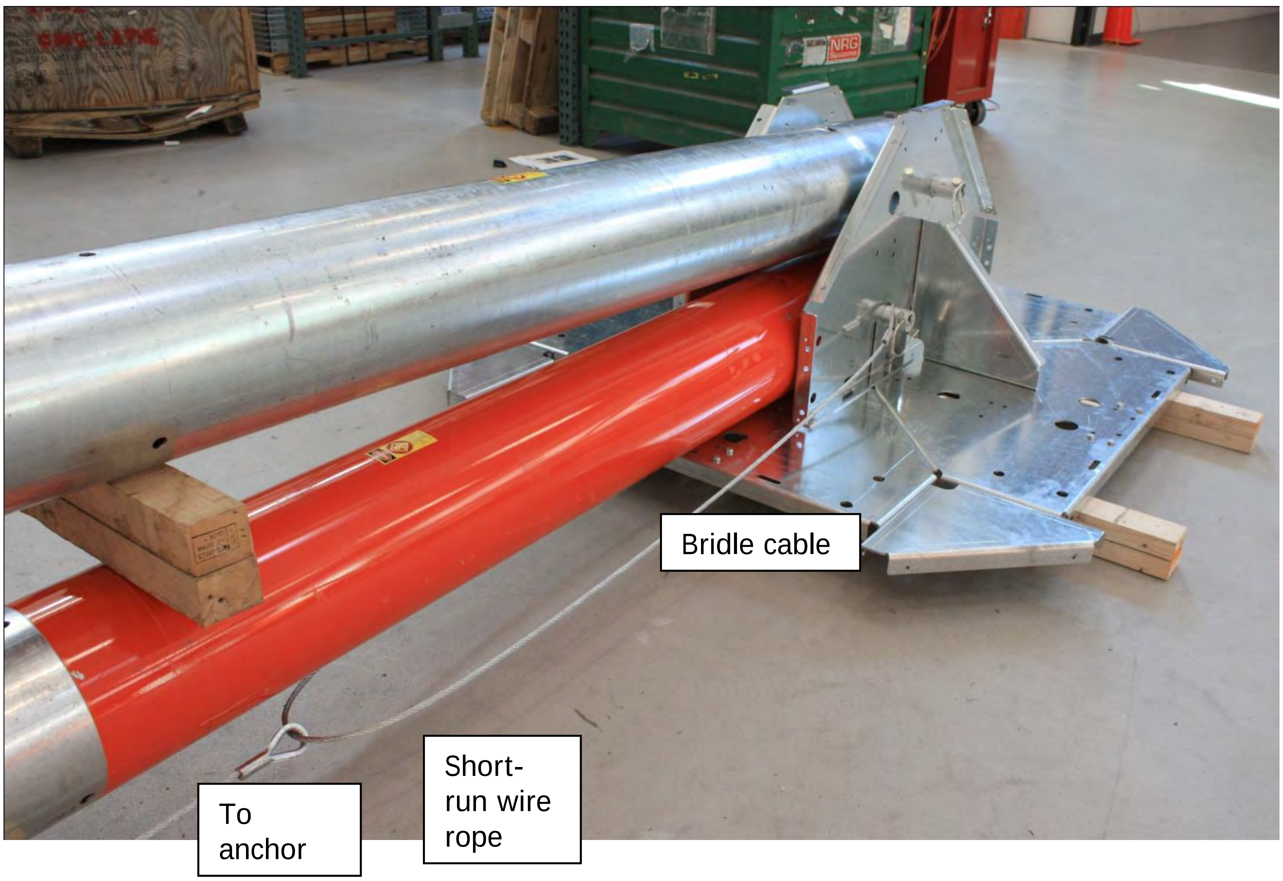
Place the baseplate at the installation site, orienting it with the gussets closer to the winch.

At the beginning of a lift, the forces acting on the baseplate are predominantly horizontal. These forces tend to slide the baseplate toward the winch and/or tip the baseplate up on edge. To counteract these forces, the baseplate must be anchored using the set-up described in the section entitled Cable from Baseplate to 8" Screw-in Anchor.

Cable from Baseplate to 8″ Screw-in Anchor

A bridle cable and short-run of wire rope (assembly supplied with the tower) are used to secure the baseplate. The bridle straddles the tower tube pivot pipe, as shown in Picture 17. Secure the bare-end of the short-run of wire rope (attached to the bridle) to the 8″ screw-in anchor. The 8″ screw-in anchor is installed in close proximity to the baseplate (for details on anchoring, see the section entitled Site Layout Map). Thread the bare-end of the wire rope through the triple-eye of the 8″ anchor. Make sure the cable assembly is tight (no sag) using a come-along and Chicago Grip to assist. Secure the bare-end wire rope using three (3) 5/16″ wire rope clips.

Drive ground rods through the baseplate holes to provide a grounding pathway for the tower and additional anchoring for the baseplate. Affix a 5/8″ Acorn clamp to each of the ground rods. Clamp one end of the bare 8-gauge copper wire to the Acorn clamp and the other end to the tower, affixed to a ground lug and screwed into the baseplate.



Picture 17

Picture 18

Picture 19

Install the Anchors

See Appendix B: Anchoring Guidelines for more information on installing anchors. Depending on the soil type, anchoring can take varying levels of planning, effort and time. Be sure to know what soil types you are dealing with as part of your pre-installation planning process.

Leave the eye of all anchors approximately 150 mm (6 inches) above ground.

Tube Layout

Lay out the disassembled tube sections on the ground according to sequence described, beginning at the baseplate. Pay close attention to the location of the guy rings, the transition tube, and the color of the tubes (for painted towers). Refer also to the Tower Layout drawing located in Appendix A: 80m XHD with Standard Footprint and the painted tower drawing located in Appendix G: Super 60m TallTower Painted Version.

Table 3: Tube Layout (SI Units)

Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Base Tube + (4) 2.2 m, 254 mm Ø Tubes No guy ring on this section.	(5) 2.2 m, 254 mm Ø Tubes Guys attached to this guy ring are color coded: Red	(5) 2.2 m, 254 mm Ø Tubes Guys attached to this guy ring are color coded: White	(5) 2.2 m, 254 mm Ø Tubes Guys attached to this guy ring are color coded: Black	(5) 2.2 m, 254 mm Ø Tubes Guys attached to this guy ring are color coded: Yellow	(4) 2.2 m, 254 mm Ø Tubes + (1) Transition Tube + (1) 2.2 m 203 mm Ø Tube Guys attached to this guy ring are color coded: Blue	(1) 2.2 m, 203 mm Ø Tube Guys attached to this guy ring are color coded: Green

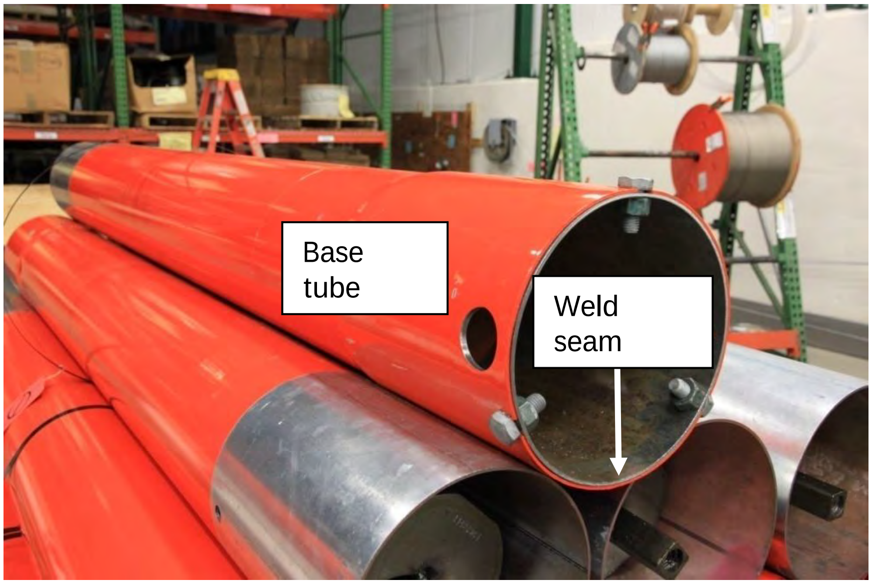
Table 4: Tube Layout (Imperial Units)

Section 1	Section 2	Section 3	Section 4	Section 5	Section 6	Section 7
Base Tube + (4) 87 inch, 10 inch Ø Tubes No guy ring on this section.	(5) 87 inch, 10 inch Ø Tubes Guys attached to this guy ring are color coded: Red	(5) 87 inch, 10 inch Ø Tubes Guys attached to this guy ring are color coded: White	(5) 87 inch, 10 inch Ø Tubes Guys attached to this guy ring are color coded: Black	(5) 87 inch, 10 inch Ø Tubes Guys attached to this guy ring are color coded: Yellow	(4) 87 inch, 10 inch Ø Tubes + (1) Transition Tube + (1) 87 inch, 8 inch Ø Tube Guys attached to this guy ring are color coded: Blue	(1) 87 inch, 8 inch Ø Tube Guys attached to this guy ring are color coded: Green

Install the Tower Base tube

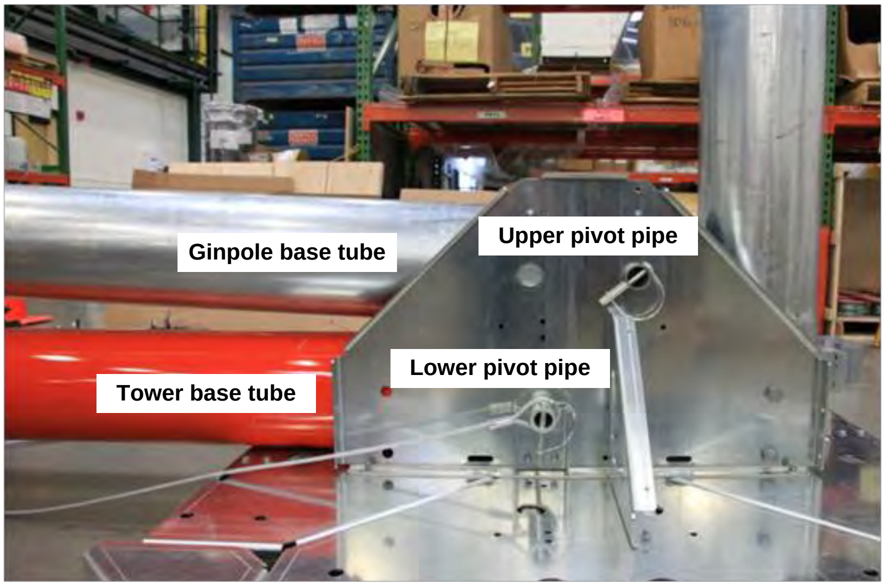
Identify the tower base tube. The base tube has a 51 mm (2 inch) diameter hole drilled through the flared (wider) end. It also includes an insert in the flared portion of the tube, as shown in Picture 20.

NOTE: Both the tower and ginpole base tubes possess a 51 mm (2 inch) diameter hole drilled through the flared end. However, the tower base tube is painted orange whereas the ginpole base tube is not painted.



Picture 20

Attach the base tube to the baseplate using the pivot pipe through the lower holes in the center of the baseplate sides. Make sure the weld seam of all tubes points down, as shown in Picture 20. Make sure the base tube is pointed in the direction intended for tower assembly and subsequent tilt-up (see Site Layout for more details on tower layout). Secure the pivot pipe using a quick release pin at each tube end.



Picture 21

Install Tower Tube

Insert 5/8"-11X1-1/2" bolts through the holes in the un-flared tube end. Place a 5/8" inner diameter washer and a 5/8"-11 nut loosely on each bolt. Make sure the bolts are inserted from the inside of the tube (nuts are on the outside of the tube), as shown in Picture 22 and Picture 23. Line up the mating slots in the flared end of the mating tube with the bolts in the un-flared tube – one bolt is aligned vertically and the remaining two bolts point downward.

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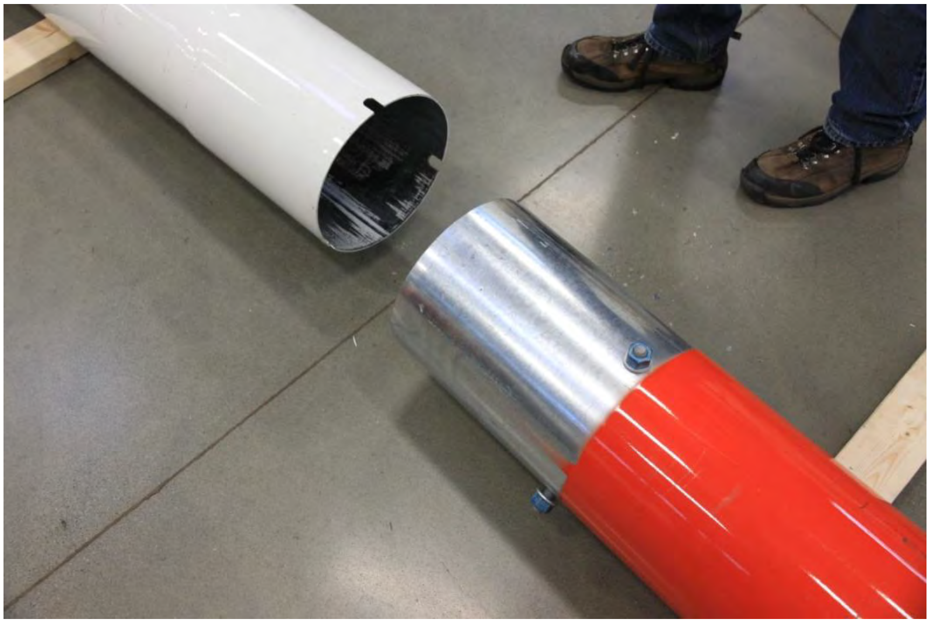
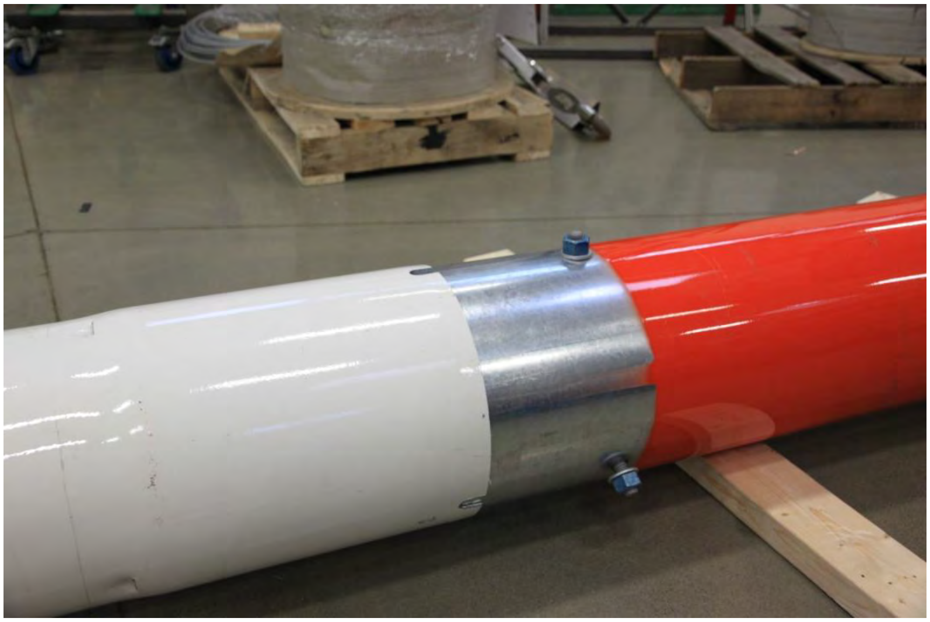
Picture 22



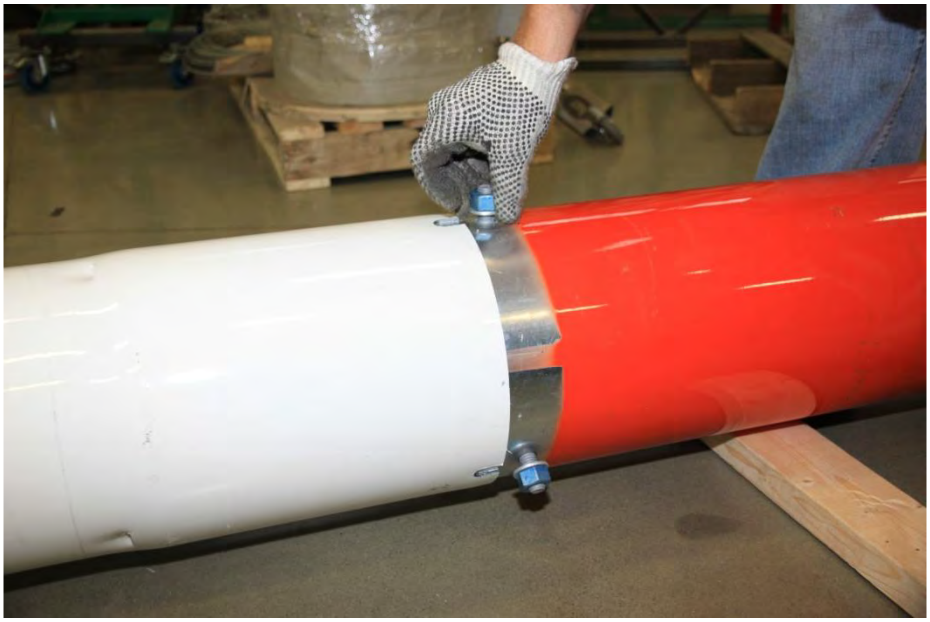
Picture 23

Slide tube sections together, as shown Picture 24.



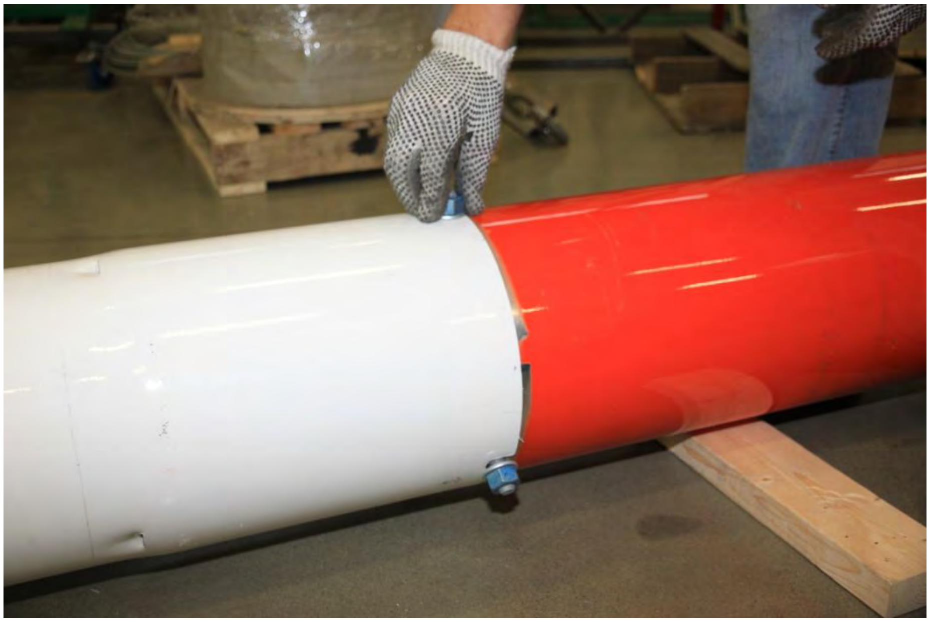
Picture 24

As the flared end nears the bolts, pick up top bolt and washer so that the slot can mate with the bolt shank. Continue to slide the mating tubes together until the slots bottom out against the bolts.



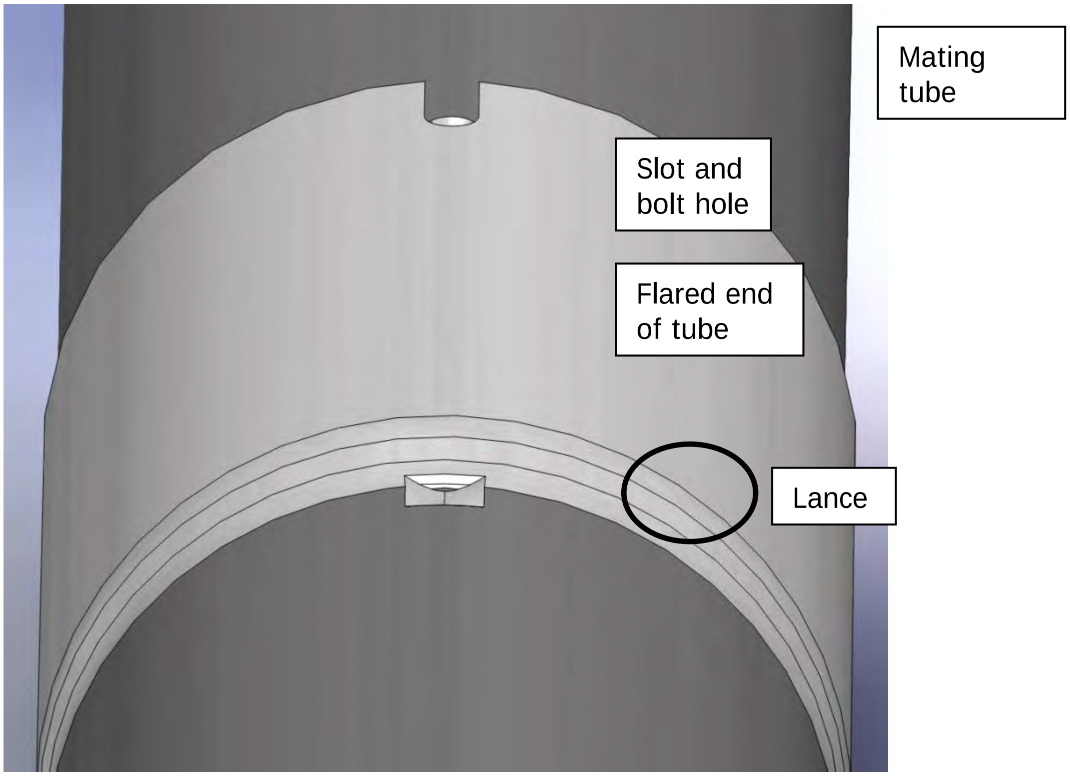
Picture 25

Hand tighten the nuts.



Picture 26

Place a wood block against the unflared end of the mating tube, as shown Picture 28. Using a mallet, hammer the wood block several times using a firm blow. Verify the end of the mating tube is less than 3.2 mm (1/8 inch) from each of the three (3) the lances. If the gap between the tube and any of the lances exceed 3.2 mm (1/8 inch), apply additional blows to the wooden block using the mallet until the tube is fully seated.



Picture 27

Picture 28

Using a torque wrench and 1-1/16″ socket, torque the 5/8″-11 nuts to 203 Nm (150 ft-lbs).

Picture 29

Picture 30

To provide anti-rotation to the bolt-nut assembly, screw on 5/8”-11 Palnuts on top of each 5/8”-11 nuts.

Continue to assemble the tubes in the manner described above and place guy rings over the tubes according to the sequence outlined in Table 3 and Table 4.

Make sure the guy ring is placed so the guy ring corners are bent towards the baseplate, and the guy ring corners are in line with each anchor point. Place wood blocks every 5 to 6 meters (15 – 20 feet) to support the tower above the ground, keeping the tower as straight as possible.

Attach the lightning spike

Attach the lightning spike to the top tower tube using the three (3) hose clamps provided. To prevent the lightning spike from rotating, insert the ¼-14X1.25” self-drilling screw into the clearance hole, near the base of the rod, and drive the screw into the tower tube using an electric drill and 3/8” bit as shown in Picture 32.

If you are using a Flash Technology L-864 beacon light as part of your obstruction marking system, the lightning spike must stick up above the light a minimum of 0.9 m (36 inches) to satisfy required clearance distances. In addition, for the Flash Technology L-864 beacon, there must be a minimum of 0.45 m (18 inches) of clearance between the lightning spike and the mounting plate or beacon housing as shown in Picture 31.

Clearance distances between the lighting system and lightning rod are make and model dependent. Check with the manufacturer of the lighting system you are using to verify the required clearances. Adjust or modify the lightning spike accordingly.

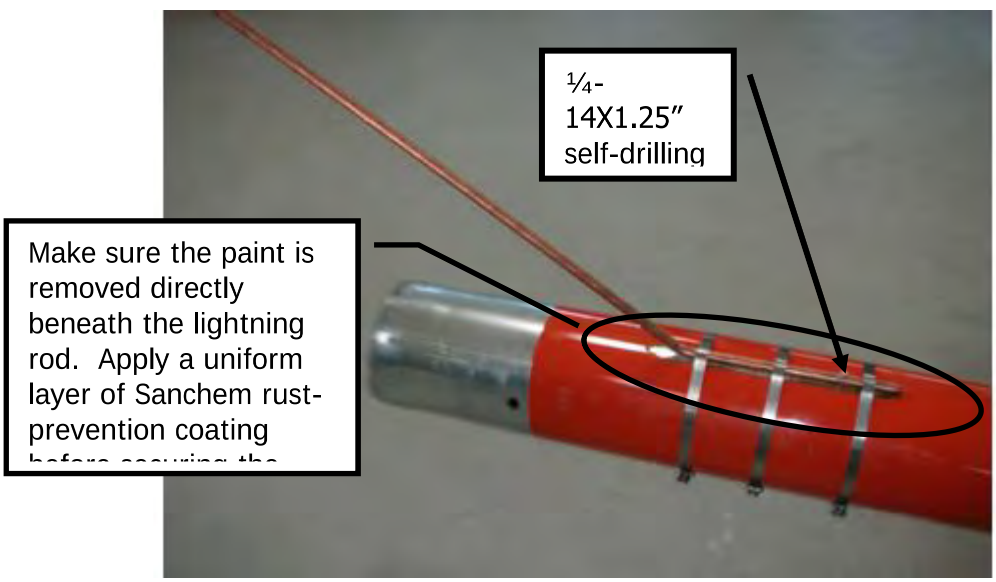
You will need to prepare the surface of the top tower tube by removing the orange paint directly beneath the lightning spike. Use a grinder or other suitable device to remove the paint from the tube to ensure the lightning spike will be in direct contact with bare metal (see Picture 32). Once the paint is removed, apply a liberal layer of rust-prevention coating (such as Sanchem, Inc. NO-OX-ID "A-SPECIAL") to ensure a long-term bond between the lightning rod and metal tube.

Your lightning spike installation should look similar to the set-up shown in Picture 31.

NOTE: Analysis and testing conducted by NRG Systems verified the copper down-tower conductor is not necessary for lightning protection of the tower and instruments. The copper down-tower conductor is not included in the lightning kit.

For more details on lightning protection, contact Renewable NRG Systems.

Picture 31



Picture 32

Attach sensors and booms

Assemble the sensors, sensor boots, and sensor signal cables to the booms. Wrap the sensor signal cables to the boom. Secure with weather rated electrical tape such as Scotch Super 88. Secure the booms to the tower with the supplied hose clamps.

Picture 33

If you purchased the sensors and booms as part of a NRG-NOW System, cabling was supplied for (1) 60 m level direction vane, (2) 60 m level anemometers, (1) 50 m level direction vane, (2) 50 m level anemometers, and (2) 40 m level anemometers. It is always easiest to run the cables from the sensor and booms down the tower. Refer to Appendix E: Aligning Wind Vanes for wind vane alignment tips.

Spiral wrap your sensor cables

Spiral-wrap the sensor cables around the tower, completing one wrap per tube joint. The spiral-wrap destablilizes vortex shedding and minimizes natural frequency oscillations of the tower. Use electrical tape to secure the sensor cables to the tower every few meters. Also tape cables to the tower above and below each guy ring. Where the cables cross each guy ring, protect the cables by wrapping them with a thick layer of electrical tape as shown in Picture 34.

Picture 34

Attach the Guy Wires

Organize and layout the lifters and guy wires

On the Super 60 m XHD TallTower, there are 24 guy wires and 6 lifter wires. Both sets of guy wires and lifters are color coded for the different levels to make this job easier. **Be very careful to place all wires exactly as described below to avoid having to disassemble and re-assemble.**

Sort out and identify the different length guy wires and match them with the appropriate guy ring level and place them on the right-hand side of the tower at the corresponding guy level. Also, make sure the front guy wires are placed opposite of the quadrant occupying the lifter securing anchor. This will ensure the front guys do not get entangled with the lifters.

To minimize the risk of entangling the lifters and guys, it is recommended that back guy wires (the guy wires opposite the winch) are attached to their guy rings, rolled out, and secured to their anchors first (as described below). Once the back guys are laid out, roll out the side guy wires, and then proceed to lay out the front guys.

Sort out and identify the different length lifter wires and match them with the appropriate guy ring level and place them on the left-hand side of the tower at the corresponding guy level.

Table 5: Super 60 m XHD TallTower Guy Levels

Guy Ring Level	Label Text	Label Color
1 Lowest Level	9.90 m (32.5 feet)	Red
2	19.36 m (63.5 feet)	White
3	28.82 m (94.6 feet)	Black
4	38.28 m (125.6 feet)	Yellow
5	47.74 m (156.6 feet)	Blue
6 Highest Level	57.86 m (189.8 feet)	Green

Shackle guy wires to the guy rings

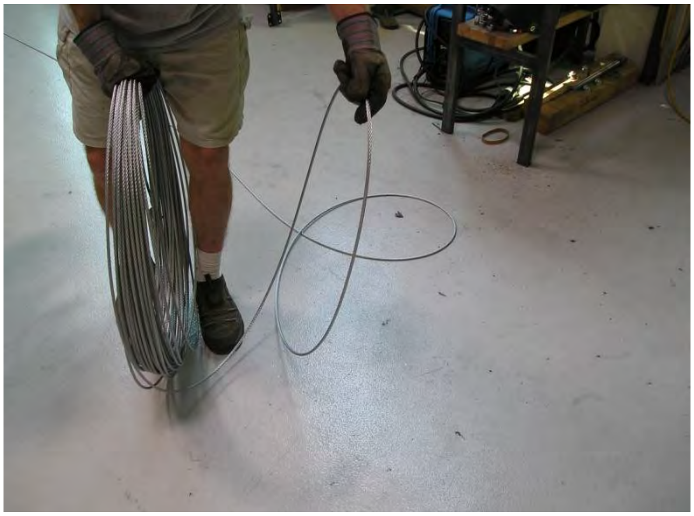
Secure the back guy wires first to their corresponding guy rings using shackles. Attach the guy wires to the guy ring holes under the tower tube. Roll out the back guy wires to their anchor points and secure as described below. Next secure the side guy wires to their corresponding guy rings using shackles. The side guy wires attach to the side guy ring holes. Roll the side guy wires out to their anchor points and secure. Lastly, secure the front guy wires to their corresponding guy rings using shackles. The front guy wires attach to the top guy ring holes. Roll out the front guy wires along the right-hand-side of the tower in a direction towards their anchor points. The front guy wires will be secured after the tower has been erected.

Roll out each guy wire from the tower to its anchor point

Do not allow twists or kinks in the guy wires. The guy wire and lifter coils can be uncoiled in a hand-over-hand method while walking out towards each anchor.

Picture 35: CORRECT

Do not un-spool cable off the side of the coil as shown in Picture 36.



Picture 36: NO!

Pass the split rings through the eye of each shackle bolt to keep the shackle pins from loosening.

Picture 37

Secure guy wires to the anchors

Secure guy wires to the back and side anchors by threading the cable through the anchor loop and clamping the cable onto itself using 3 wire rope clips. Place the wire rope clip on the wire so the saddle (the forged, grooved part) cradles the wire coming from the tower and the "U" bolt part clamps down on the dead end of the guy wire ("Never saddle a dead horse" may help you to remember how to secure the wire rope clips).

Picture 38

Picture 39

Leave a little slack in the guy wire, and tighten the wire rope clip nuts. Don't tighten the wire rope clip nuts too tightly; you will need to adjust the guy length numerous times as the tower is erected.

Shackle lifter wires to the guy rings

Secure the lifter wires to the upper shackles containing the front guy wires on the top of the tower tube. Carefully lay out the lifters in an orderly fashion on the left-hand side of the tower. The unattached ends can easily become entangled around each other and the other guy wires lying on the ground. In terms of stacking, make sure that the back guys are at the bottom followed by the side guy wires, the front guy wires, and, lastly, the lifter guy wires. Keeping the lifter wires organized will avoid having to stop during the lift process to untangle the front guys or lifters. A picture showing the attachment of the 4th level (Yellow) lifter and front guy is shown in Picture 40.

Picture 40

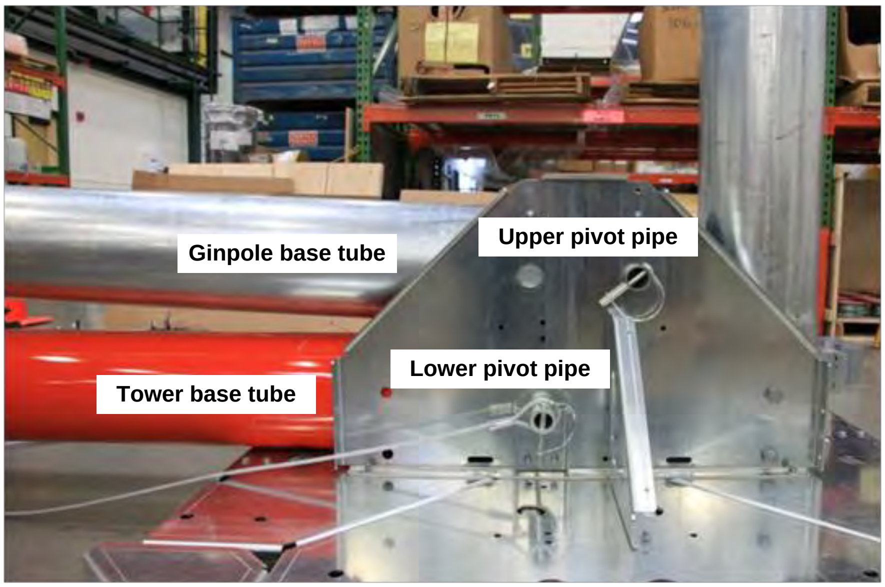
Ginpole Assembly

Layout the ginpole tubes

Identify the ginpole, helper ginpole tubes, and hardware.

Attach the ginpole base tube to the baseplate

The ginpole base tube lays on top of the tower base tube. Place the ginpole base tube with the pivot pipe clearance hole between the baseplate's vertical channels. Line up the holes in the ginpole base tube with the holes in the baseplate's vertical channels and insert the pivot pipe through the baseplate clearance holes. Secure the pivot pipe with quick release pins.



Picture 41

Slide together the 10 tubes that comprise the ginpole

Slide and bolt sections together following the instructions specified in the previous section entitled Install Tower Tube. Aligning the weld seams (visible on interior of tubes) of each tower section will make it easier to slide the sections together. Place a log, sawhorse, or other type of support underneath the 8^{th} or 9^{th} section to raise the ginpole above the tower tube – make sure there is at least 0.76 m (2.5 feet) of clearance between the ground and ginpole tube #5.

Picture 42

NOTE: Make sure the jumper strut center ring plates are slipped over the flared end of ginpole tube #6 prior to installing tube #7 in the build sequence. Failure to do so will require partial disassembly of the ginpole tubes because the center ring plates cannot be installed after the complete assembly of the ginpole.

Picture 43

Slide and bolt the top ginpole section on so that the slot in the ginpole top is perpendicular to the ground, as shown in the Picture .

Picture 44

Attach the ginpole jumper strut end-flanges

Attach the ginpole jumper strut end-flanges to the ginpole base tube. There are four (4) end-flanges per tube. Slide the end-flanges of the base tube flush against the flared end of ginpole tube #2. Use ½"-13X1-1/4" bolts and ½"-13 hex nuts to secure the end-flanges and tighten using a ¾" socket or open-end wrench.

Picture 45

Align the end-flanges so that upper 5/8″-11X1-1/2″ bolt is in the middle of the top end-flange, as shown in Picture 46.

Picture 46

Attach the ginpole jumper strut end-flanges to ginpole tube #10, above the flared-end, as shown in Picture . To ensure correct orientation of the end-flanges, make sure the top tube 5/8-11X1-1/2" bolt bisects the top end-flange.

Picture 47

Attach the turnbuckles to the end-flanges

Attach the four (4) turnbuckles to the end-flanges affixed to the lower ginpole base tube, as shown in Picture . Secure the turnbuckles by tightening the supplied hardware.

Picture 48

Unscrew the turnbuckles fully and apply Anti-Seize to the threads as shown in Picture .

Picture 49

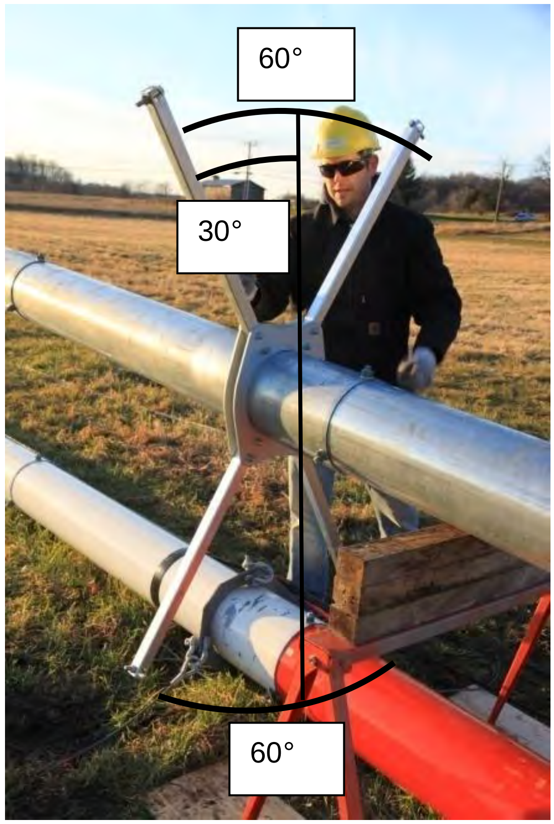
Attach the ginpole jumper struts

Install the ½”-13X2.5” bolts through the ends of the four (4) square tube jumper struts. Tighten the ½”-13 nuts using a ¾” socket or open-end wrench.

Picture 50

Install the four (4) square tube jumper struts between the center rings as shown in Picture . Use ½”-13X2.5” inch bolts and ½”-13 nuts to secure and tighten using a ¾” socket or open-end wrench.

NOTE: Make sure the jumper struts are oriented as shown in Picture . The top and bottom jumper struts are 60° apart and oriented approximately 30º with respect to vertical.



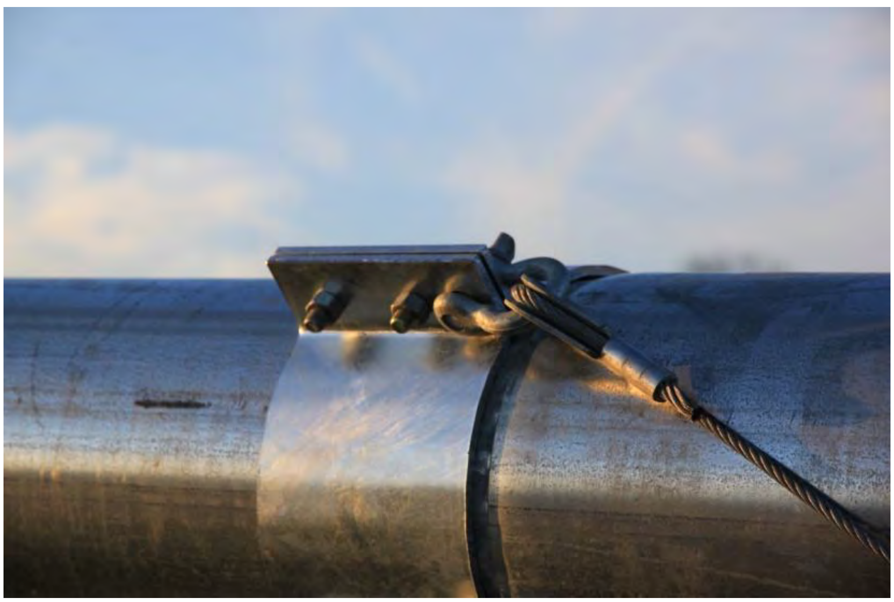
Picture 51

Picture 52

Attach the ginpole jumper strut cables

Locate the four (4), 54 foot long, jumper strut cables outfitted with 5/16" thimbles and ½" shackles. Affix the ½" shackles from each jumper strut cable to the available clearance hole on the top end-flange, as shown in the pictures below.

Picture 53



Picture 54

Picture 55

Pass each jumper strut wire through the larger clearance hole at the tip of each jumper strut, as shown in Picutre 55 & 56. Alternatively, you might consider passing the jumper strut wire through the clearance hole prior to inserting the ½"-13X2.5" bolts and ½"-13 nuts. Do not let any of the jumper strut wires cross or get tangled. Preserve the respective quadrant (upper left and right, lower left and right) for each jumper strut wire – rope attached to the upper left end-flange will pass through the upper left jumper strut and terminate on the upper left end-flange nearest the baseplate.

Picture 56

Remove the unused bolt and nut from each turnbuckle and insert a 5/16″ thimble into the clevis of the turnbuckle. Re-insert the bolt and nut and tighten. Now pass the 5/16″ jumper strut wire rope through the thimble, pull the wire rope taught (by hand) and secure the wire rope using three (3) 5/16″ wire rope clips, as shown in Pictures 57 & 58. The pass-through direction does not matter.

Picture 57

Picture 58

Attach the ginpole top mounting hardware

Assemble the left and right outer rocker plates together with the shim between the plates, using the three (3) 5/16″-18 hex head cap screws and locknuts, as shown in Picture 59. Loosely tighten the nuts at this time to permit sufficient clearance for the lifter thimbles.

Picture 59

While one crew person slips the left and right outer rocker plate assembly through the slot (from below) at the top of the ginpole, another crew member slips the inner rocker plate through the slot (from above) and inserts the 2-1/2″ diameter pivot pipe through all three plates.

NOTE: Make sure the plates are oriented as shown in the picture below.

Picture 60

Secure the 2-1/2" diameter pivot pipe with quick release pins on each end.

Picture 61

Important! Attach the Lifter Wires & Front Guy Wires

In order to avoid the front guy wires getting tangled on the upper tower bolts during the lift, attach the front guy wires to the lifter wires at the top of the ginpole.

Carefully lay out the lifters and front guy wires one level at a time starting at the lowest level (RED). In an orderly fashion, roll out the wires on the left-hand side of the tower back towards the ginpole. Keeping the two wires separate but lying flat near each other, use something to mark on the front guy wire the total length of the lifter. Leaving the front guy wire on the ground, take the lifter and attach the end to the rocker plate as shown in Picture 62 and Picture 63. Then take the level one front guy wire, add 12-16 inches to the mark you have made and attach that length to the matching level lifter. Attach beyond the colored tape, approximately 6 inches below the rocker plate with a wire rope clip (use the correct size wire rope clip to attach the wires together). This will create a little bit of slack so the front guy wires are never tightened during the lift. Continue this method one level at a time moving up the tower. Picture 64 shows what all guy wires and lifters look like when the tower is vertical.

In terms of guy wire stacking, make sure that the back guys are at the bottom followed by the side guy wires, the front guy wires, and, lastly, the lifter guy wires. Keeping the lifter wires organized will avoid having to stop during the lift process to untangle the front guys or lifters.

There are six (6) lifters employed on the Super 60 m XHD TallTower. The designation and markings are shown in

Table 6 below.

Table 6: Super 60 m XHD TallTower Lifter Marking

Lifter No.	Lifter Color	Coupler Plate Hole
6	Green	6 (top – away from base of tower)
5	Blue	5
4	Yellow	4
3	Black	3
2	White	2
1	Red	1 (bottom – toward base of tower)

Insert the thimble of each lifter between the left and right outer rocker plates, as shown in Picture . Secure each thimble using a 5/8″-11X2″ bolt and 5/8″-11 nut and tighten using a 1-1/16″ socket or open-end wrench.

NOTE: Be sure to connect the lifters in the proper order and make sure they are not tangled with each other or guy wires. In Picture and Picture , the shortest lifter [marked RED (see

Table 6)] attaches to the rocker plate closest to the tower baseplate; the longest lifter (marked GREEN) attaches to the 6th hole, in a direction away from the tower baseplate. Disregard the 7th and 8th holes of the rocker plate (ORANGE and PURPLE lifters) shown in Picture as these lifters are only included on the NRG 80m XHD TallTower.

After all the lifters have been installed in the rocker plate assembly, tighten the three (3) 5/16″-18 hex head cap screws and nuts.

Picture 62

Picture 63

Picture 64

Critical Installation Step: Attach the pulley blocks to the ginpole

It is mandatory that installers use a five (5) part line to raise the NRG Super 60 m XHD TallTower. The use of a 5-part line insures the lifting load is properly distributed to the rocker plate.

Attach the two (2) 5″ pulley blocks to the ginpole. The assembly sequence is as follows:

Insert one (1) 5/8″ shackle into each of the three (3) available holes in the inner rocker plate. The winch cable dead-end is attached to the lower shackle (as shown in Picture and described later).

Attach one (1) 5″ pulley block to each of the middle and upper 5/8″ shackles.

Attach two (2) ½″ shackles, one on each side of the pulley block, to the middle 5/8″ shackle.

Secure one (1), 3/16″ guy wire thimble to each of the two (2) ½″ shackles.

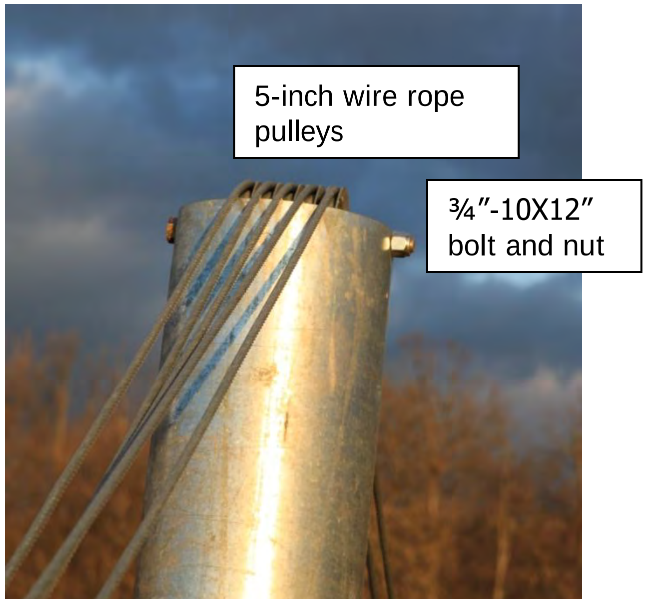
The assembly should look like the one shown in Picture .

Picture 65

Configure the helper ginpole

Locate the two (2), 254 mm (10 inches) diameter, thin-wall (12 GA), unpainted tubes, with only flared and lanced joints. These tubes comprise the helper ginpole. The base tube of the helper ginpole does have two (2) bolt holes in the flared end to accommodate two (2) 30.5 cm (12 inches) long through-bolts.

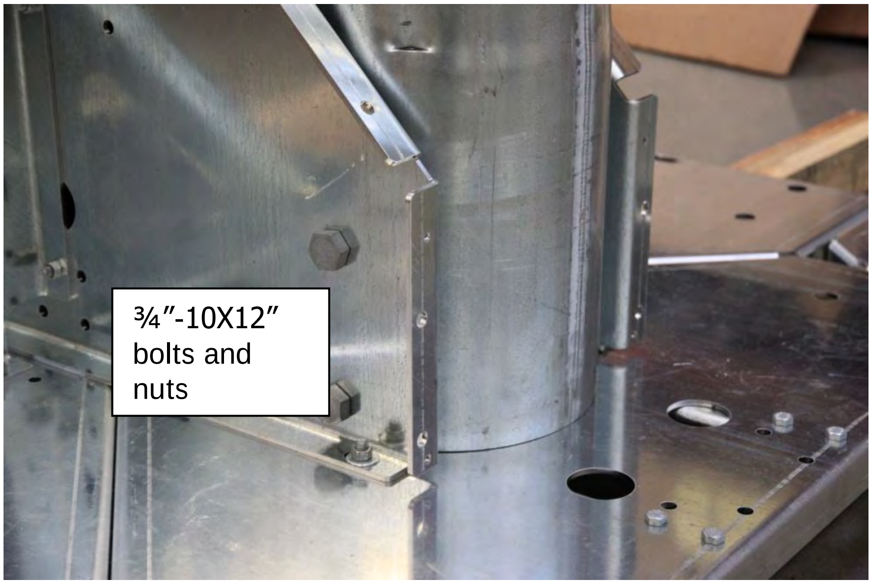
Assemble the top and bottom helper ginpole tubes together on a flat surface by sliding the tapered end of the bottom tube into the flared end of the top tube. Insert the ¾″-10X12″ long bolt through one of the top tube clearance holes. Slide the bolt through two of the provided spacers, then the five (5), 5-inch wire rope pulleys, through the second set of spacers, and, finally, through the second top tube clearance hole. Secure using the ¾″-10 nut supplied and tighten using a 1-1/8″ socket or open-end wrench.



Picture 66

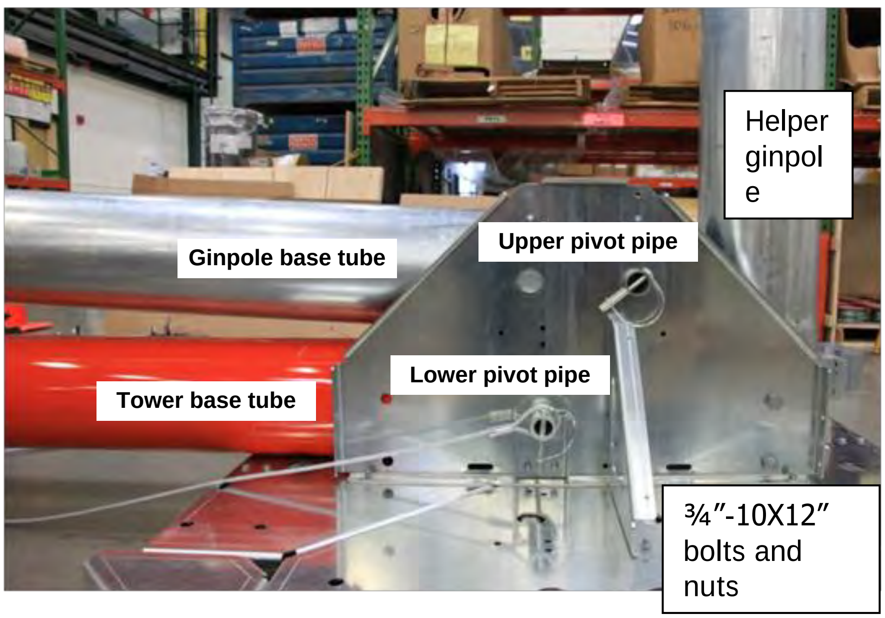
Tilt-up the helper ginpole assembly, making sure the (unused) clearance holes are on the bottom and the V-belt pulleys point to the sky. Walk the helper ginpole between the uprights of the baseplate behind the tower and ginpole base tubes, aligning the clearance holes of the tubes and uprights. Insert the two (2) ¾″-10X12″ bolts through the holes on the helper ginpole tube and secure with ¾″-10 nuts. Tighten the nuts using a 1-1/8″ socket or open-end wrench.

Picture 67



Picture 68

The completed baseplate and base tube assembly should look like the one in Picture 69.



Picture 69

Setting up the winch and hydraulic power unit (HPU)

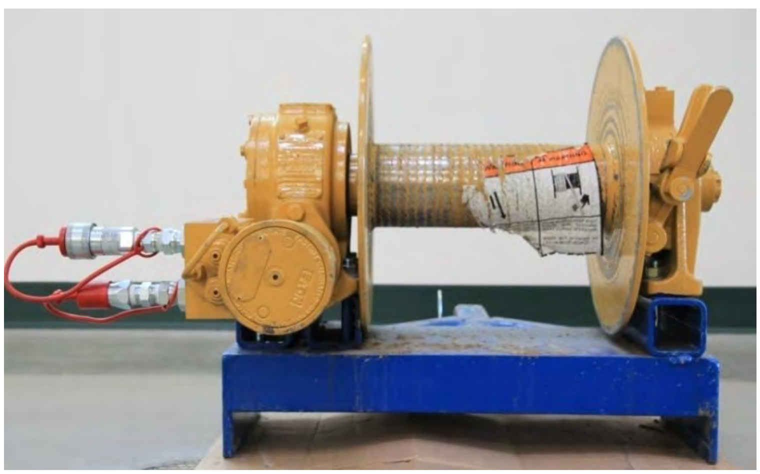
The NRG Systems supplied winch kit (NRG Kit # 4234) consists of the following equipment:

- Bloom Manufacturing Inc. Winch Model LS10H-6.2T-XL14-20-5884
- Drum spooled with 228.6 m (750 feet) of 3/8 inch diameter wire rope (per Federal Spec RR-W-410F)
- Winch support plate [to mount to 51 mm (2 inch) receiver hitch]

NOTE: The winch for the Super 60 m XHD is the same winch used to install the 80m XHD TallTower. Therefore, the winch for the Super 60 m XHD TallTower is compatible with the 80m XHD TallTower and can be used to raise and lower the 80m XHD TallTower. The winch for the Super 60 m XHD TallTower is NOT compatible with the NRG 50m XHD and 60m XHD TallTowers and SHALL NOT be used to raise and lower these towers.

Caution: The winch cable is not wound under tension. ON FIRST USE, DO NOT USE THIS WINCH TO LOWER A SUPER 60 M XHD OR AN 80 M XHD TALLTOWER. To properly tension the winch cable, MAKE SURE THE FIRST USE OF THIS WINCH IS TO RAISE THE NRG SUPER 60 M XHD OR AN NRG 80 M XHD TALLTOWER.

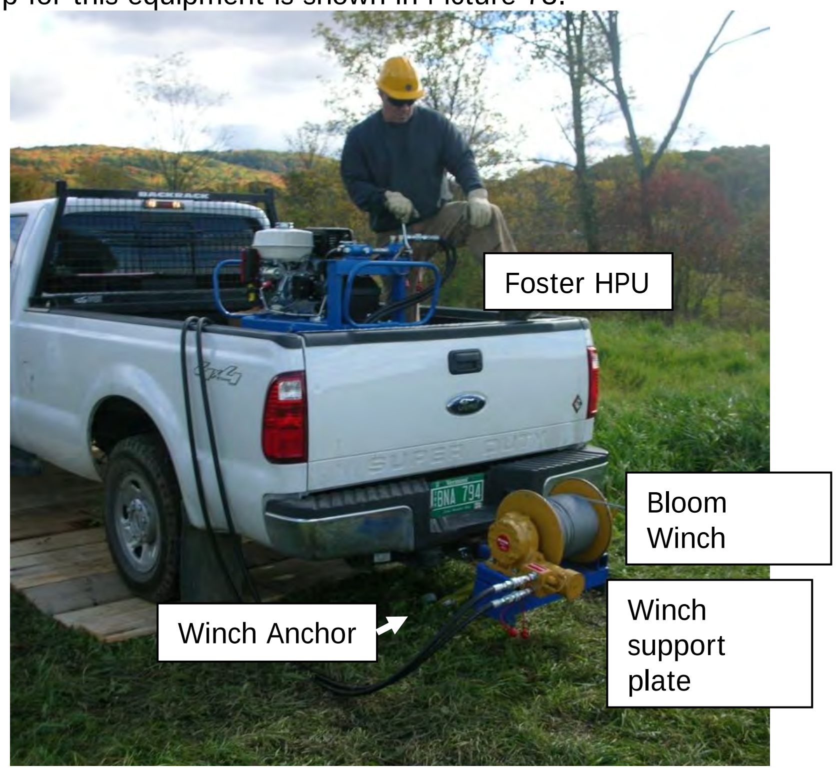
Picture 70



Picture 71

Picture 72: Foster Manufacturing Corp. HPU Model 13-1-8GC

A recommended set-up for this equipment is shown in Picture 73.



Picture 73

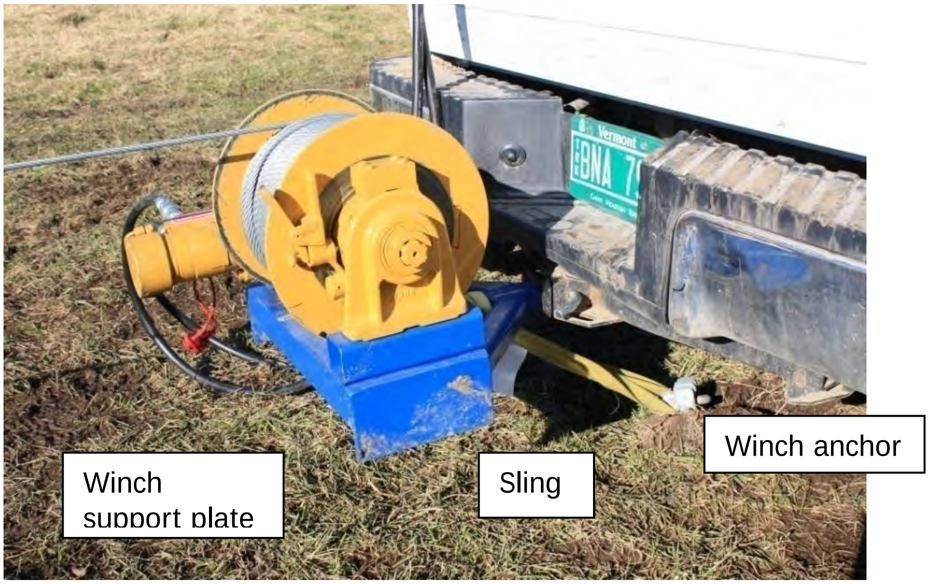
Verify that the fleet angle – the angle between the winch and the first turning block is less than 3°. Setting the fleet angle to less than 3° will aid in the proper level winding of the winch cable on the drum. An example of a proper fleet angle is shown in Picture .

Picture 74

Anchor the winch

Secure the winch support plate using a sling [with a minimum working load limit of 26.7 kN (6000 lbf)].

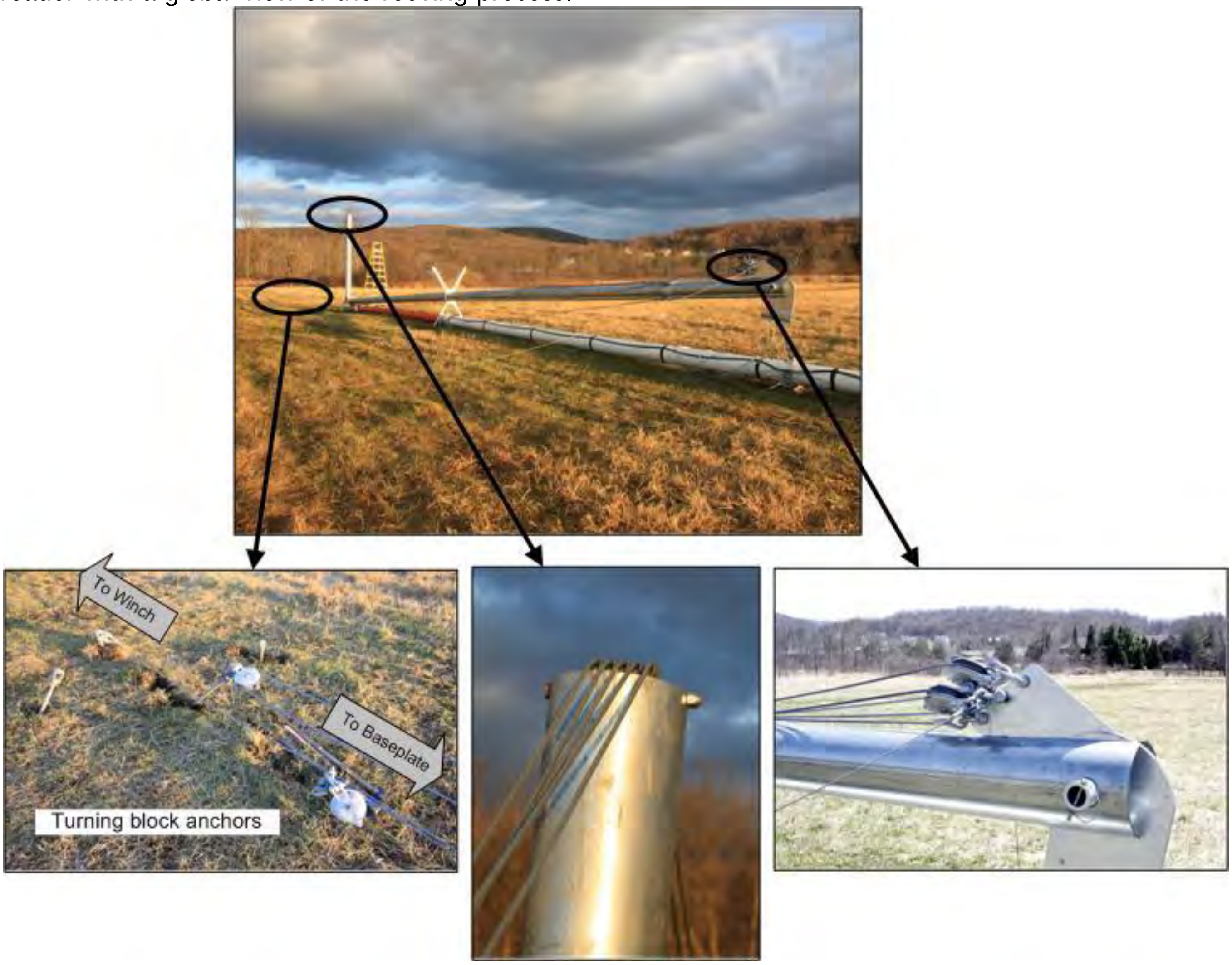
NOTE: Even though the winch and support plate are mounted to a vehicle, it is imperative the winch assembly be secured to the winch anchor.



Picture 75

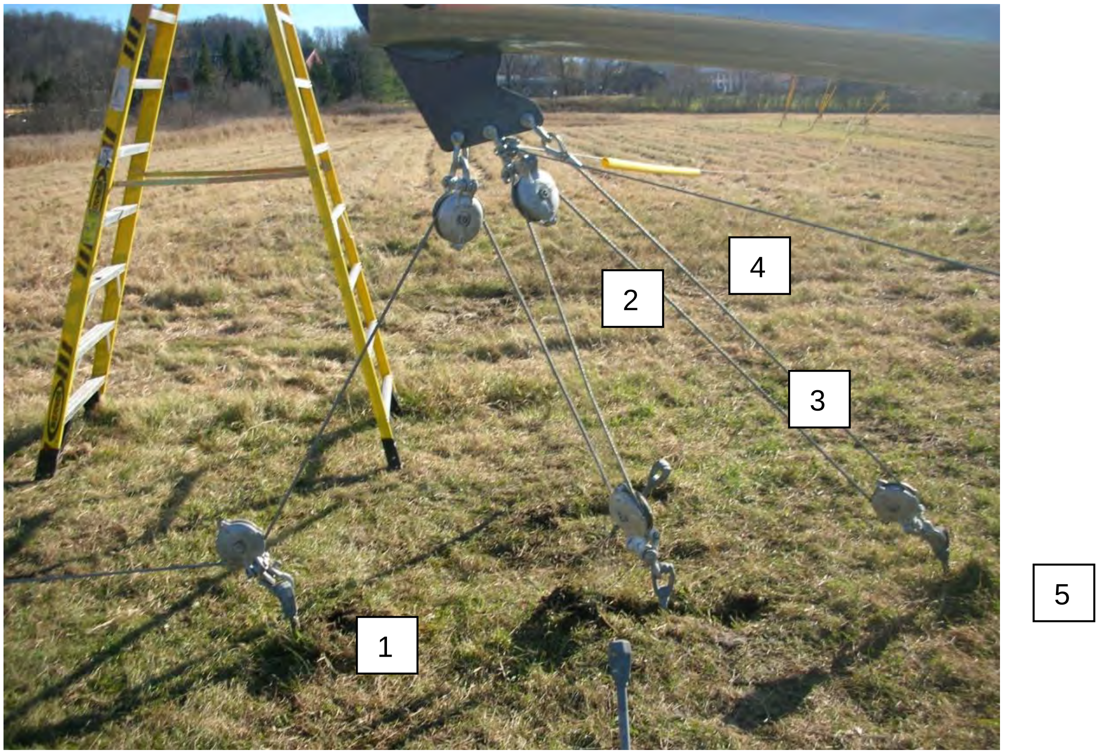
Reeving the winch cable

Operate the winch in reverse to un-spool the winch cable for reeving. The pictures below provide the reader with a global view of the reeving process.



Picture 76

Picture 77 is taken when the tower is vertical and the ginpole is nearly horizontal (opposite its start position). This picture is out of sequence but the photograph shows clearly the reeving sequence because all five (5) pulley blocks are in close proximity.



Picture 77

IMPORTANT: The direction of the winch cable through the pulley blocks is important to prevent the block and tackle from binding up. Follow the instructions included below.

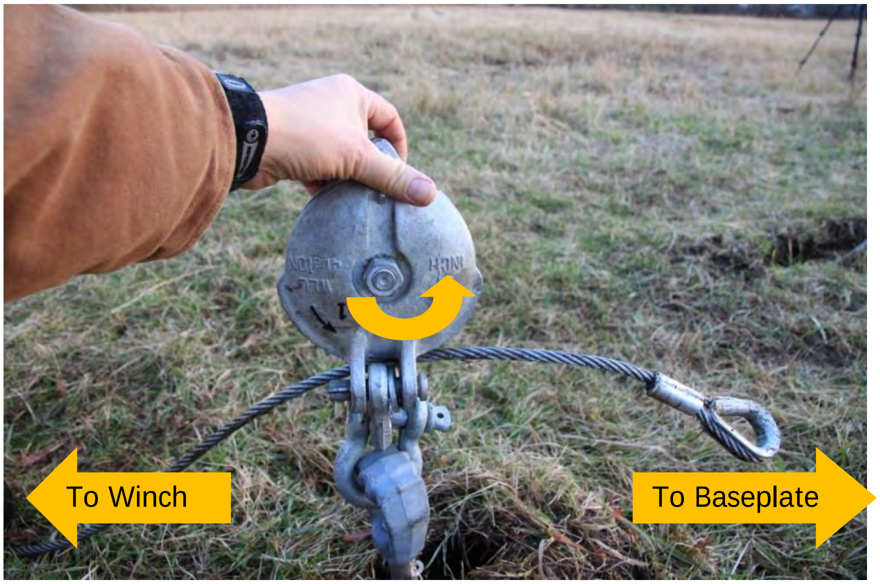
Reeve out the winch cable and route as follows:

1. Through the pulley block on the ground nearest the winch (pulley #1) See picture 78.
2. Over one of the helper ginpole sheaves
3. Through the pulley block at the top of the main ginpole (pulley #2) See picture 79.
4. Over another helper ginpole sheave
5. Through the pulley block on the ground attached to the middle anchor (pulley #3) [see Picture 80]
6. Over another helper ginpole sheave
7. Through the pulley block on the main ginpole (pulley #4) [see Picture 82: Reeving through Pulley #4]
8. Over another helper ginpole sheave
9. Through the pulley block on the ground attached to the middle anchor (pulley #5) [see Picture 83Picture].
10. Over another helper ginpole sheave
11. Ending at the top of the main ginpole [see Picture 84].

Note: To open the supplied pulleys, remove the pin from one side of the pulley.

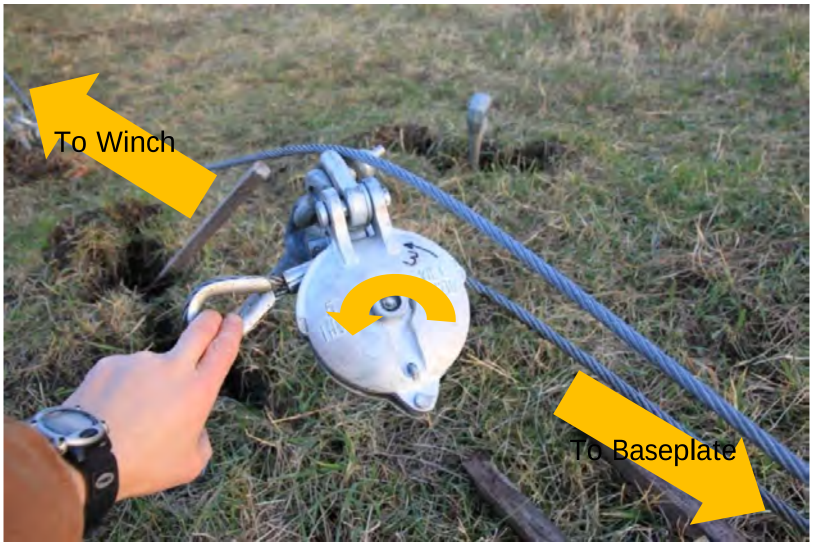
Note: When putting the winch cable over the top of the helper gin pole, it does not matter which cable goes in which helper ginpole sheave. However, to reduce the potential for entanglement, it is recommended to place the winch cable in the V-belt pulleys in an orderly fashion, occupying the left-most sheave first, followed by the next closest sheave, and so on. It is also not necessary to center the helper ginpole pulleys.

The following photographs illustrate the winch cable reeving sequence.



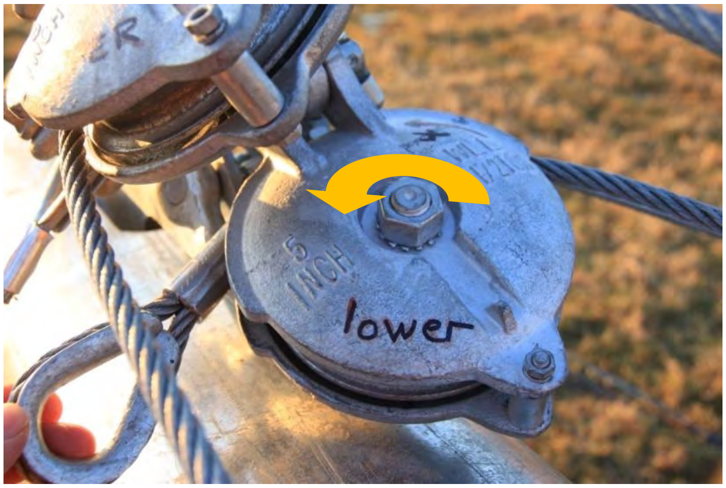
Picture 78: Reeving through Pulley #1

Picture 79: Reeving through Pulley #2

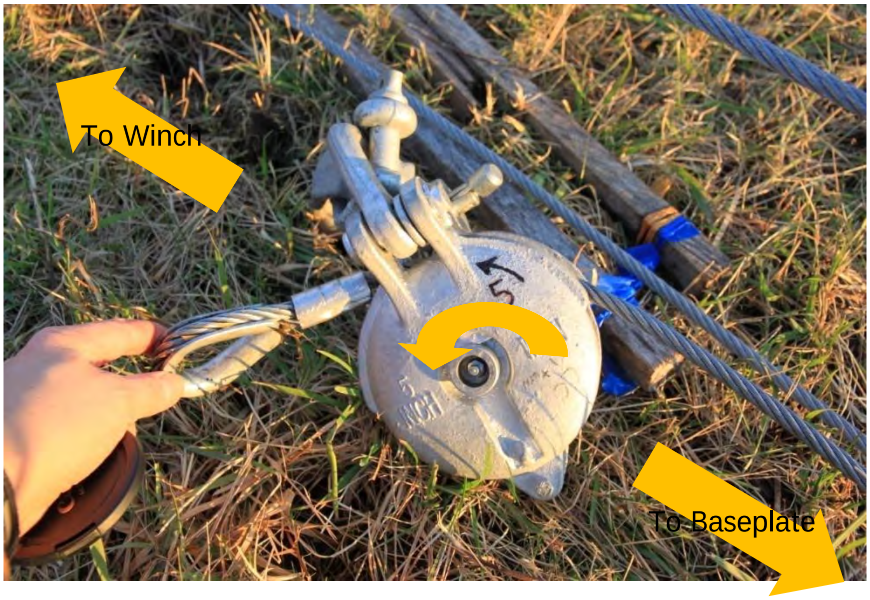


Picture 80: Reeving through Pulley #3

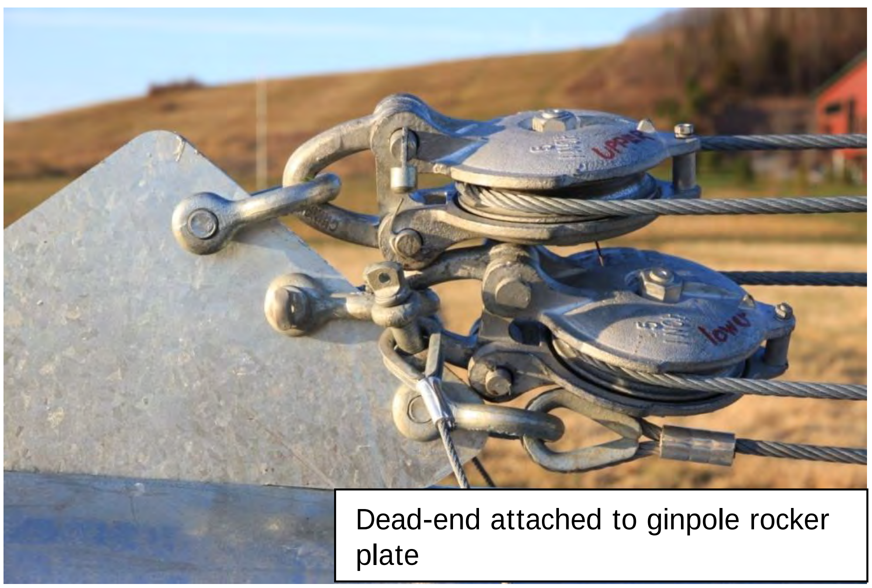
Picture 43



Picture 82: Reeving through Pulley #4



Picture 83: Reeving through Pulley #5



Picture 84: Affixing dead-end to ginpole rocker plate

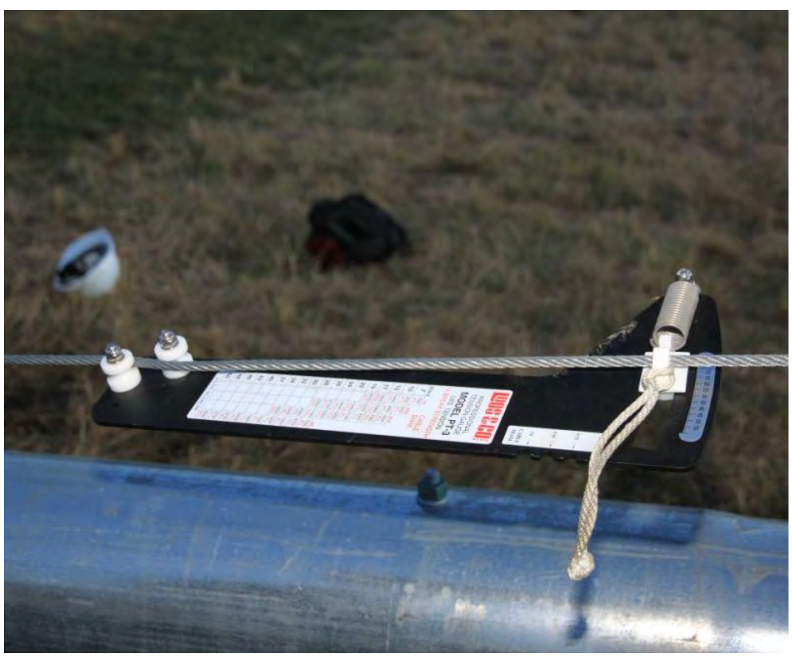
Critical Installation Step: Tensioning the ginpole jumper strut cables

Once the cable has been reeved, pick up ginpole until it is plumb straight (not drooping or curving up), and then tension the strut cables. After the ginpole is vertical, it is impossible to access all of the jumper strut cables in order to tension them.

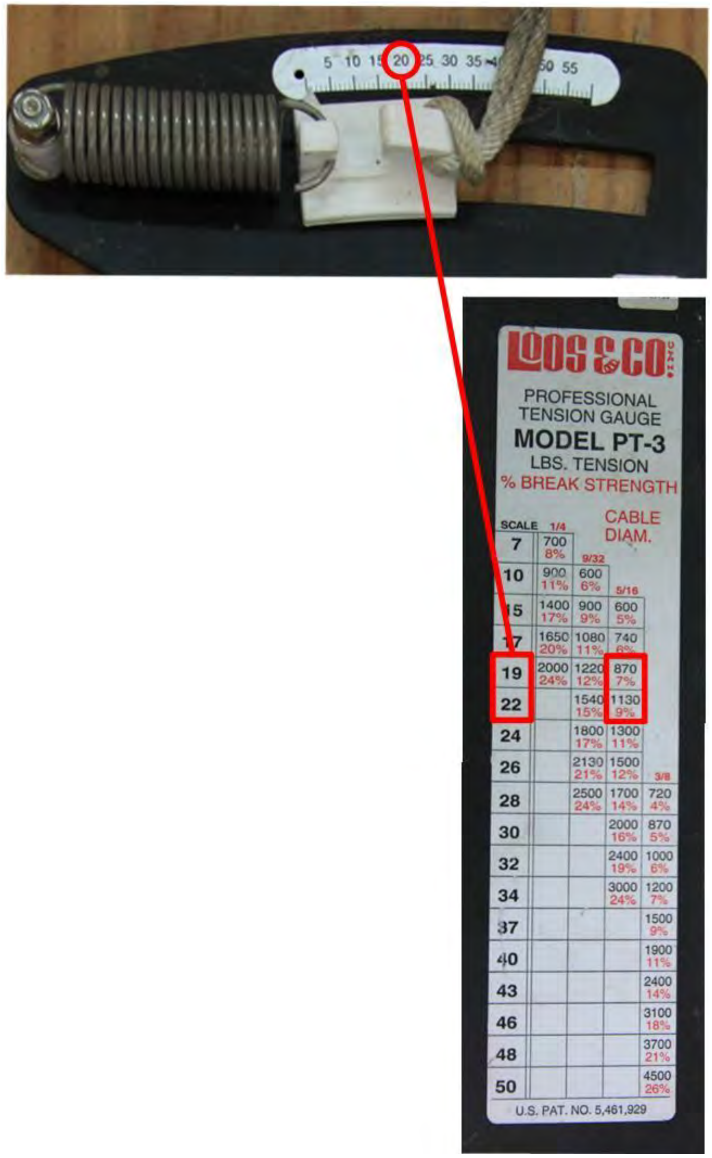
Incrementally tighten the turnbuckles. Using two (2) adjustable wrenches (one to resist rotation, the other to rotate the turnbuckle body), tighten the turnbuckles (in turn tightening the jumper strut wires).

Picture 85

Incrementally tighten all four (4) turnbuckles (in succession) and measure the tension in the jumper strut wire using the Loos & Co Model PT-3 Tension Gauge, as shown in Picture 85. Continue to adjust the turnbuckles until the tension in the jumper strut wires is 44.5 kN (1000 lbf). The scale on the Tension Gauge should read 20, with an acceptable range of between 19 to 22 as shown in Picture 86.



Picture 86


LOOS & CO. INC.
PROFESSIONAL TENSION GAUGE
MODEL PT-3
LBS. TENSION
% BREAK STRENGTH
CABLE DIAM.
SCALE 1/4 9/32 5/16 3/8
7 700 8%
10 900 11% 600 6%
15 1400 17% 900 9% 600 5%
17 1650 20% 1080 11% 740 6%
19 2000 24% 1220 12% 870 7%
22 1540 15% 1130 9%
24 1800 17% 1300 11%
26 2130 21% 1500 12%
28 2500 24% 1700 14% 720 4%
30 2000 16% 870 5%
32 2400 19% 1000 6%
34 3000 24% 1200 7%
37 1500 9%
40 1900 11%
43 2400 14%
46 3100 18%
48 3700 21%
50 4500 26%
U.S. PAT. NO. 5,461,929

Picture 87

Ginpole Tilt-Up

Confirm all lifters and shackles are secure

Carefully double check all connection points to make sure everything is secure before starting to lift the ginpole.

Lift the ginpole

> It is critical during the ginpole <u>and</u> tower lift that the 3/16" diameter side guy wires remain snug but not overly taut. Monitor the ginpole side guy wires to verify there is a slight sag in them at all times during the lift. If necessary, adjust the ginpole side guy wire tension by adding or removing slack

Make sure the ginpole remains centered side-to-side. If the pole is off center, carefully adjust the wire ropes to re-center. As the ginpole comes up, watch the lifters to make sure they are not caught on objects (e.g., tower tube bolts, booms, stumps, debris, rocks, equipment, etc.). Also check that they are not entangled. When the ginpole is half-way erected, remove the helper ginpole. Continue lifting. As the lifter wires tighten, <u>**STOP**</u>.

Do not lift the tower yet. Check that the shackles are not twisted at the guy rings.

Picture 88

Picture 89

Tower Tilt-Up

Understanding Guy Wire Tensioning While Raising TallTower (Do not raise the tower yet)

As a tower is raised, unless the anchors are placed in precisely their correct positions, and unless the site is perfectly level, some guy wires will tighten and some will loosen as the tower is raised. The same is true as a tower is lowered on the same site. For this reason, guy wire tension must be checked and adjusted as needed to maintain uniform tension until the tower installation procedure is complete.

Note: Refer to the Section entitled *Guy Tension Check* for a description of methods to measure guy tension.

A guy wire that becomes too tight can put very high forces on both the anchor and the tower. This force can rapidly grow if the tower lifting or lowering procedure continues. These high forces can suddenly buckle the tower and cause it to collapse, endangering the tower installation crew and possibly damaging vehicles or equipment nearby.

Ideally, one should strive to maintain the tower as straight as possible during the lift. Never exceed the maximum permissible tower deflections listed in the *Critical Installation Step: Permissible Deflection*.

> It is critically important that proper tension be maintained on side guy wires at all times during the lifting procedure to provide side support for the tower. Too little tension can allow the tower to buckle to the side. Too much tension may cause failure of the tower, anchors, or guy wires. Refer to the Sections entitled *Guy Tension Check and Adjusting Guy Wires* for instructions on measuring

Be sure that guy wires do not get caught on tree branches, roots, rocks, or other obstructions.

This sequence of observing, communicating observations, issuing commands to guy wire tenders, adjusting the side guy wires, and re-tightening wire rope clips must be well understood before lifting a tower. The sequence will be repeated many times before a tower installation is completed.

Adjusting Guy Wires

Included in the NRG Installation Tool Kit (Kit # TBD) are the following mechanical devices, used to assist in adjusting the guy wires:

Klein Tools, Inc. Chicago Grip (PN 1659-20)

Lug-All Come-Along (Model 115-R)

Loosening Guy Wires

As the tower is raised, the side guys may become tight. To loosen the wire rope, follow these steps:

1. Hook one end of the come-along to a 3/4" shackle affixed to the anchor rod, as shown In pictures 90 & 91.. Do not hook the come-along through the triple-eye as the transfer loads will pinch the guy wire and prevent loosening.
2. Let out several feet of slack in the come-along and set it on the ground.

3. Clamp the Chicago Grip to the guy wire approximately 0.6 – 1 m (2 - 3 feet) above the upper wire rope clip. Make sure the loop on the Chicago Grip points down.
4. Attach the other hook of the come-along to the loop of the Chicago Grip.
5. Crank the come-along to pull tension in the mechanical devices until the wire rope segment that supports the wire rope clips goes slack.
6. Loosen the wire rope clips.
7. Reverse the direction of the come-along and let out sufficient wire rope for loosening.
8. Re-tighten the wire rope clips.
9. Continue to let out slack on the come-along until the load is transferred to the wire rope clips.
10. Repeat as necessary to create the proper cable tension.

Picture 90

Picture 91

Tightening Guy Wires

To tighten the guy wires, reverse the procedure outlined in the Section entitled *Loosening Guy Wires*.

Tower Lift Crew

We suggest the following organization to form an efficient and safe crew to erect NRG TallTowers. Each member of the lift crew should have a good understanding of the tasks they are required to perform during the lift.

Six (6) Member Crew:

Crew leader (1): This person will coordinate the other members. It is especially important to maintain clear communication among the members of the crew. The tower footprint is large and walkie-talkie radios are highly recommended.

Winch operator (1): This person operates the winch and HPU, following the direction given by the crew leader.

Side guy wire tenders (4): Four (4) people to assist adjusting side guys, tending the back guy wires at the end of the lift, and otherwise observing guy wires. They must be familiar with taking in and letting out guy wires. See the section entitled Adjusting Guy Wires for details on adjusting guy wires.

Lift the Tower

The tower lift consists of three (3) distinct phases:

Tower Lift from 0° to 60°
Tower Lift from 60° to 80° (60° to 75° for non-flat terrain sites or unfavorable winds)
Tower Lift from 80° to 90° (75° to 90° for non-flat terrain sites or unfavorable winds)

Below is a detailed description of each the the three (3) phases.

Phase 1: Tower Lift from 0° to 60°

When all crew members are ready, under the direction of the crew leader, the winch operator will begin to lift the tower.

The winch operator should make sure the cable winds evenly on the winch drum.

Warning: Allowing the cable to wind unevenly will result in crossovers that will damage the cable and fill the winch drum before the tower is fully raised.

Lift the tower about 1 m (3 feet) off the ground while checking side guy tensions. The lifters are set up to produce a slight bow in the tower, with the top approximately 0.6 m (2 feet) higher than the middle (we refer to this as a "positive curve"). This is normal, and it needs to be maintained throughout the entire lift to avoid tower buckling or collapsing.

Adjust the side guy wire tensions to prevent the tower from either falling off to one side or bowing which could damage the tower.

Warning: The tower must remain straight side-to-side and maintain a positive curve as described above. Failure to maintain the proper shape can cause the tower to collapse, endangering the crew and equipment. Never exceed the maximum permissible tower deflections (listed below in the *Critical Installation Step: Permissible Deflection*) at any point during the lift.

Critical Installation Step: Permissible Deflection

Tower deflection shall not exceed the following maximum permissible deflections: Tower deflection ≤ 0.25 meters (0.83 feet) or one (1), 10" tube diameter, between any one (1) guy level Tower deflection ≤ 0.76 meters (2.5 feet) or three (3), 10" tube diameters, between four (4) guy

Ginpole deflection shall not exceed 0.15 meters (0.5 feet) or ½ of one (1), 10" tube diameter

If the tower or ginpole deflection approaches the maximum permissible limits, **STOP** the lift and assess the situation. What is causing the deflection? Is a back guy snagged? Are the back guys uniformly tensioned? Understand the cause of the deflection and correct the problem. Verify tower and ginpole deflections are well within the maximum permissible limits prior to proceeding with the tower lift. If the lateral tower deflection exceeds the limits, the side guys should be adjusted to straighten the tower.

Watch the winch anchors for movement. The maximum lifting force will be experienced when the tower is first lifted a few feet off the ground. If the winch anchors do not hold, immediately lower the tower. If the winch anchors do not hold under the tower lift, either the anchors were installed incorrectly or another type of anchor is needed. See Appendix B: Anchoring Guidelines for more information.

Watch the tower baseplate for movement toward the winch. If the baseplate slips, immediately lower the tower.

If everything looks acceptable, continue to lift the tower a little at a time, checking tower side guy tension throughout the lift. At times, it may be necessary to adjust the side guy wire tension, particularly if the side guys are above, below, or otherwise out of line with the tower pivot. In addition, regularly check the ginpole side guys to make sure their tensions are roughly equal and not too tight - verify there is a slight catenary in them at all times during the lift. If necessary, adjust the ginpole side guy wire tension by adding or removing slack. Do these checks and adjustments ONLY when the winch is stopped. See the Sections entitled *Guy Tension Check and Adjusting Guy Wires* for instructions on measuring and adjusting guy tension.

Throughout the lift, the ginpole must remain in a straight line as viewed from the winch. If it leans to either side, the cause should be determined and corrected. The safety wire cable tension should be adjusted as needed to keep the ginpole centered. When adjusting the safety wire cable tension, lengthen the *loose* wire rope and shorten the *tight* wire rope (sounds backward, but it is correct). Do not allow the ginpole to be at a severe angle to the base plate pivot since the pivot loads will be all on one side of the gin pole. In this case, lower the tower, and then realign the tower with respect to the winch and/or level the baseplate as needed. Extreme imbalance in the ginpole side guys may overload the ginpole, resulting in ginpole collapse.

Work slowly and smoothly. Fast, uneven movements tend to make the tower bounce, shake or swing. *Be sure that communication between all members of the lifting team is clear and concise.* Continue lifting and adjusting until the tower is about 60 degrees above horizontal (just above the half-way point). **STOP**.

Phase 2: Tower Lift from 60° to 80° (60° to 75° for non-flat terrain sites or unfavorable winds)

Beyond 60 degrees above horizontal, it is absolutely essential that proper tension be maintained on all back guy wires during the last part of the lift. The tower will lift very easily at this point because the weight of the ginpole will be enough to tip the tower with little effort from the winch. Any wind blowing in the direction of the lift will also reduce the load on the winch; excessive wind in the direction of the lift can lead to a loss of control of the tower. *Therefore, the crew must control the lift from this point by applying resistance on back guy wires #1, #2, #4, and #6.* Resistance is provided by clipping a carabiner/rope assembly (shown below) onto a back guy and providing a constant pull force at a distance away from the tower. Pull solidly on the ropes, leaning into them to maintain as much tension as practical. Four (4) sets of carabiner/ropes are provided with the ginpole kit, one each for back guy wires *#1, #2, #4, and #6*.

Picture 92

Phase 3: Tower Lift from 80° to 90° (75° to 90° for non-flat terrain sites or unfavorable winds)

Critical Installation Procedure: Lift-Slack Cycle ("Inch-Worm" Method)

For the tower lift between 80° and 90°, it is imperative the Lift-Slack Cycle (or "Inch-Worm" Method) be followed to incrementally raise the tower. The Inch-Worm Method ensures a minimum tension exists on the back guy wires at all times during the lift when the tower is between 80° and 90°. Failure to provide sufficient tension on the back guy wires (e.g., not following the Inch-Worm Method) may result in the tower deforming or buckling.
For non-flat terrain sites or when the wind is unfavorable, it is important to begin the Lift-Slack Cycle ("Inch-Worm" Method) when the tower is at 75° and to apply the method for the duration of

When the tower is at 80° (75° in non-flat terrain or unfavorable winds), with the crew maintaining tension on the back guys using the wire rope/carabiners), pull each back guy wire towards the anchor, pulling the rope and carabiner tensioner back in-line with the tower. Then fasten the wire rope with the wire rope clips to remove any excess slack. Refer to the Sections entitled *Guy Tension Check* and *Adjusting Guy Wires* for instructions on measuring and adjusting guy tension. One-by-one, as the back guy wire slack is removed, the means of applying tension is transferred from manual (crew) to mechanical (back guy wire) means and personnel can relax their applied load once the slack is removed.

Continue the lift by alternately powering the winch and smoothly and incrementally letting out on the back guy wires (in order from top-of-tower to the bottom) using mechanical methods outlined in *Adjusting Guy Wires*. Table 7 includes approximate slack lengths for the back guy wires to be applied at each lift-slack cycle.

The values in Table 7 are approximate and should be adjusted to maintain back guy tensions within the recommended range, as reported in Table 9 and Table 11 included in the Section entitled *Guy Tension Check*. Similarly, the amount of lift during each lift-slack cycle should be limited by the tightest back guy wire – **STOP** the lift before the tightest back guy wire reaches the upper limit tension value listed in Table 9 or Table 11. Then slacken all back guy wires per Table 7, Table 9, and Table 11 and repeat the lift-slack cylce.

The important point here is let the back guy tension and back guy slack length dictate the amount of tower lift for each lift-slack cycle.

With each Lift-Slack Cycle, anticipate raising the tower approximately 1°.

Table 7 Recommended Back Guy Wire Slack Lengths

Guy Level	Slack Length (inches)
1 (Bottom)	9
2	12
3	14
4	24
5	26
6 (Top)	30

Continue this process until the **top** of the tower is directly over the base (sight with a carpenter's level or transit – do not guess).

Check that wire rope clips on the back and side guy wires are secure.

Attach Front Guys

Locate the front guys and, one-by-one, attach them to their respective anchors. Start with front guy #6 (top level) and work down the tower.

Plumb the tower following the instructions outlined in the section entitled *Plumb and Straighten Tower.*

After the tower is plumb, adjust the guys to their correct tension, following the procedure outlined in *Adjusting Guy Wires.*

Plumb and Straighten Tower

Using a carpenter or digital level, measure the verticality of the base tube. Adjust the lowest level guy wires as needed until the base tube is vertical (90º ± 0.5º). Working upward, adjust all four guys at each level while sighting up the tower from the base to straighten the tower (see Picture 93).

Picture 93

Once the tower is plumb (within one-quarter (¼), 10" tube diameter over entire tower), make final adjustments to the guy wires so that they are properly tensioned (see Section entitled *Guy Tension Check* for details).

Guy Tension Check

We recommend two (2) techniques outlined in ANSI/TIA-222-G to more accurately set guy wire tensions to ensure they are consistent and match well with the tensions assumed during the tower structural analysis. The two (2) methods described below are:

Tangent Intercept Method

Pulse Method

Critical Installation Step: Guy Tension Measurement Methods

When the tower is erect, you may use either the Tangent Intercept or Pulse Method, whichever you prefer.

During tower erection, you may use either the Tangent Intercept or Pulse Method to measure and adjust the tension in the Back Guy Wires.

Tangent Intercept Method

The basis for the Tangent Intercept Method of verifying guy wire tensions is a visual "sighting" technique shown in Figure 1 and described below.

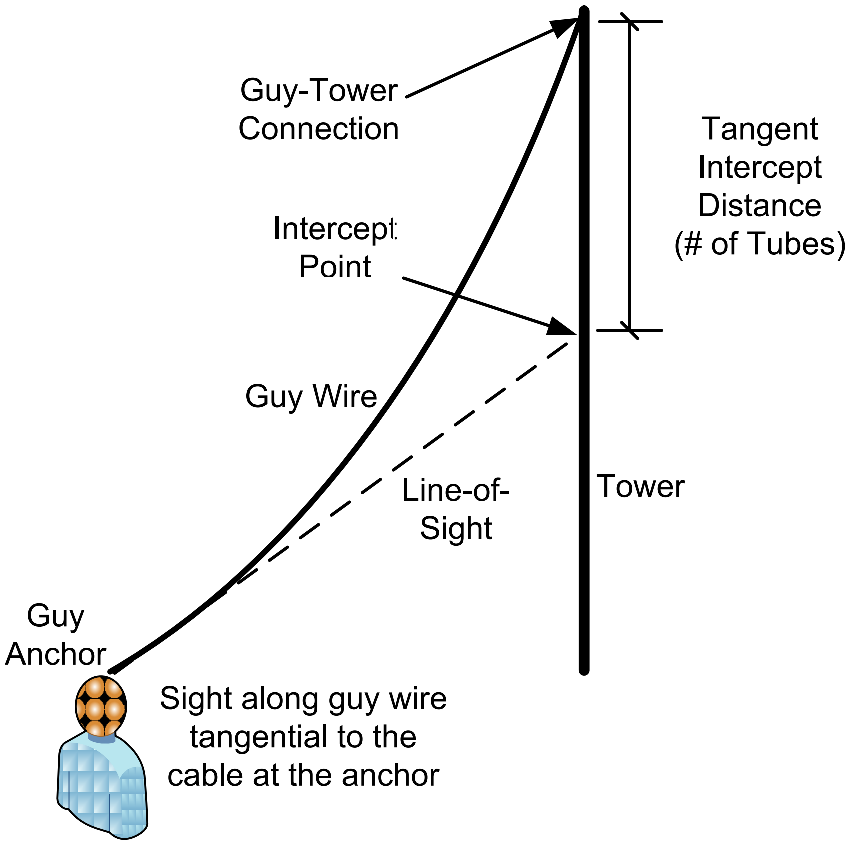


Figure 1 Tangent Intercept Method

Sight along the guy wire, tangential to the cable at the anchor point. Extend the line-of-sight until it intersects the tower. The tangenet intercept is the distance between the guy-tower connection and the intersection of the line-of-sight with the tower. This tangent intercept distance is measured in terms of the number of tower tubes and is directly related to the guy wire tension.

As an example, Picture 94: Level 1 Guy, Sag = 1-1/4 Tube shows a view of the Level 1 guy wire from near the ground up toward the guy ring. If you look closely, you will note that the projected line of the lower portion of the guy intersects the tower at about one tower tube below the Level 1 guy ring (visible just above the ribbon). This represents a "Guy Sag" of "1-1/4 Tubes". Picture 95: Level 1, Guy Sag = 2.5 Tubes shows the same guy somewhat looser. In this case, the guy wire appears to intersect about 2-½ tower tubes below the guy ring (Guy Sag = 2.5 Tubes).

Picture 94: Level 1 Guy, Sag = 1-1/4 Tube

Picture 95: Level 1, Guy Sag = 2.5 Tubes

Using this sighting technique, adjust guy tensions to fit within the limits shown in Table 8 or Table 9 below.

Table 8 Guy Tensioning per the Tangent Intercept Method (Tower Erect at 90°)

Guy Level	Guy Slack Range (# of Tubes below Guy Ring)	
	Least Sag	Most Sag
1 (Lower)	1	1 1/2
2	1 ¼	1 ¾
3	1 ½	2
4	1 ¾	2 1/2
5	2 ¼	3
6 (Upper) (Including transition as one tube)	3 ¼	4

As an example, for Level 1, the least sag the guy wire should have is 1 tube; the most sag is 1 ½ tubes. Therefore, the guy wire in Picture 3 meets the requirement, but the guy wire in Picture 94 is too loose.

Table 9 Guy Tensioning per the Tangent Intercept Method (During Tower Erection)

Guy Level	Guy Slack Range (# of Tubes below Guy Ring)	
	Least Sag	Most Sag
1 (Lower)	1	3

Guy Level	Guy Slack Range (# of Tubes below Guy Ring)	
	Least Sag	Most Sag
2	1 ¼	3
3	1 ½	4
4	1 ¾	5
5	2 ¼	6
6 (Upper) (Including transition as one tube)	3 ¼	7

Pulse Method

The pulse method is as follows:

1. Apply a sharp jerk to the guy wire above its anchor point (just above the wire rope clips). You may need to lift up the guy guard to access the wire rope. The jerk to the guy wire will transmit a pulse along the wire (you can see the pulse visually, and, if holding loosely onto the wire rope, you can feel it in your hand when the pulse returns down the wire). Coincident with the applied jerk, start your stopwatch. Your stopwatch should be capable of measuring time to within a 1/10th of a second.
2. Measure the time it takes the pulse to travel up and back down, twice (N = 2 pulses).
3. Repeat Steps 1 and 2 three (3) times and record the average value.
4. Verify the average measured pulse time is within the allowable range as shown in Table 10 and Table 11.
5. If necessary, adjust the guy wire tension per the Section entitled *Adjusting Guy Wires*.

Table 10 Guy Tensioning per the Pulse Method (Tower Erect at 90°)

Guy Level	N (# of pulses)	Minimum Time (sec)	Maximum Time (sec)
1 (Lower)	2	2.5	3.1
2	2	2.8	3.3
3	2	3.1	3.6
4	2	3.3	4.0
5	2	3.8	4.4
6 (Upper)	2	4.3	4.9

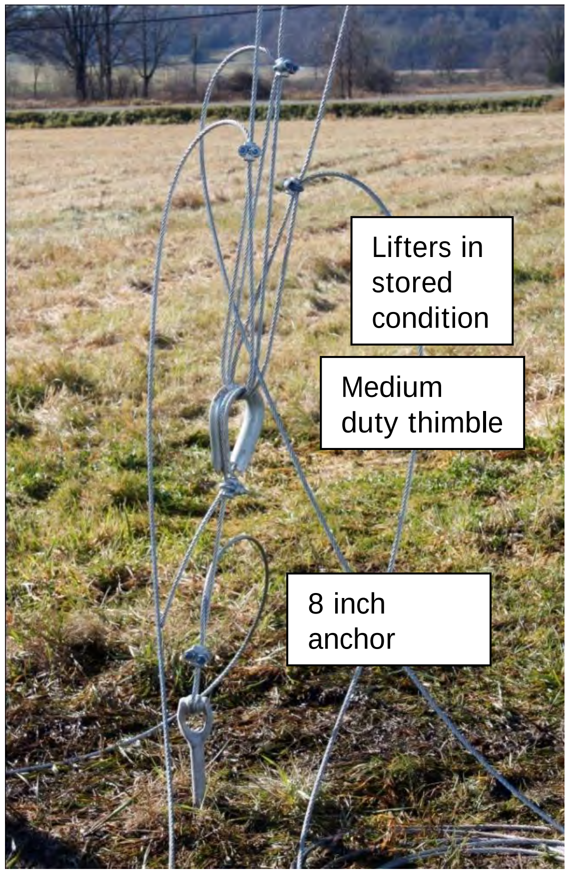
Table 11 Guy Tensioning per the Pulse Method (During Tower Erection)

Guy Level	N (# of pulses)	Minimum Time (sec)	Maximum Time (sec)
1 (Lower)	2	2.5	4.3
2	2	2.8	4.4
3	2	3.1	5.1
4	2	3.3	5.8
5	2	3.8	6.4
6 (Upper)	2	4.3	7.1

Transfer Lifters

Transfer the lifting guys one at a time from the ginpole to the spare 8 inch diameter screw-in anchor located approximately 5 meters (15 feet) from the tower baseplate, in close proximity to the ginpole.

Prepare the 8 inch screw-in anchor by attaching two large medium duty thimbles, as shown in Picture 96 below. The thimbles are attached to the 8 inch anchor using a short-run of 5/6 inch diameter wire rope and three (3) 5/16″ wire rope clips.

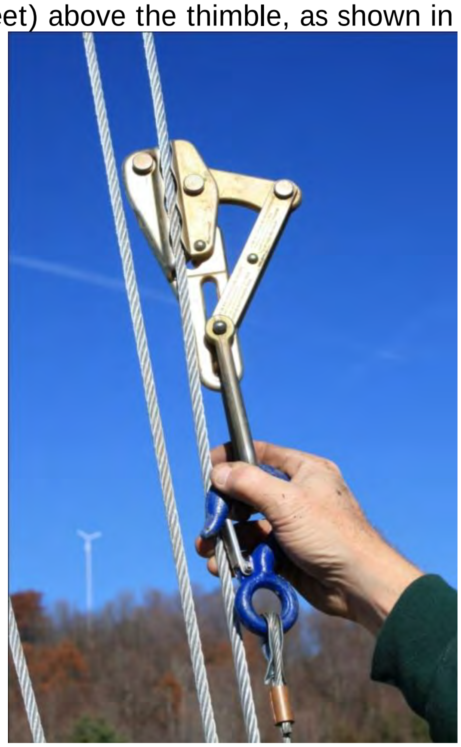


Picture 96

Once the thimbles are in place, transfer the lifters one-at-a-time, starting with level #1. To remove the lifter from the ginpole, clip the Chicago Grip and come-along to the lifter approximately 1 m (3 feet) above the rocker plate. Wrap a sling around the tip of the ginpole and secure the free end of the come-along to the sling, as shown Picture 97.

Picture 97

Pull tension using the come-along until the lifter goes slack. Loosen and remove the bolt/nut that attaches the lifter. Reverse direction on the come-along, un-clip the Chicago Grip and hand transfer the lifter over to the stationary thimble for storage. Clip another Chicago Grip and come-along to the lifter approximately 2 meters (6 feet) above the thimble, as shown in Picture 98.



Picture 98

Affix the free end of the come-along to the 8 inch anchor using a ¾″ shackle attached to the shank of the anchor. Pull tension in the lifter using the come-along until the slack in the lifter has been removed. Weave the lifter through the thimble and secure using three (3) 5/16″ wire rope clips, as shown in Picture 99.

Picture 99

Reverse the come-along until the load has been transferred to the stored lifter. Remove the come-along and Chicago Grip, and proceed onto the next lifter. Lifters #1 through #3 attach to one of the storage thimbles; lifters #4 through #6 attach to the second thimble. Picture 100 shows the storage of three lifters and the proper tension you will want to achieve.

Picture 100

Final Inspection and Maintenance

Tighten all wire rope clips on each guy wire, allowing approximately 100 mm to 200 mm (4 inches to 8 inches) between clips. Final torque on wire rope clips should be as listed in Table 12 below.

Table 12: Wire Rope Clip Torque Values

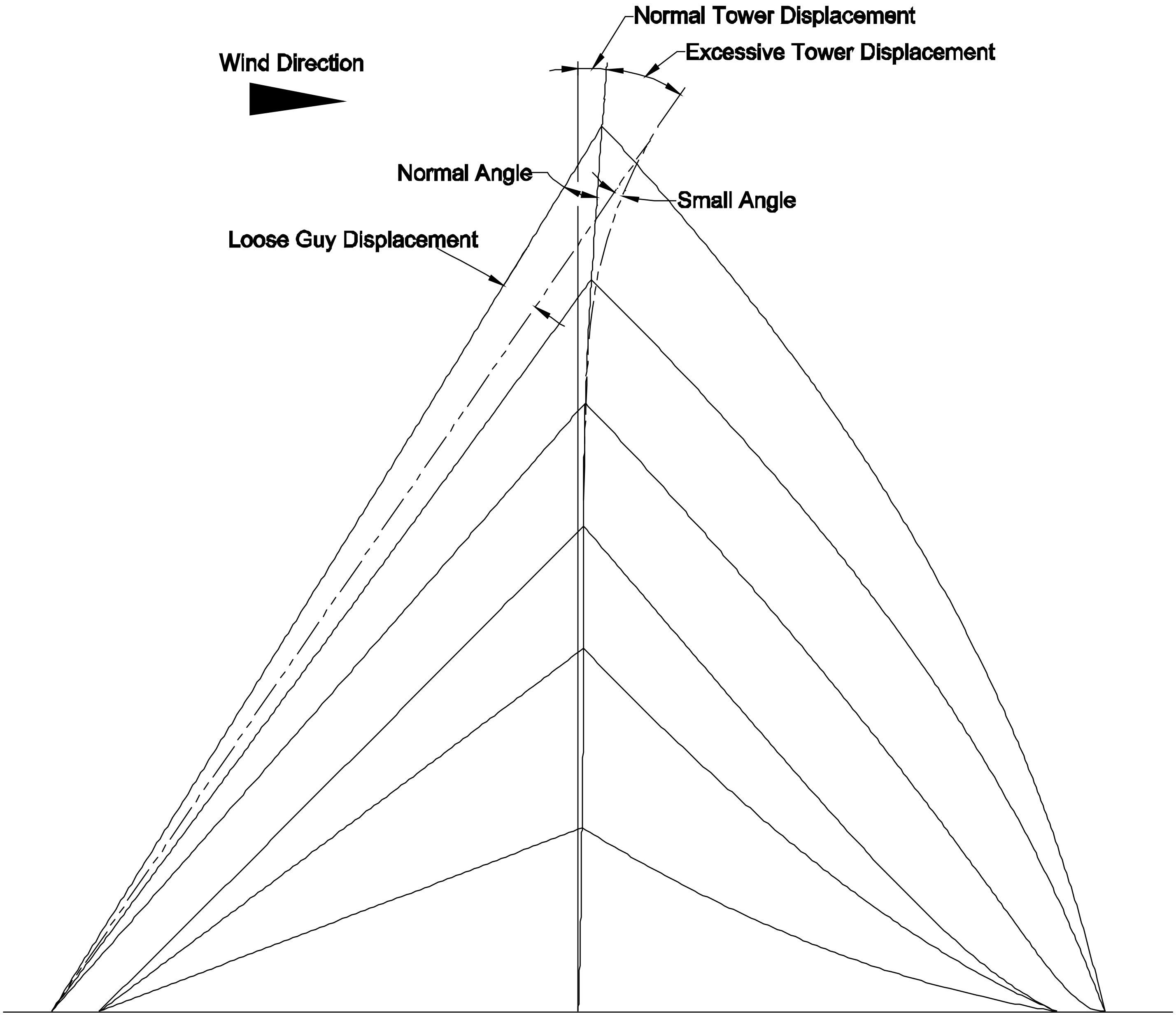
Wire rope clip size (inches)	Torque Wrench N-m (ft-lbf)
3/16	10 (7.5)
5/16	41 (30)
3/8	61 (45)

The ginpole may be left in place, or it may be removed and disassembled, if desired. If using guy guards, attach one to each guy wire as well as the ginpole lateral guy wires.

Picture 101: Guy guards

Check the tower in 2 or 3 weeks; tighten loose guys and straighten the tower if needed. It is especially important to do this before any icing events occur. Also check the guy wires after any severe ice or wind storm. Some settling of the tower or anchors may occur, and guy wires can stretch. Loose guy wires can also result when the wire rope clips securing the guys are forced down by the impact of sliding ice.

One of the most important reasons for good tower maintenance, particularly guy tension maintenance, is to avoid a form of tower failure known as "Snap-Through." Snap-Through typically occurs when the guys are allowed to become loose, and a high wind is blowing on the tower. Even in normal conditions, the upper guys work at a narrower angle to the upper tower than the lower guys, reducing their effectiveness at restraining sideways bending (see Picture 102: Snap Through). If the guys are allowed to become loose, the working angle is further decreased. If the loads are high enough, or the guys are too loose, the angle between the guy and the tower will reduce to zero, and the guy can no



longer restrain the sideways motion. The result is that the upper tower "snaps through" and falls over.

Picture 102: Snap Through

Tower Lowering

Lowering the tower is the reverse of raising the tower, although there are differences between the methods and a few additional precautions. As with lifting, tower lowering consists of three (3) distinct phases:

- Tower Lowering from 90° to 85° (90° to 80° for non-flat terrain sites or unfavorable winds)
- Tower Lowering from 85° to 60° (80° to 60° for non-flat terrain sites or unfavorable winds)
- Tower Lowering from 60° to 0°

Each of the phases of tower lowering is described below.

Critical Installation Step: Tensioning the ginpole jumper strut cables

> If the ginpole was removed, set-up the ginpole as described in the section entitled Ginpole. Make sure the ginpole jumper strut cables are properly tensioned.

Phase 1: Tower Lowering from 90° to 85° (90° to 80° for non-flat terrain sites or unfavorable winds)

Critical Installation Procedure: "Inch-Worm" Method

> For the tower lowering between 90° and 85°, it is imperative the "Inch-Worm" Method be followed to incrementally lower the tower. The Inch-Worm Method ensures a minimum tension exists on the back guy wires at all times during the lowering when the tower is between 90° and 85°. Failure to provide sufficient tension on the back guy wires (e.g., not following the Inch-Worm Method) may result in the tower deforming or buckling.
> For non-flat terrain sites or when the wind is unfavorable, apply the "Inch-Worm" Method) when

If the tower will be lowered onto blocking, place the blocking now while it is still safe to work under the tower.

Remove the upper level lifter from the storage thimble and walk it over to the ginpole. Attach a sling to the end of the ginpole. To the lifter, attach a Chicago Grip and come-along approximately 1 m (3 feet) from the thimble. Attach the free end of the come-along to the sling and lift the ginpole. Affix the lifter to the rocker plate on the ginpole. Repeat the transfer process for the remaining lifters.

Disconnect the front guys, starting with Level 1 and working up to Level 6.

With the tower vertical at 90°, lower the tower approximately 1°. Pull each back guy wire towards the anchor to remove any excess slack and then fasten the wire rope with the wire rope clips to secure. Refer to the Sections entitled *Guy Tension Check* and *Adjusting Guy Wires* for instructions on measuring and adjusting guy tension.

Continue the process by alternately powering the winch to lower the tower and then incrementally take-up the slack on the back guy wires (in order from top-of-tower to the bottom) using the mechanical methods outlined in *Adjusting Guy Wires*.

When removing slack in the back guy wires, maintain back guy tensions within the recommended range, as reported in Table 9 and Table 11 included in the Section entitled *Guy Tension Check*.

Continue the Inch-Worm Method until the tower is at 85° (80° for non-flat sites or unfavorable wind).

Phase 2: Tower Lowering from 85° to 60° (80° to 60° for non-flat terrain sites or unfavorable winds)

During Phase 2 of tower lowering, tension must be applied manually using the supplied carabiner/ropes to back guys #1, #2, #4, #6. Manual tension helps prevent wind loads and/or the weight of the ginpole from suddenly pushing the tower back upright, which could cause guy wire or anchor failure. Leave the guy wire attached to the anchor and pull outward on the guy wire to take out the slack. The use of the carabiner/ropes allows the crew members to maintain tension by hand without being under the tower.

As the tower is lowered and reaches an angle of 60°, it is no longer necessary to maintain manual tension on the back guy wires.

Phase 3: Tower Lowering from 60° to 0°

Continue lowering the tower by letting out the winch cable.

Stop the winch at least every 20 degrees to re-check side-guy wire tension. Refer to the Sections entitled *Guy Tension Check* and *Adjusting Guy Wires* for instructions on measuring and adjusting guy tension.

It is critical to keep the tower straight at all times. This is particularly important when the tower is near the ground where forces are at their greatest and most difficult to control.

The force on the winch is greatest as the tower nears the ground. Be sure to stand to either side of the winch cable, rather than directly in line with it.

To lower the ginpole, put the helper ginpole in place. As the ginpole nears the ground, place the winch cable (all five (5) strands) into the 5 V-belt pulleys on the top of the helper ginpole. You will need the use of a 3 meter (10 foot) ladder to access the V-belt pulleys. The pole can then be lowered to the ground.

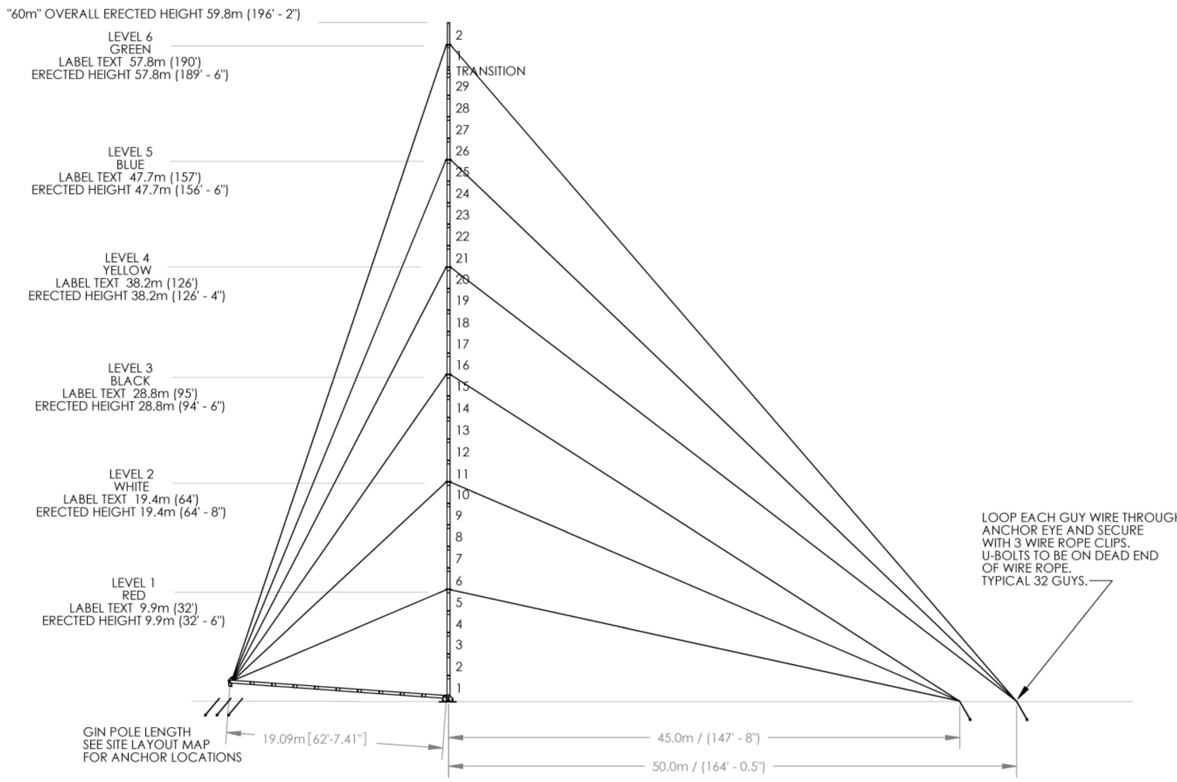
Appendix A: Super 60 m XHD TallTower with Standard Footprint

Tower Layout

TUBE SPECS (in order of assmbly):

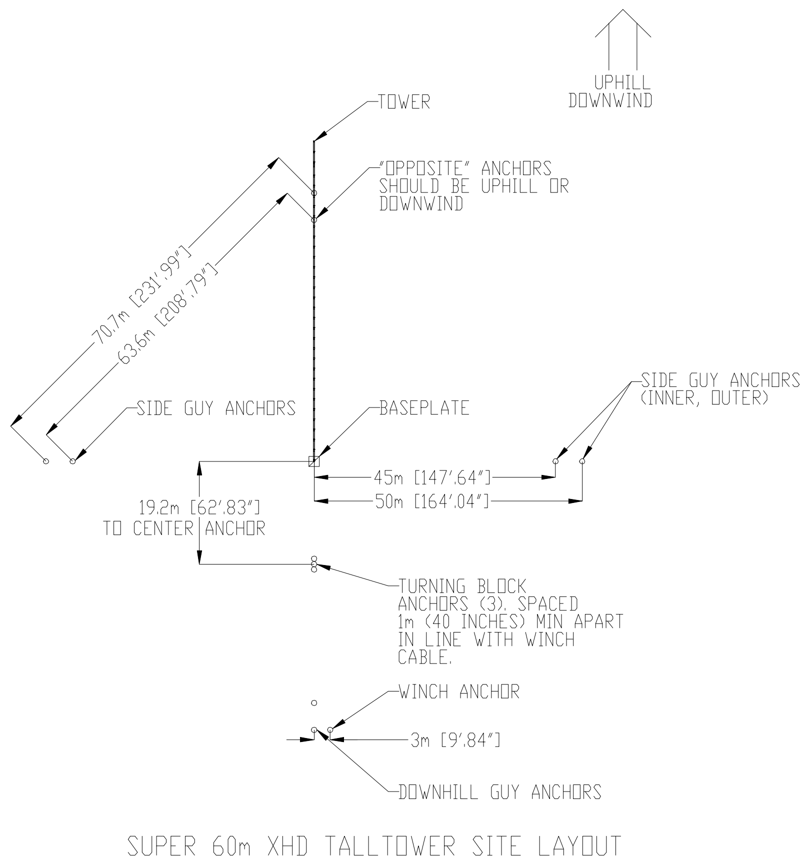
Tower:
Base Tube (with pivot pin hole) 10" Ø x 87"L (1 tube)
Plain Tubes 10" Ø x 87"L (28 tubes)
10" - 8" Transition, 36"L
Plain Tubes 8" Ø x 87"L (2 tubes)

Gin Pole:
Base Tube (with pivot pin hole) 10" Ø x 87"L (1 tube)
Plain Tubes 10" Ø x 87"L (8 tubes)
Top Tube 10" Ø x 87"L (1 tube)



Picture 103: Super 60 m XHD TallTower Layout

Site Layout



Picture 104: Super 60m Site Layout

Tower Erection Forces (tower only)

ANSI/TIA-222-G wind velocity	Horizontal base reaction	Winch anchor reaction (b)
0 m/s (0 mph)	28.9 kN (6500 lbs.) (a)	40.0 kN (9000 lbs) @ 44° from Horizontal (c) Load spread between the 4 anchors Maximum load per anchor 16.0 kN (3600 lbs)

Tower Erection Forces (with typical NOW System – 3 booms at 30 m, 3 booms at 40 m, 3 booms at 58 m)

ANSI/TIA-222-G wind velocity	Horizontal base reaction	Winch anchor reaction (b)
0 m/s (0 mph)	30.4 kN (6830 lbs.) (a)	42.3 kN (9500 lbs) @ 44° from Horizontal (c) Load spread between the 4 anchors Maximum load per anchor 16.9 kN (3800 lbs)

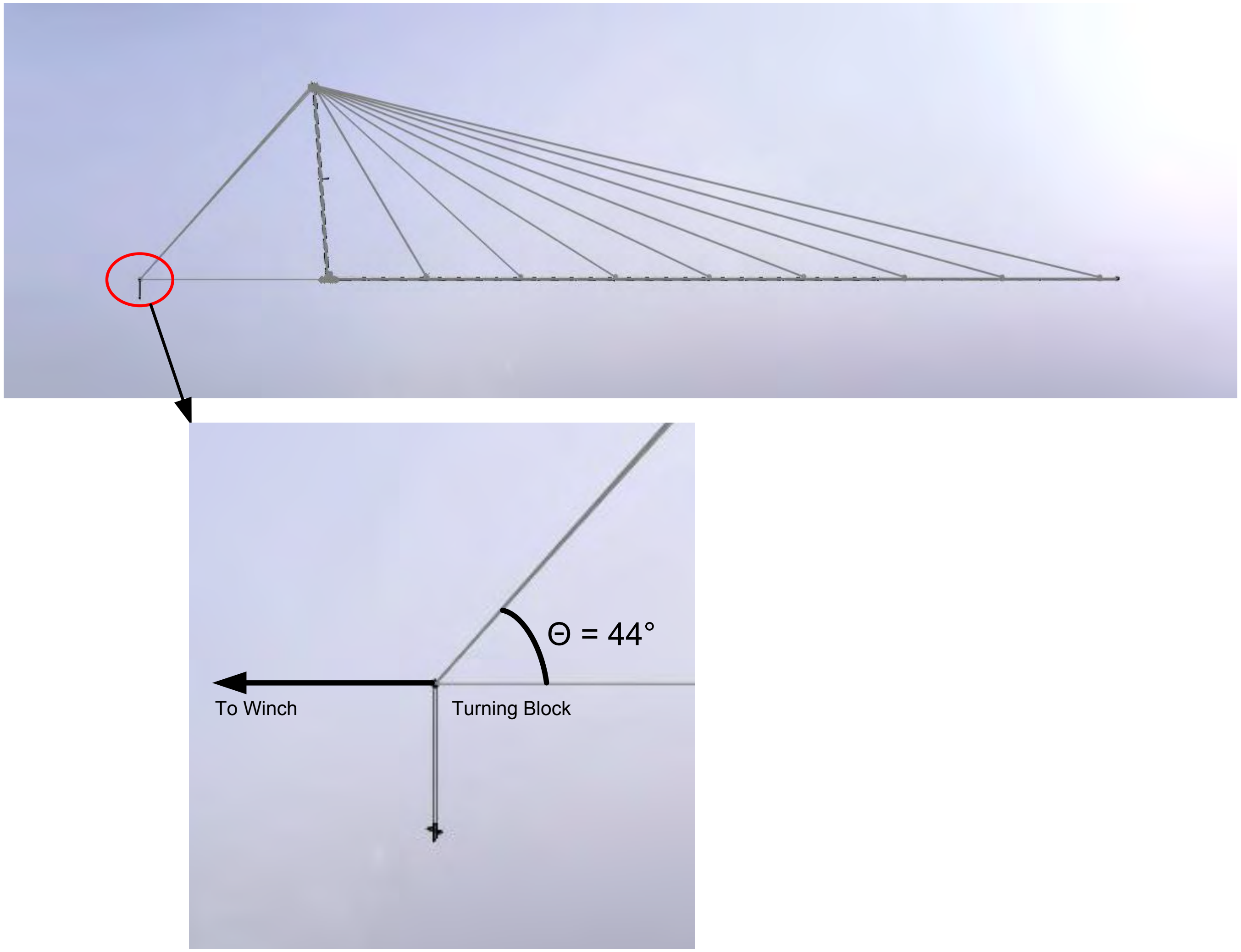
Notes:

The maximum horizontal reaction occurs when the tower is just off the ground.

Maximum force on the winch anchor during tower erection (occurs when tower is just above the ground).

Orientation view defining angle shown in Picture 4 below.

The reported tower erection forces do not assume any factor of safety.



Picture 105: Angle of winch cable at maximum load

ANSI/TIA-222-G Compliance Limits, Maximum Anchor Loads, and Baseplate Loads

The following graphs allow you to verify your tower meets ANSI/TIA-222-G requirements. Reactions and member forces apply to a Super 60 m XHD TallTower equipped with galvanized steel wire rope per Federal Specification RR-W-410F.

To use the graphs, you will need to obtain wind and wind with ice load requirements. ANSI/TIA-222-G Annex B lists design criteria for U.S. counties and its territories. You should also confirm the design criteria with your local permitting agency.

Using wind and wind with ice design values, find the point at which they intersect on graphs shown in Figure 2 or Figure 3 and verify that this point is within the recommended operating zone. Maximum anchor loads and baseplate loads are obtainable using Figure 4 through Figure 7, below.

Consideration for unusual winds and winds with ice must be given to mountainous terrain and gorges.

Please note that these graphs are based on the 3-second gust definition of wind speed per ANSI/TIA-222-G.

Code Compliance Curve – Imperial Units

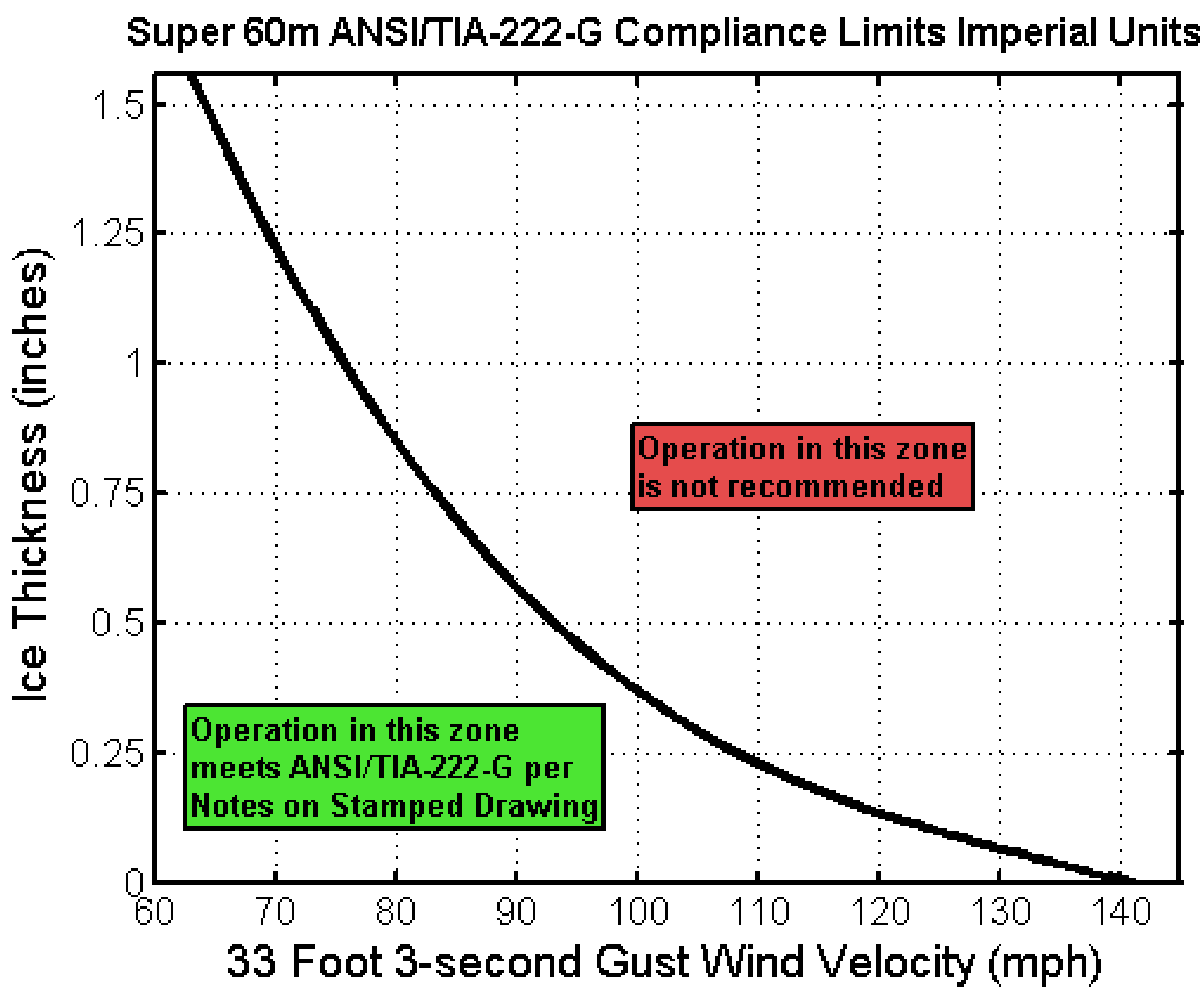


Figure 2: Super 60m ANSI/TIA-222-G Compliance Limits Imperial Units

Code Compliance Curve – SI Units

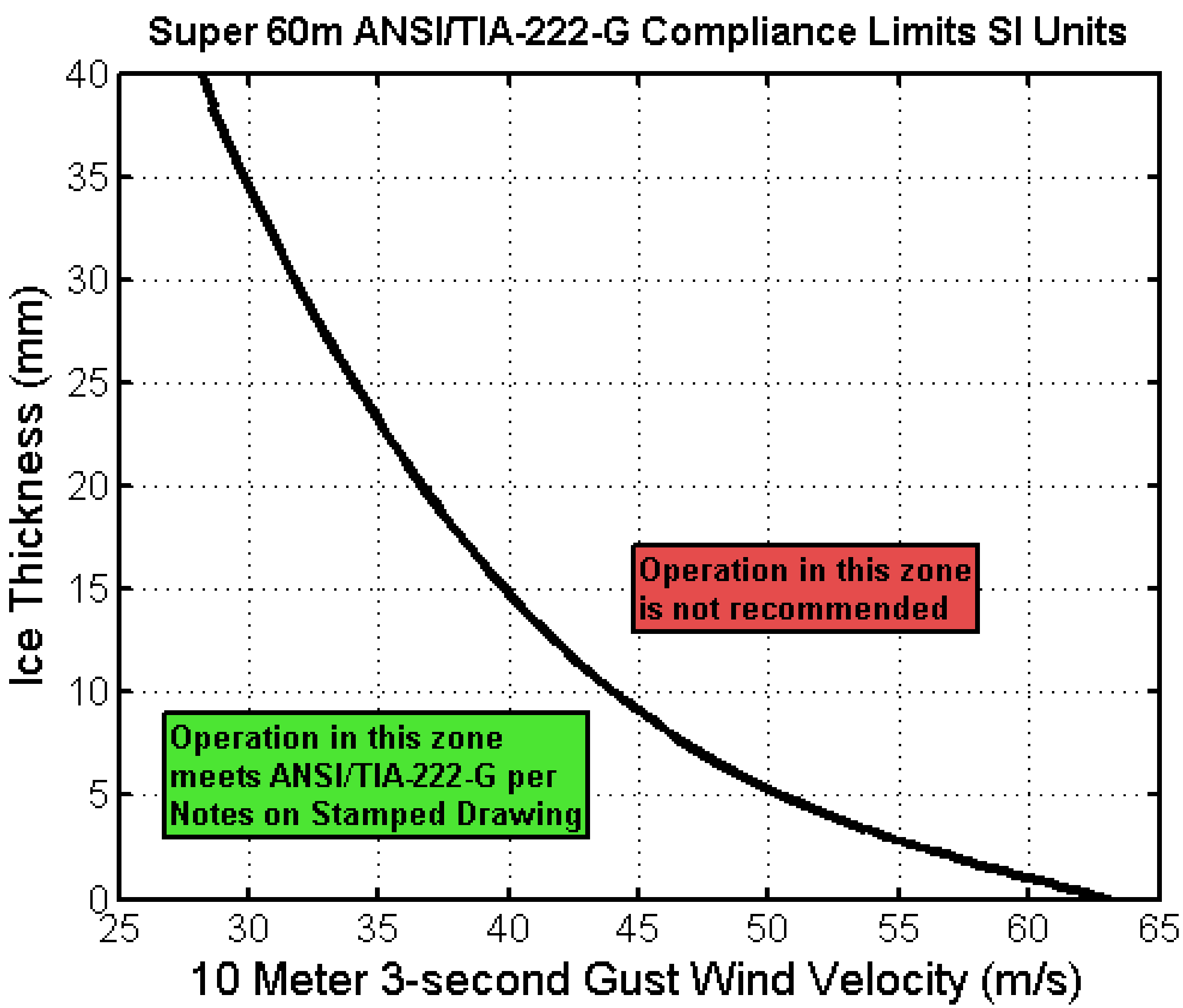


Figure 3: Super 60 m XHD TallTower ANSI/TIA-222-G Compliance Limits SI Units

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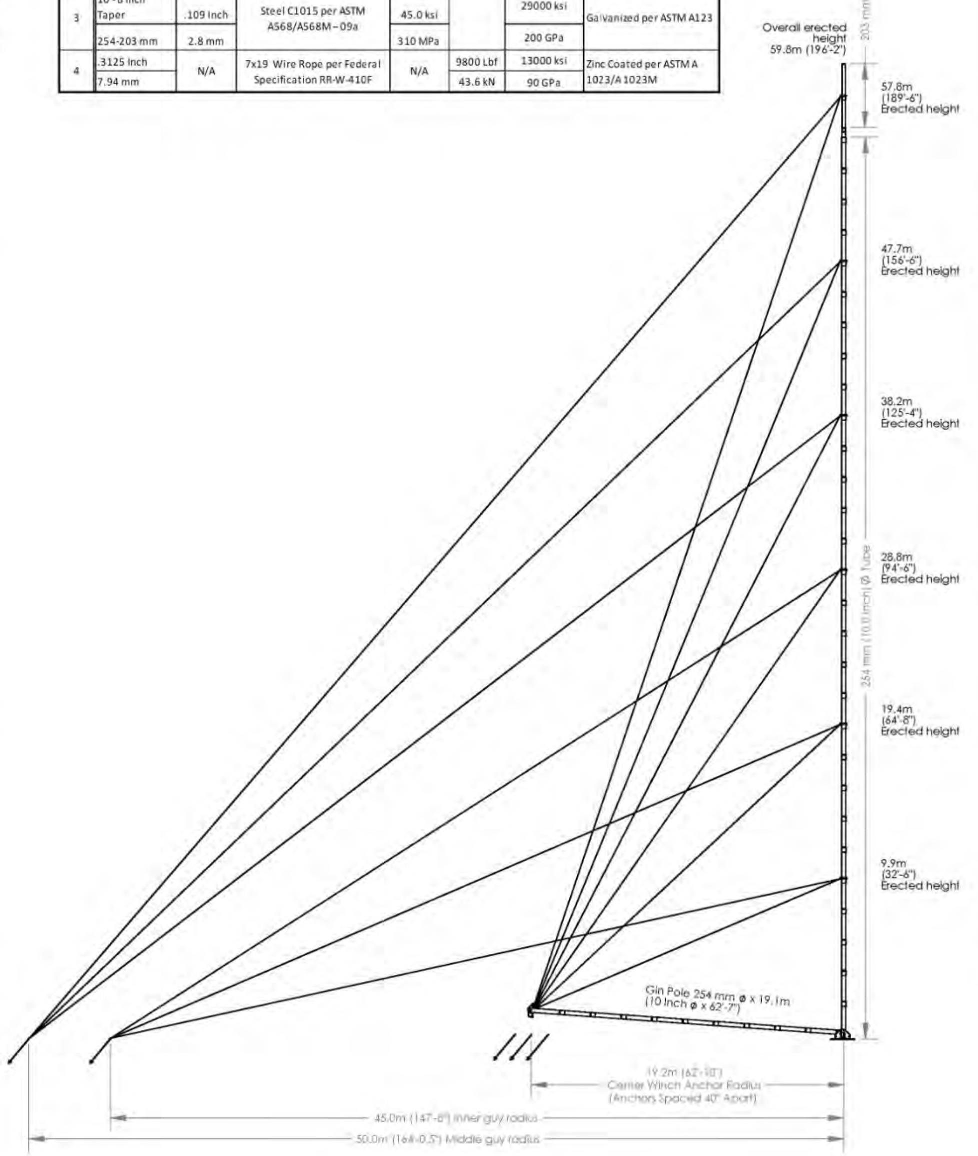
REV.	DESCRIPTION	DATE	APPROVED
A	INITIAL RELEASE	9-18-12	SHC

PART # 7533

	Outer Diameter	Wall Thickness	Description	Yield Strength	Breaking Strength	Modulus of Elasticity	Corrosion Protection
1	10 Inch	.134 Inch	Steel C1020 per ASTM A568/A568M – 09a	45.0 ksi	N/A	29000 ksi	G-90 Pre-Galvanized per ASTM A-653 and ASTM-924 or ASTM-A123
	254 mm	3.40 mm		310 MPa		200 GPa	
2	8 Inch	.134 Inch	Steel C1020 per ASTM A568/A568M – 09a	45.0 ksi		29000 ksi	
	203 mm	3.40 mm		310 MPa		200 GPa	
3	10 - 8 Inch Taper	.109 Inch	Steel C1015 per ASTM A568/A568M – 09a	45.0 ksi		29000 ksi	Galvanized per ASTM A123
	254-203 mm	2.8 mm		310 MPa		200 GPa	
4	.3125 Inch	N/A	7x19 Wire Rope per Federal Specification RR-W-410F	N/A	9800 Lbf	13000 ksi	Zinc Coated per ASTM A 1023/A 1023M
	7.94 mm				43.6 kN	90 GPa	



Unit Notation
mm = Millimeters
m = Meters
ft = Feet
m/s = Meters per Second
MPa = 1,000,000 Pascals
kip = 1,000 US Pound Force
Lbf = Pound Force
kN = 1,000 Newtons
ksi = 1,000 US Pound Force per Square Inch
mph = Miles per Hour
ø = Diameter

STATE OF VERMONT STEVEN H. CLARK NO. 7276 MECHANICAL LICENSED PROFESSIONAL ENGINEER

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INTERPRET DWG 3RD ANGLE PROJECTION

MATERIAL: SEE TABLE

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NRG SYSTEMS

7533_60m Super NRG TallTower - with Anchors

DRAWN: EMR 8-31-12
RESPONSIBLE ENG APPROVAL: SHC 8-31-12
SHEET SIZE: B
PART #: 7533
REV.: A
SHEET: 1 OF 2

REV

PART # 7533

	Reactions and Member Forces																							
	No ice				6.4mm (0.25 in) Ice				12.7mm (0.5 in) Ice				19mm (0.75 in) Ice				25mm (1 in) Ice				40mm (1.6 in) Ice			
	Imperial		SI		Imperial		SI		Imperial		SI		Imperial		SI		Imperial		SI		Imperial		SI	
10 m (33 feet) Wind Velocity (3-second gust)	141	mph	63.0	m/s	108	mph	48.3	m/s	93	mph	41.6	m/s	84	mph	37.6	m/s	75	mph	33.5	m/s	63	mph	28.2	m/s
Top of Tower Wind Velocity (3-second gust)	205	mph	91.6	m/s	157	mph	70.2	m/s	137	mph	61.2	m/s	122	mph	54.5	m/s	109	mph	48.7	m/s	92	mph	41.1	m/s
Inner Guy Anchor Force	6.3	kip	28.0	kN	5.9	kip	26.2	kN	5.9	kip	26.2	kN	6.2	kip	27.6	kN	6.4	kip	28.5	kN	8.3	kip	36.9	kN
Angle from Horizontal	23	degrees			22	degrees			21	degrees			20	degrees			18	degrees			15	degrees		
Outer Guy Anchor Force (Notes 4, 5)	**12.5**	kip	**55.6**	kN	**12.3**	kip	**54.7**	kN	**12.3**	kip	**54.7**	kN	12.3	kip	54.7	kN	11.4	kip	50.7	kN	11.3	kip	50.3	kN
Angle from Horizontal	41	degrees			41	degrees			40	degrees			40	degrees			39	degrees			36	degrees		
Tower Base Down Thrust	30.0	kip	133.4	kN	31.7	kip	140.9	kN	35.1	kip	156.1	kN	39.0	kip	173.6	kN	41.9	kip	186.5	kN	54.4	kip	241.9	kN
Tower Base Shear	0.129	kip	0.6	kN	0.152	kip	0.7	kN	0.144	kip	0.6	kN	0.133	kip	0.6	kN	0.223	kip	1.0	kN	0.587	kip	2.6	kN
Tower Base Torque (due to stored lifting guys)	6.0	kip-in	0.68	kN-m	6.6	kip-in	0.7	kN-m	7.8	kip-in	0.9	kN-m	8.8	kip-in	0.99	kN-m	8.9	kip-in	1.01	kN-m	9.2	kip-in	1.04	kN-m
Winch Anchor Load (Note 10) (during erection)	9.0	kip	40.0	kN																				
Angle from Horizontal	44	degrees	44	degrees																				
Tower Base Shear (Note 10) (during erection)	6.5	kip	28.9	kN																				
Initial Guy Tension 7.9mm (0.313 in) Diameter	0.255	kip	1.13	kN																				
Maximum Guy Tension 7.9mm (0.313 in) Diameter (Note 5)	4.5	kip	20.0	kN	4.6	kip	20.5	kN	4.9	kip	22.0	kN	**5.3**	kip	**23.5**	kN	**5.2**	kip	**23.1**	kN	**5.2**	kip	**23.0**	kN
Maximum Tower Deflection	36.1	in	918	mm	37.3	in	947	mm	38.8	in	987	mm	40.1	in	1019	mm	37.4	in	949	mm	32.6	in	829	mm
Maximum Combined Stress Ratio (CSR) in 203mm (8 in) Diameter Tube (Note 5)	0.230		Section No. L2		0.218		Section No. L2		0.199		Section No. L2		0.199		Section No. L2		0.187		Section No. L2		0.202		Section No. L2	
Moment	54	kip-in	6.1	kN-m	49	kip-in	5.6	kN-m	41	kip-in	4.6	kN-m	39	kip-in	4.4	kN-m	34	kip-in	3.8	kN-m	34	kip-in	3.9	kN-m
Axial Load	8.1	kip	36	kN	8.5	kip	38	kN	9.4	kip	42	kN	10.3	kip	46	kN	10.8	kip	48	kN	12.8	kip	57	kN
Maximum Combined Stress Ratio (CSR) in Transition 254mm (10 in) - 203mm (8 in) Diameter Tube (Note 5)	0.228		Section No. L3		0.215		Section No. L3		0.195		Section No. L3		0.194		Section No. L3		0.181		Section No. L3		0.195		Section No. L3	
Moment	59	kip-in	6.7	kN-m	54	kip-in	6.1	kN-m	44	kip-in	5.0	kN-m	42	kip-in	4.7	kN-m	36	kip-in	4.1	kN-m	36	kip-in	4.0	kN-m
Axial Load	8.1	kip	36	kN	8.5	kip	38	kN	9.5	kip	42	kN	10.3	kip	46	kN	10.9	kip	48	kN	12.9	kip	57	kN
Maximum Combined Stress Ratio (CSR) in 254mm (10 in) Diameter Tube (Note 5)	0.343		Section No. L30		0.342		Section No. L30		0.366		Section No. L30		0.418		Section No. L30		0.437		Section No. L30		0.644		Section No. L30	
Moment	76	kip-in	8.6	kN-m	70	kip-in	7.9	kN-m	73	kip-in	8.3	kN-m	87	kip-in	9.8	kN-m	89	kip-in	10.0	kN-m	147	kip-in	16.6	kN-m
Axial Load	29.8	kip	132	kN	31.3	kip	139	kN	34.0	kip	151	kN	37.6	kip	167	kN	40.2	kip	179	kN	53.6	kip	238	kN

Notes:

1. Wind forces and member loads are calculated using ANSI/TIA-EIA-222-G-2 (2009)"Structural Standards for Antenna Supporting Structures and Antennas".
2. Wind speeds are defined as the 3-second gust at 10 m (33 ft) above ground level per ANSI/TIA-222-G-2.
3. ANSI/TIA-222-G-2 wind and ice load factors are included in the following table. For wind with ice load cases, the ice thickness with height is assumed constant (no ice escalation). The limit state conversion for ice thickness (2.0) per ANSI/TIA-222-G-2 2.6.8 is omitted.

					Velocity Pressure Coefficient (Kz)						
Load Case	Classification of Structure	Wind Direction Probability Factor (K_d)	Importance Factor (I)	Exposure Category	z_g	α	$K_{z\,min}$	Topographic Category	Topographic Factor (K_{zt})	Gust Effect Factor (G_h)	Design Ice Thickness
Wind without Ice	I	0.95	0.87	C	274 m (900 ft)	9.5	0.85	1	1	1.10	N/A
Wind with Ice	I	0.95	1.0	C				1	1	1.10	Constant ice thickness with tower height - no ice escalation with height. The limit state conversion for ice thickness (2.0) per ANSI/TIA-222-G-2 2.6.8 is omitted.

4. Maximum wind load reduced (for bold-face marked load cases) to maintain anchor loads below 55.6 kN (12.5 kip). Maintaining maximum anchor loads below 55.6 kN (12.5 kip) ensures a resistance factor of 1.2 provided anchors are pull tested to 66.7 kN (15 kip).

REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
	SEE SHEET 1		

Notes (continued):

5. Member forces and reactions are calculated using tnxTower by Tower Numerics(Version 6.0), a three-dimensional elastic beam-column finite element analysis (FEA) program that accounts for second-order effects. The effective yield stress is computed using tnxTower per Equation 4.5.4.1 (for axial compression) and 4.7.2 (for bending) of ANSI/TIA-222-G-2. The Combined Stress Ratio (CSR) is determined using tnxTower per Equation 4.8.2 of ANSI/TIA-222-G-2. The maximum CSR and Section No. in which it occurs is listed for 203mm (8 in) diameter tube, the transition, and 254mm (10 in) diameter tube. The corresponding moment and axial load is listed for each section. The reaction, member force, or CSR limiting the wind and wind with ice input load is emphacized using large boldface font for each load condition.
6. This tower design meets the requirements of ANSI/TIA-222-G-2 for the given loading conditions, with exceptions. Contact NRG Systems, Inc. for more information.
7. The baseplate ground surface area is 19.5 ft2. The baseplate cross-sectional area is sized to ensure the factored resistance of Clay soil (as defined in Annex F of ANSI/TIA-222-G-2) is greater than the reactions from the factored load combinations listed in Section 2.3.2 of ANSI/TIA-222-G-2. The presumptive soil parameters per ANSI/TIA-222-G-2 assume dry soil conditions. If your soil can develop a significant ice lens (do due poor soil drainage) during freezing, it may be necessary to provide a foundation to ensure adequate bearing strength. In this case, foundation design must be considered separately and is not a part of this analysis. Foundation details must be approved for the specific application and site by a qualified professional.
8. A locally qualified professional must determine the applicability of this analysis for the expected site conditions. Due to the lack of involvement in the siting or construction phase of this product at a specific location, liability is strictly limited to issues arising from negligence or willful misconduct by NRG or the professional engineer completeing this analysis. No warranty, expressed or implied, is made concerning the suitability of this product for a given application or location.
9. Given dimensions are nominal. Actual dimensions may vary.
10. Erection forces are at zero wind speed on a flat terrain site and do not include tower appurtanances such as booms and obstruction marking lighting. The lifting guys are modeled as discrete appurtenances. The Winch Anchor Load is the summation of the four (4) winch anchor loads. Therefore, the Winch Anchor Load is spread between the four (4) anchors such that the maximum load per anchor is 16.0 kN (3600 lbf) during erection of a bare tower on flat terrain site.

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MATERIAL: SEE TABLE

FINISH: --- UNLESS OTHERWISE SPECIFIED

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NRG SYSTEMS

7533_60m Super NRG TallTower - with Anchors

DRAWN: EMR 8-31-12

RESPONSIBLE ENG APPROVAL: SHC 8-31-12

SHEET SIZE: B | PART #: 7533 | REV: A

SCALE: ---

CAD FILE: 7533_60m Super NRG TallTower - with Anchors

FOLDER: C:\NRG Vault\NRG Vault\Engineering Files\7500\

SHEET 2 OF 2

Anchor Loads – Imperial Units

(The loads shown on the graph apply to each of the anchors)

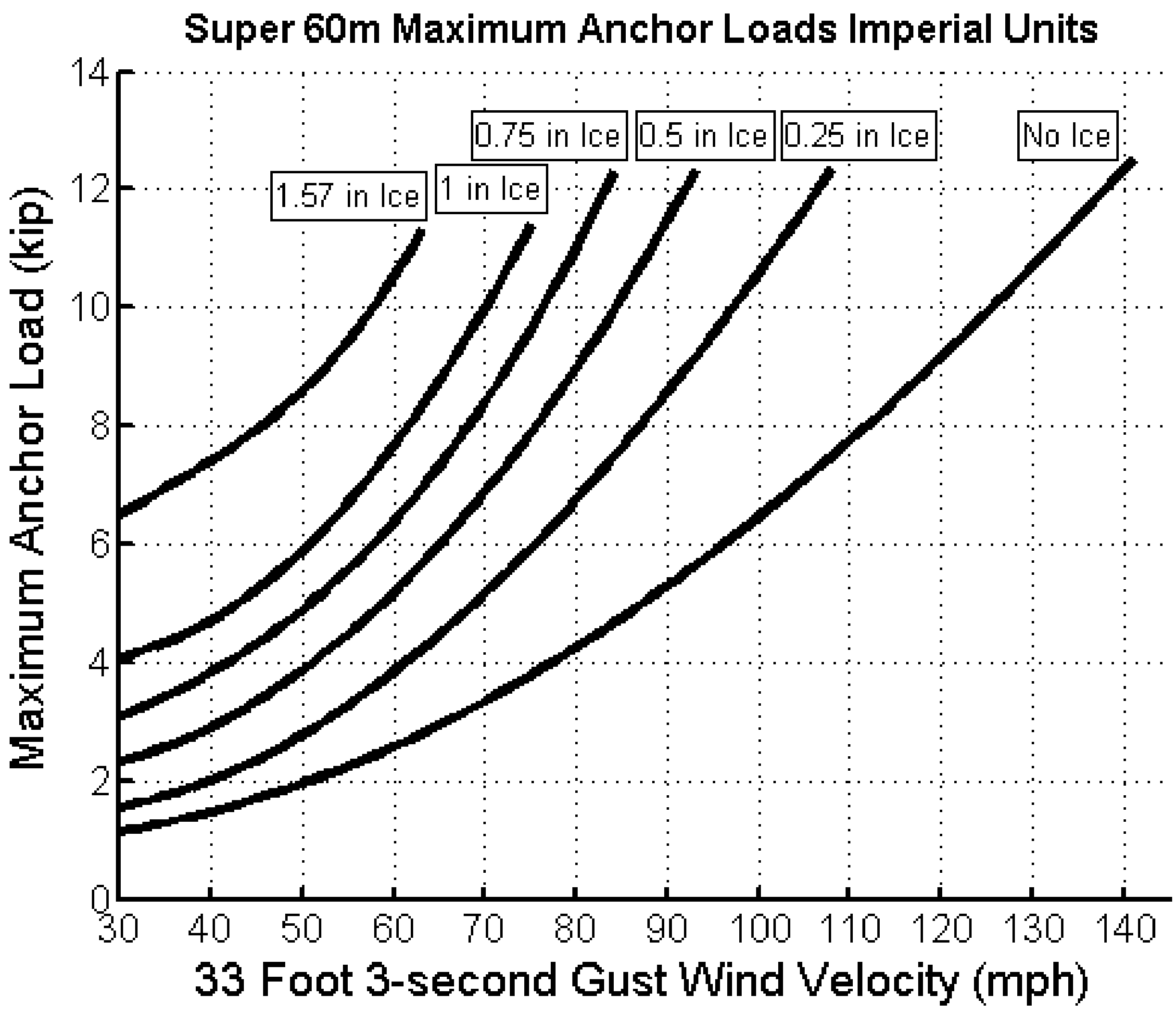


Figure 4: Super 60 m XHD Maximum Anchor Loads Imperial Units

Anchor Loads - SI Units

(The loads shown on the graph apply to each of the anchors)

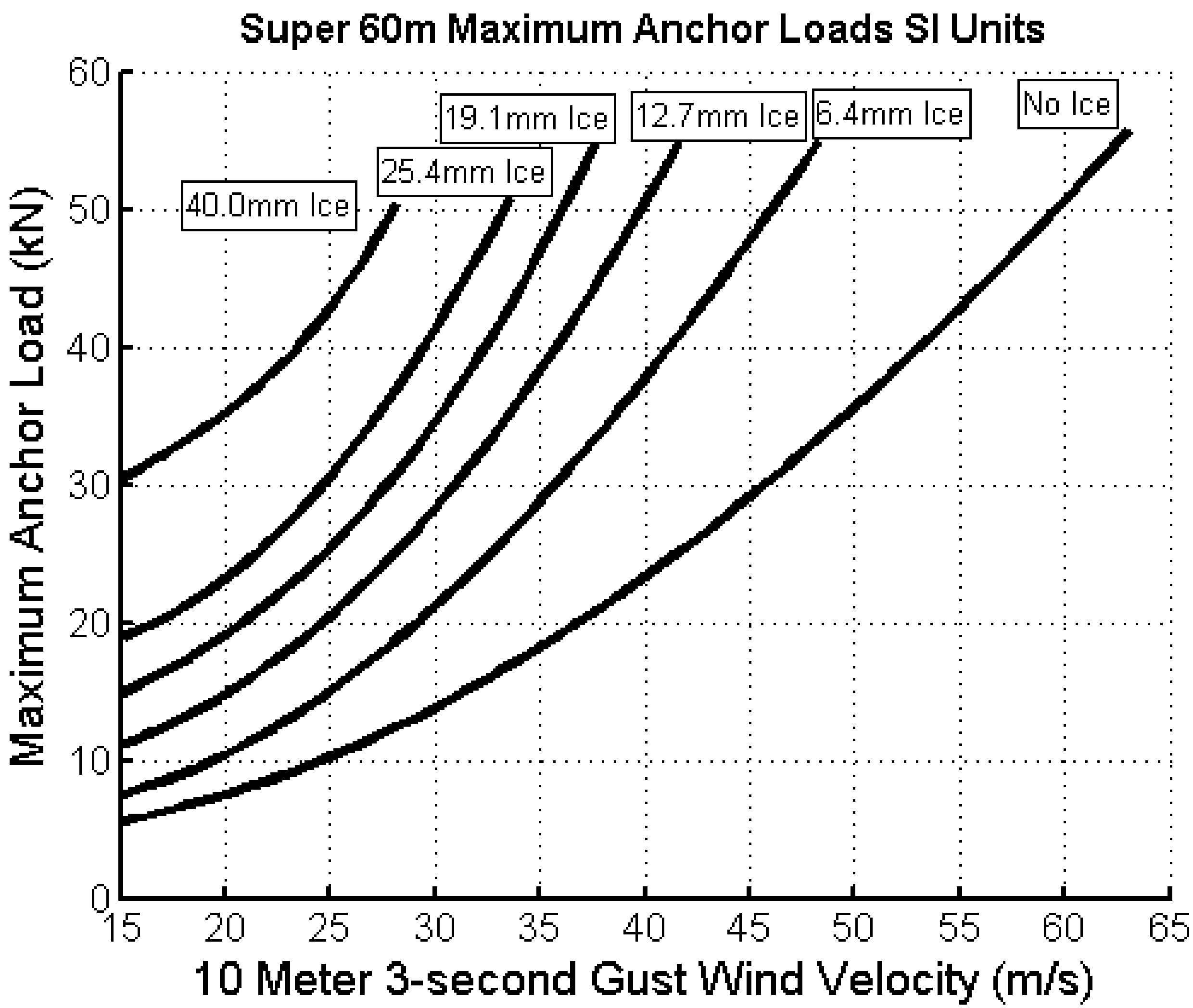


Figure 5: Super 60 m XHD Maximum Anchor Loads SI Units

Baseplate Loads – Imperial Units

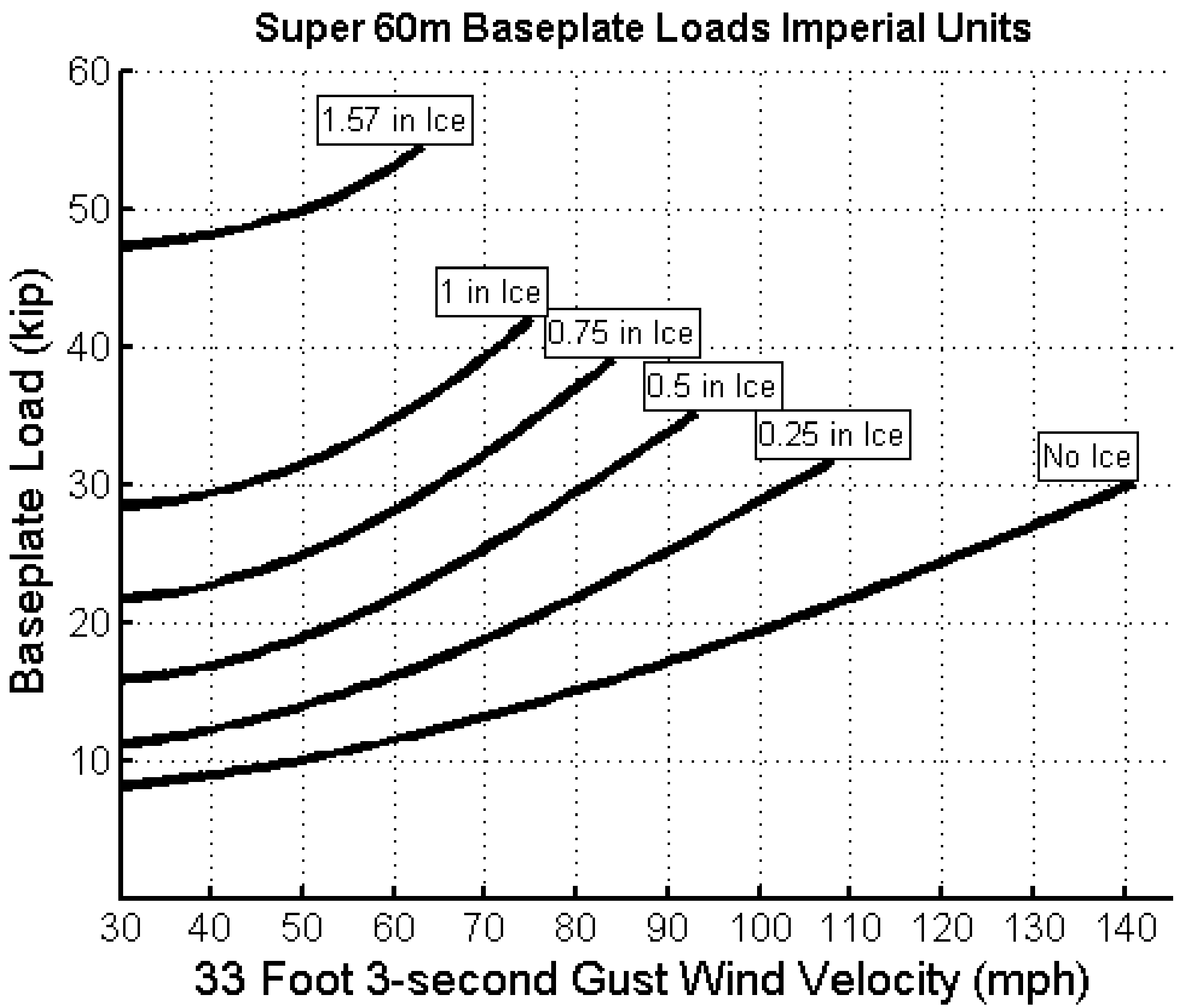


Figure 6: Super 60m Maximum Baseplate Loads Imperial Units

Baseplate Loads – SI Units

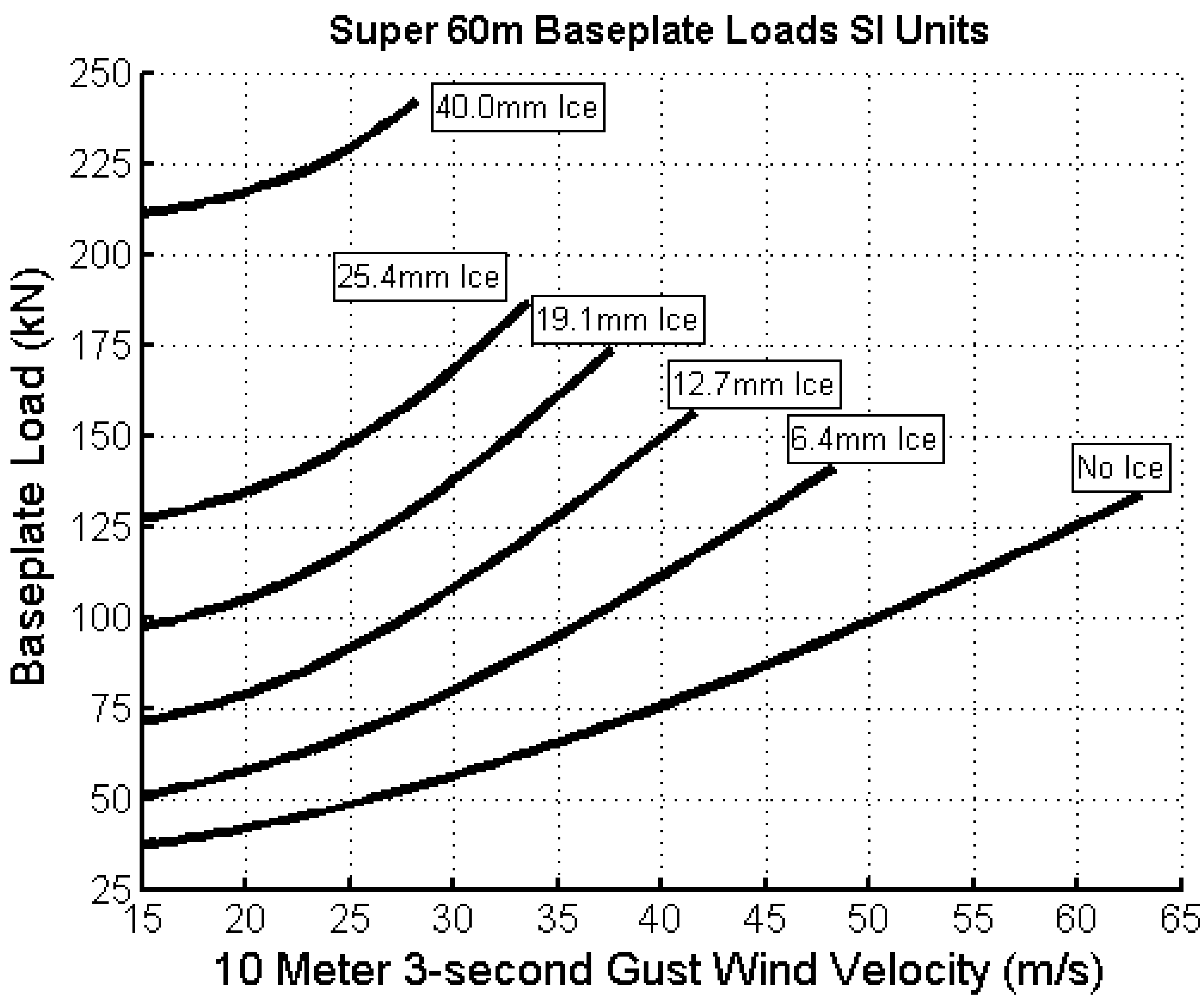


Figure 7: Super 60m Maximum Baseplate Loads SI Units

Appendix B: Anchoring Guidelines

Determine site soil and anchor type before you order your tower

Per ANSI/TIA-222-G, for design purposes, one can assume Class 6 soils. However, the Standard requires that soil parameters and assumptions be validated prior to installing the tower.

Before your tower is ordered, determine the soil type, preferably through soil sampling. Order the correct anchors based on the results of the soil sample.

The purpose of this section is to give you the information needed to provide suitable anchoring for your Super 60 m XHD TallTower. **Because anchor requirements are site specific, it is the responsibility of the customer to determine suitable anchors. If you are not sure what is required, seek professional guidance.**

Local utility companies can often provide useful information regarding anchoring used in the site area. Do not use rebar anchors, especially when the surface soils are loose or wet.

Table 13: Soil Classes

Class	Common Soil Types	Geological Soil Classification
3	Dense clays, sands and gravel; hard silts and clays	Glacial till; weathered shales, schist, gneiss and siltstone
4	Medium dense sandy gravel; very stiff to hard silts and clays	Glacial till; hardpan; marls
5	Medium dense coarse sand and sandy gravels; stiff to very stiff silts and clays	Saprolites, residual soils
6	Loose to medium dense fine to coarse sand; firm to stiff clays and silts	Dense hydraulic fill; compacted fill; residual soils
7**	Loose fine sand; Alluvium; loess; soil-firm clays; varied clays; fill	Flood plain soils; lake clays; adobe; gumbo; fill

** In class 7 soils, it is advisable to place anchors deep enough to penetrate underlying class 5 or 6 soil.
Charts reproduced by permission, The A.B. Chance Company.

Anchor Choices and other considerations

The choice of anchors must take into consideration soil type, maximum winds expected, icing or other weather that may affect the tower, and a safety factor suitable for the location and to meet any legal requirements. Considerations include but are not limited to: tornadoes, hurricanes or typhoons, locations where very high winds are expected, potential for flooding or periodic soaking of the soil, soil erosion, and icing events.

Screw-In Anchor Description

Screw-in anchors are the most commonly used anchors for normal clay soils without rocks. The 8 inch single helix anchors are installed by hand, using a cross bar to screw them into the earth like a corkscrew. The 8 inch twin helix anchors require machinery.

The Super 60 m XHD tower employs two (2), 8 inch diameter screw-in anchors and sixteen (16), 8 inch twin helix anchors.

Table 14: Specifications for 203 mm (8 inches) diameter Screw-In Anchors

Length Overall:	**203 mm (8 inches) Anchor**
Helix diameter:	203 mm (8.0 inches)
Length Overall:	1.65 m (66 inches)
Rod diameter:	25 mm (1 inch)
Material:	Galvanized steel
Holding Power: (These anchors are not suitable for soils denser than class 5.)	
Class 5 soils *	44.5 kN (10000 pounds)
Class 6 soils *	31.1 kN (7000 pounds)
Class 7 soils **	17.8 kN (4000 pounds)

* See Table 13 for soil class descriptions
** In class 7 soils, it is advisable to place anchors deep enough to penetrate underlying class 5 or 6 soil.

Table 15: Specifications for Mid-Strength 203 mm (8 inches) diameter Twin Helix

Length Overall:	2.7 m (9 feet) (including 7 foot rod)
Helix Diameter:	203 mm (8.0 inches)
Materials:	TBD
Holding Power:	
Class 3 soils *	12700 kg (28000 pounds)
Class 4 soils *	10900 kg (24000 pounds)
Class 5 soils *	9090 kg (20000 pounds)
Class 6 soils *	6800 kg (15000 pounds)
Class 7 soils *	5450 kg (12000 pounds)

* See Table 13 for soil class descriptions
** In class 7 soils, it is advisable to place anchors deep enough to penetrate underlying class 5 or 6 soil.

Rock Anchor description

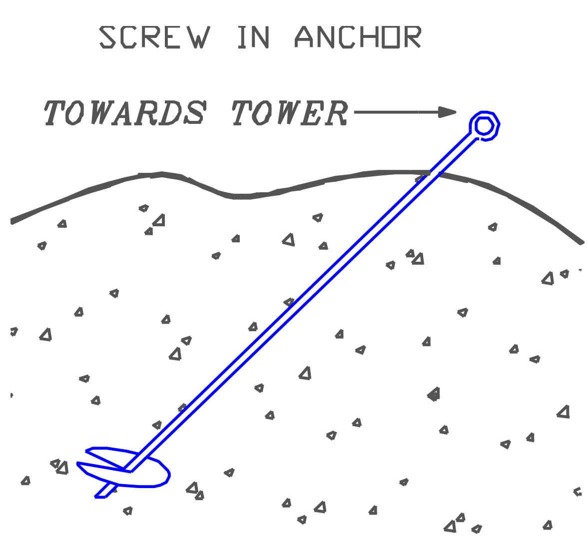
Rock anchors are placed into solid rock, when anchoring to either bare rock, or thin soils with solid rock near the surface. They are constructed of a threaded rod with integral eye, and two opposing wedge halves. The anchor is placed in a hole pre-drilled in the rock. Twisting the eye of the anchor forces the wedges against the sides of the hole and locks the anchor in place. Load actually increases the wedging force, developing holding power equal to the full tensile strength of the rod.

Table 16: Specifications for Rock Anchors

Holding Power:	9072 kgf (20,000 pounds)
Rod Length Overall:	0.38 m (15 inches), 0.76 m (30 inches) or 1.35 m (53 inches), other lengths available
Anchor Diameter:	44 mm (1.75 inches) as supplied, 60 mm (2.375 inches) max. expanded
Rod Diameter:	19 mm (.75 inches)
Materials:	Malleable iron, dipped in rust-resisting black paint
Required Hole Size:	50 mm (2 inches) diameter (nominal)
Use Rock Drill Size:	50 mm (2 inches) diameter

Installing Screw-In Anchors

Note: Unlike a tent stake, screw-in anchors are installed in line with the pull of the guy wires from the tower. It is important to install the anchor at an angle, so the eye of the anchor is toward the tower and the helix screws in away from the tower.



Picture 106: Installing Screw-in Anchors

Screw the anchor into the ground by placing a stout bar through the eye of the anchor, and rotating clockwise. It is sometimes helpful to start the anchor into the ground straight down for the first turn,

then push it down to the correct angle and complete the installation. Continue screwing the anchor into the ground until about 150 mm (6 inches) of the anchor rod remains above the ground.
If the anchor cannot be installed due to rocks in the soil, or other obstacles, try placing the anchor as much as 1 m (3 feet) from its ideal position to avoid the obstacle, or replace the screw-in anchor with the correct anchor for the soil. Arrowhead anchors are often suitable for rocky soils.

If necessary, a hole can be dug for the screw-in anchor to the proper installed depth, the anchor placed in the hole, and the hole back-filled. The earth must be tamped onto the anchor hard while back filling. The holding power of an anchor placed this way will not be as great as an anchor screwed into undisturbed soil. If in doubt, get professional advice on whether this option will work for your site.

Installing 8 inch diameter twin helix anchors

The installation of the 8 inch diameter twin helix anchors requires machinery capable of delivering working torques of 8135 N-m (6000 ft-lbf).

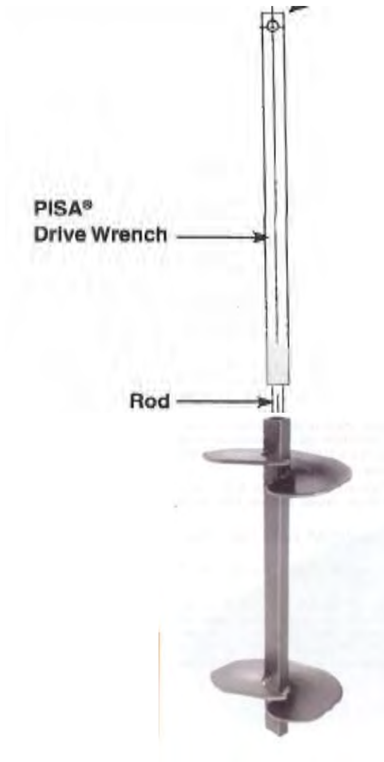
NOTE: All twelve (12) 8 inch diameter twin helix anchors employed on the Super 60 m XHD TallTower must be pull tested to 66.7 kN (15,000 lbf).

Note: It is important to install the anchor at an angle, so the eye of the anchor is toward the tower and the twin helix anchor points away from the tower. If the anchor is incorrectly installed straight into the ground, the load will bend the rod and pull it through the ground, allowing the guys to go slack. The installation tools required to install the twin helix anchors is shown in Picture 7.

Optional

Picture 107

The drive wrench slides over the anchor rod and mates with the twin helix anchor, as shown in Picture 7. The square cross section of the driver wrench permits torque transfer to the anchor for installation and, if necessary, backing-out the anchor while installing.



Picture 108

Installing Rock Anchors

Rock anchors are used when anchoring to either bare rock or thin soils with solid rock near the surface. Like any anchor, rock anchors must be placed so the force from the guy wires pulls directly on the anchor. Drill the hole for the anchor away from the tower at an angle into the ground.

Note: It is important to install the anchor at an angle, so the eye of the anchor is toward the tower and the expanding part of the anchor points away from the tower. If the anchor is incorrectly installed straight into the ground, the load will bend the rod and pull it through the ground, allowing the guys to go slack. Refer to the appropriate stamped drawing in the Appendix to determine the angle of the tower guys from the ground.

To install the anchor, a hole must be pre-drilled in the rock by hand or power tool. The hole must be 50 mm (2 inches) in diameter, and the walls of the hole should be smooth in the area that the anchor will wedge.
Place the anchor in the hole. Using a bar through the eye of the anchor, turn clockwise to tighten. The anchor will expand and wedge into the hole.

After placing the anchor, fill the hole around the rod with expanding cement grout. One brand is "Rockite" made by Hartline Products Co, Cleveland, OH, USA (telephone: +216 291 2303). Always grout rock anchors to prevent water from collecting and freezing in the drilled hole. Grouting also increases the anchor's holding strength.

Appendix C: Site Visit Procedures

Site Checklist

When making a site visit, check the following:

- Make sure the tower is straight. Stand at the base of the tower and look up to identify any bowed sections or curves in the tower that may have developed since the tower installation. Carefully adjust guy wires as necessary to straighten the tower.
- Check guy wires for excessive slack and adjust as necessary following the Section entitled Adjusting Guy Wires. It is normal for guy wires to stretch over time, and it is especially important to adjust them before they are subjected to icing or high winds.
- Check each anchor for movement or loosening. A loose anchor can also cause excessive slack in guy wires.
- Check that mounting booms, cellular antennas, temperature sensors, etc. are securely attached.
- Confirm that all grounding connections on the tower and on the logger are secure and haven't corroded.
- Check instantaneous sensor readings on each channel of your data logger. Any sensor providing erroneous readings should be disconnected from the logger and tested independently and/or replaced. It is a good idea to always have spare sensors, memory cards, batteries, and a spare data logger!
- Change the data logger's batteries. Remember that batteries are cheap, and old batteries can leak – it's better to change them prematurely rather than risk losing data or damaging your measurement equipment!

Appendix D: 2.4 m (95”) Side Mount Boom Installation

Introduction

Side mount booms are used to mount anemometers and wind direction vanes to NRG TallTowers up to 10 inches in diameter. Made of galvanized steel, the 2.4 m (95 inches) boom resists corrosion and holds sensors away from tower to avoid tower shadowing effects. The 2.4 m boom provides horizontal offset of 2.54 m (100 inches) centerline to centerline on a 10” diameter tower (10D), and 2.5 m (99 inches) centerline to centerline on an 8” diameter tower (12.38D). ½ inch mounting stem is 6.5 inches high. Height of cup centerline is 0.38 m (15 inches) (20D) above the ¾ inch boom cross section.

Installation

Step 1: Unpack box – 2 booms, 20 pieces total

Includes:

- 2 mounting brackets
- 6 hose clamps
- (2) 2-part triangular leg assemblies (Part A)
- 2 boom extensions with 90 degree bend – ¾ inch diameter tubing with ½ inch diameter stem shaft (Part B)
- 4 screws for mounting Part A to Part B (2 screws per boom)

Photo 1

Step 2: Affix Part A to Mounting Bracket

Place mounting bracket on ground or solid surface to install the 2 triangular 5/8 inch diameter boom sections. Line up the 90 degree bend with the large rectangular hole in the mounting bracket as shown in photo 2. The large hole in the mounting bracket will go towards the top of the tower.

Photo 2

Step 3: Position Part A in mounting bracket

The tube will slide into the metal bracket with a firm downward push. There is a metal tab on what will be the bottom side of the mounting bracket - see photo 4 for a detailed photo of this tab. Push the 5/8 inch tube to the bottom of the mounting bracket so that the tube hits the metal tab as shown in photo 4.

Photo 3

Photo 4

Step 4: Pre-Install the hose clamps into the mounting bracket

Select one hose clamp and feed the free end through one small side hole in the metal bracket, over the boom tubing and out the hole on the opposite side.   Position the fastener opposite the mounting bracket on the tower and with the hex head oriented towards you. Repeat 2 more times until all three clamps are in position.

Step 5: Install boom on tower

Using a 5/16 inch nut driver, attach the partially assembled boom to the tower. The section with 2 hose clamps will be toward the top of the tower. The hose clamps go around the bracket and the 5/8 tubing. Tighten the top and bottom clamps first, and then tighten the middle clamp. Photo 6 shows a detailed photo of the bottom clamp assembly.   Please note the two metal tabs are toward the base of the tower.


Photo 5

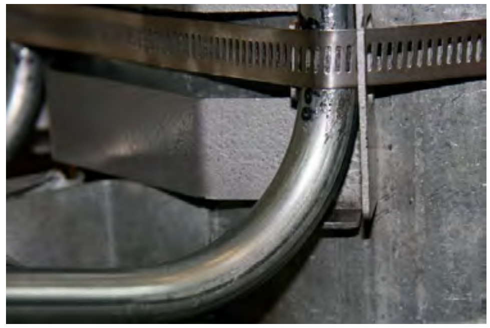


Photo 6

Step 6: Locate the 5-holed sleeve on the end of Part A

The 2 holes for the #10-32 self-tapping screws should be toward the top of the tower. See photo 7.

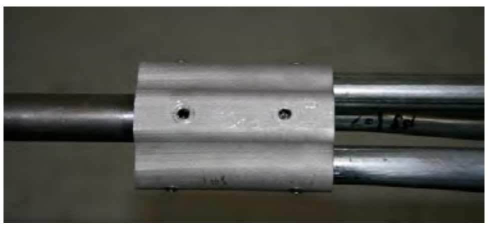


Photo 7

Step 7: Install Part B, boom extension

Insert Part B into the 5-holed sleeve and align with the stem shaft pointing straight up as in photo 8.

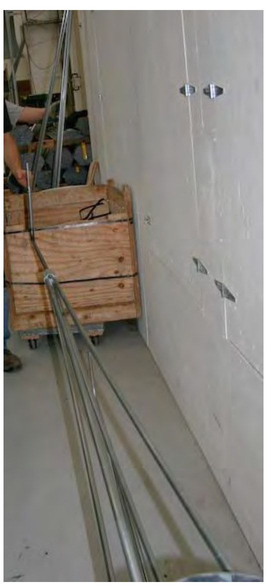


Photo 8

Step 8: Secure the boom extension

Line up the holes in the ¾ inch pipe with the sleeve. Install the 2 x 5/16 inch drive self-tapping screws in the sleeve (photo 9). Using a drill driver and holding it straight helps to get these started correctly and is much more effective than a hand screw-driver.

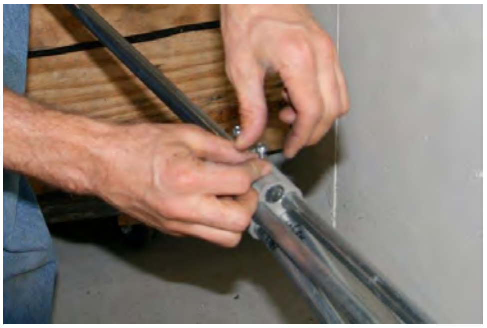


Photo 9

Tighten the self-tapping screws to secure the boom extension as in photo 10. The clutch on the drill driver can be set to a low/medium setting and that will seat the screws correctly.

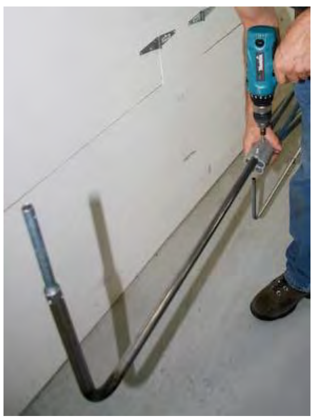


Photo 10

Photo 11 shows the finished new boom installed above the 1.53 m (60.5 inch) boom.

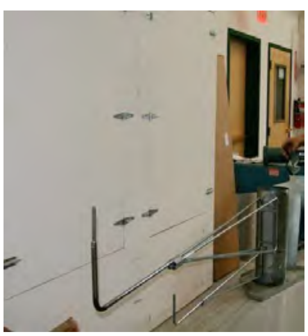


Photo 11

Appendix E: Aligning Wind Vanes

Introduction

Wind Vanes measure wind direction relative to the orientation of the fixed base on the sensor. This Application Note gives you the information you need to orient your wind vanes correctly when they are mounted to the tower. This note also includes information on using Offset and Magnetic Declination corrections when scaling your data to obtain properly scaled and oriented data.

Magnetic Declination

Since the earth's magnetic field is not uniform, the magnetic poles do not coincide with the true geographic poles. Moreover, a compass generally doesn't point to a true geographic pole; it points to a magnetic pole. This difference between a true geographic bearing and a magnetic bearing varies from location to location and is called *magnetic declination*. Magnetic declination or "compass variation" is the horizontal angle between *true north* (also called "geographic north" or "map north") and the direction the compass points, *magnetic north*.

Magnetic declination is measured as the number of degrees of error a compass shows at a site. The declination for sites located east of the magnetic north pole is expressed as the number of degrees that magnetic north is west of true north. The declination for sites located west of the magnetic north pole is expressed as the number of degrees that magnetic north is east of true north. For example, Vermont (USA) has a magnetic declination of 15 degrees west. In other words, magnetic north in Vermont is 15 degrees to the west of true north. Magnetic north in Fairbanks, Alaska (USA) is about 27 degrees east of true north; therefore, its magnetic declination is 27 degrees east.

The earth's magnetic field varies slightly in position over time. Therefore, the magnetic declination at a site also varies over time. Because of this variation, it is important that you reference an up-to-date map of declination ("isogonic map") if you choose to orient your wind vanes to magnetic north. Later you can enter a correction for magnetic declination into your wind data analysis software if desired.

Mounting and Aligning Wind Vanes

Since a magnetic compass is the simplest direction reference, it is sometimes convenient to orient wind vanes in the field to magnetic north. Most NRG customers, however, align their wind vanes to true north. Before installing your NRG logger, decide whether you want wind direction data to report north when the wind is from the *magnetic north* or when the wind is from *true north*. Be sure to make note of your choice and maintain consistency among your sites and projects.

To align a wind vane to true north:

Use a transparent orienteering compass with a rotating bezel and magnetic declination markings. In the example in Figure 7, 15 degrees west means that the direction of the compass needle (magnetic north) lies 15 degrees west of true north.

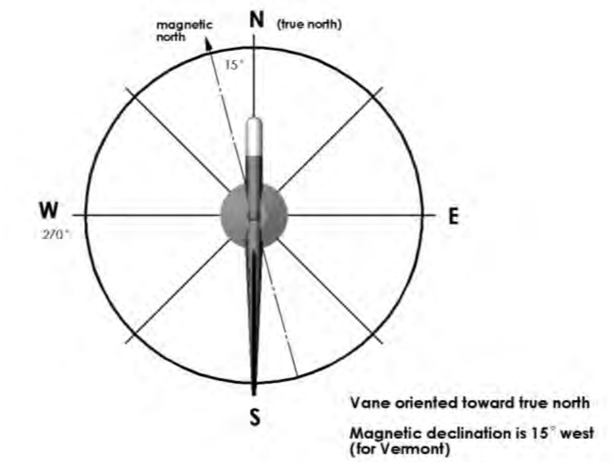


Figure 8

NOTE: Lining up the ridges on the body of the wind vane will cause the sensor to indicate a north reading. Be sure to keep this in mind when orienting the wind vane on the mounting boom.

Stand so that it is possible to sight along the tower from the top to the base. Align the bearing mark on the compass so that it points directly in line with the tower, top to base. The bearing of the TallTower in the example in Figure 8 is 270 degrees.

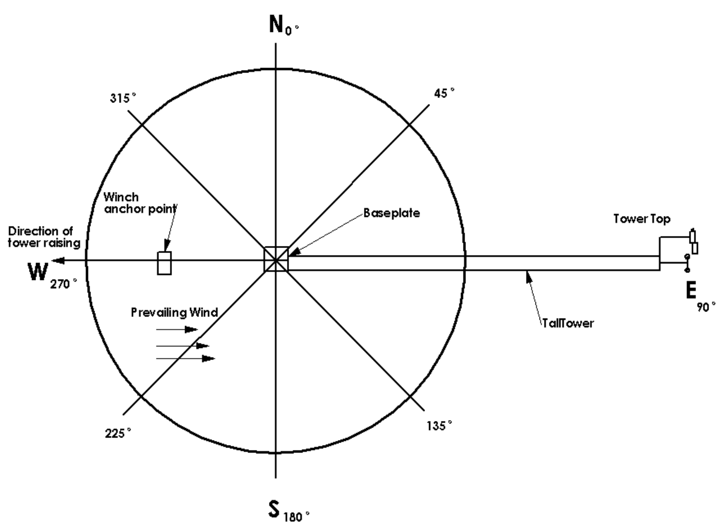


Figure 9

Without moving the base of the compass, rotate the bezel so the north end of the needle points to the declination mark that corresponds to local declination.

Loosely attach the mounting boom to the TallTower.

Lift the compass to a vertical position so the bearing mark points straight up. Use a level if necessary.

Sight through the compass so the center of the compass is over the point where the boom contacts the tower, with the bearing mark still straight up. See Figure 9.

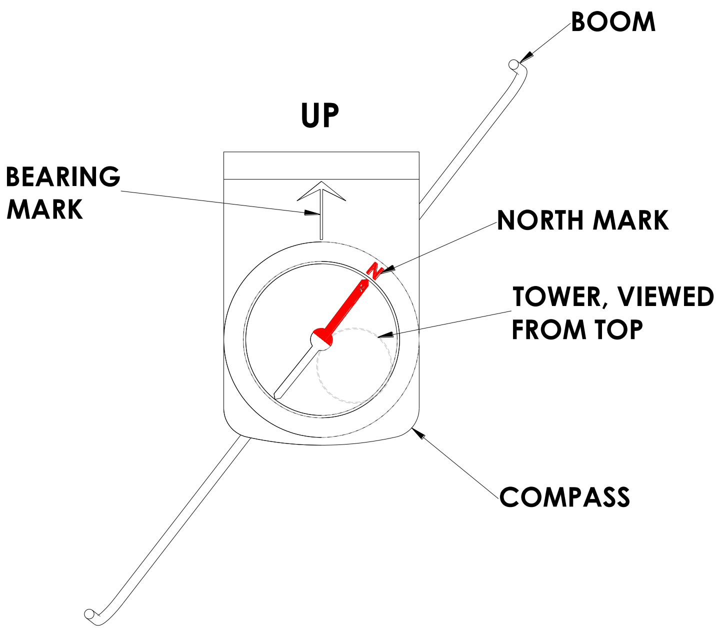


Figure 10

Have a crew member rotate the boom until it aligns with the north mark on the compass, and tighten the boom.

Attach the wind vane with the north arrow index mark on the base pointing in the same direction as the north mark on the compass. The #200P wind direction vane is designed to mount with a cotter pin and set screw to a NRG sensor mounting boom. Insert the cotter pin from the side that the positive (+) terminal is on, through the sensor so the ends exit the same side as the negative (-) terminal. Separate the ends of the cotter pin so it will not fall out. The cotter pin installs horizontally through drilled holes in the boom and vane, allowing the base of the vane to point in one of two directions, toward the tower or away from the tower. See

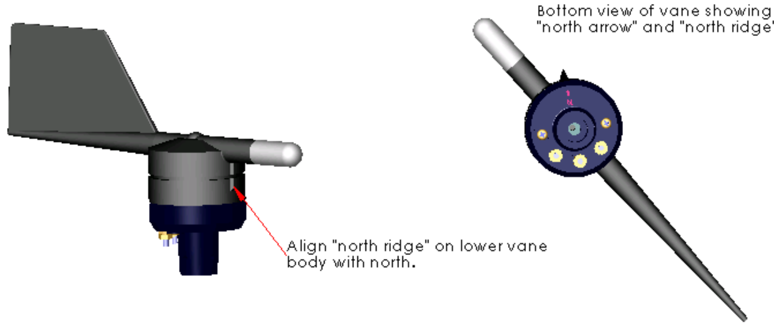


Figure 10.

Figure 10

When you raise the TallTower, the north arrow on the base of the wind vane will point to true north.

Use the compass to verify your settings. If necessary, adjust the position of the mounting boom before raising the TallTower.

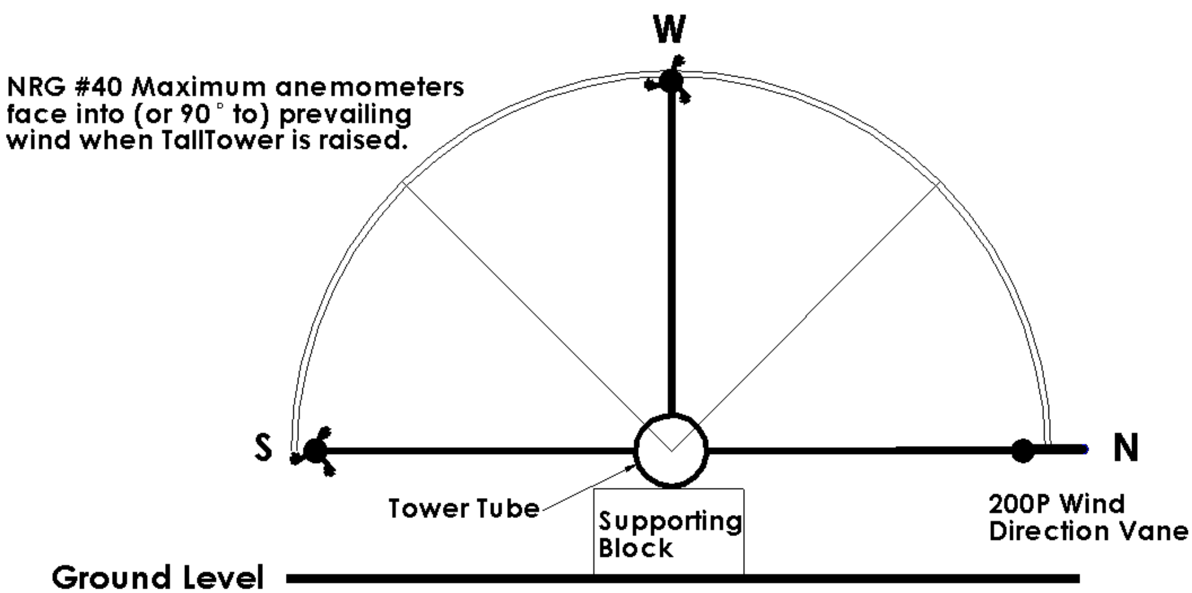


Figure 11

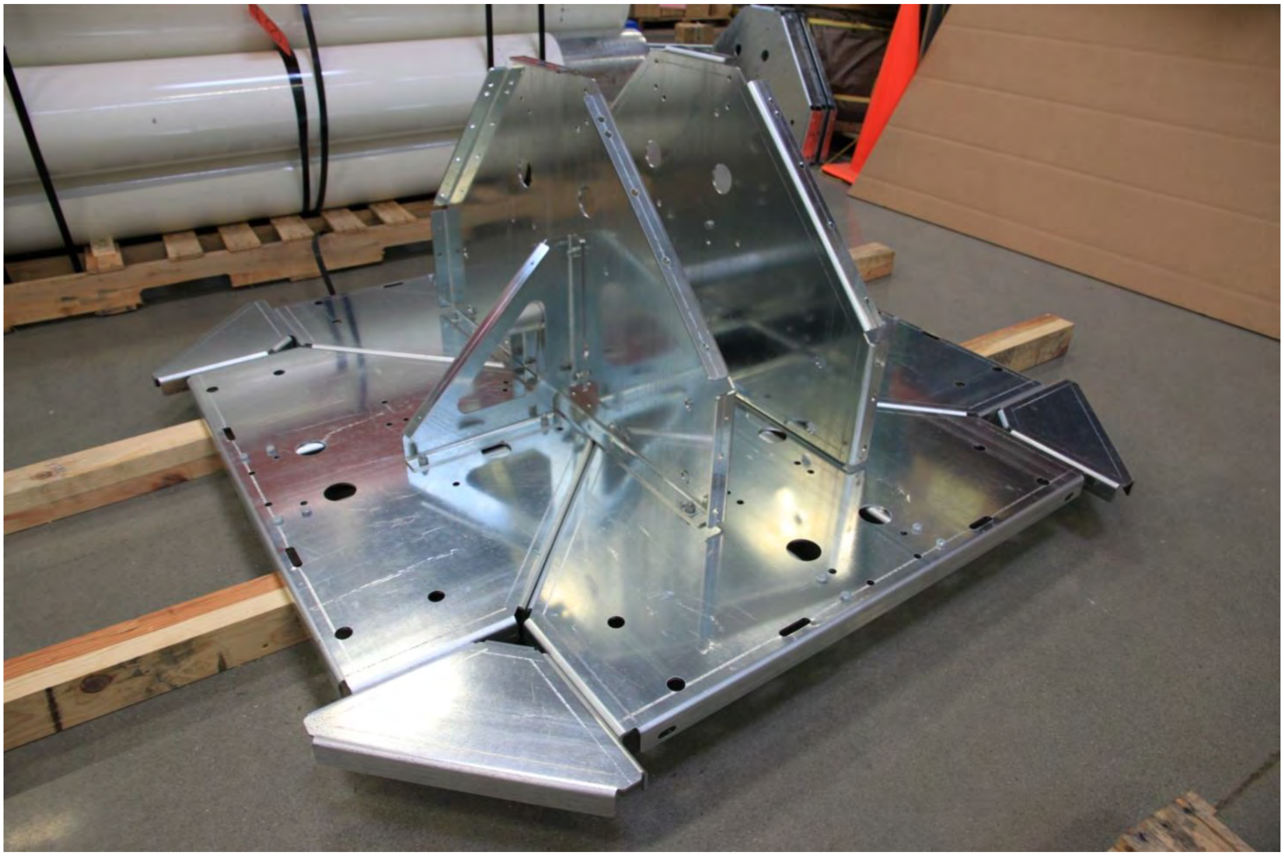
Using Data Analysis Software to Correct for Magnetic Declination

*If you orient your wind vanes toward magnetic north but want the direction data reported relative to true north, enter the magnetic declination for the site into the offset or magnetic declination field in your wind data analysis software. NRG's BaseStation Software, for example, has a field called **Mag Declin.** BaseStaion applies the declination to all wind direction data for the site if the Mag Declin field is set to anything but zero. **Declination is not needed if you orient your wind vanes to true north.***

Note: *Wind direction vanes have a small range centered around the sensor's north reading that is called the dead band and produces a zero reading. Although NRG Loggers have an algorithm that interprets north readings correctly, when the prevailing wind is from the north, it may make sense to orient the vane to a direction other than north. If you do this, compensate for the orientation by entering a value in the wind vane 'offset' field of your data analysis software. For example, if you orient your wind vane to the south (180 degrees), enter an offset of –180 for the vane.*

Note: If you orient your wind vane to a magnetic bearing other than magnetic north, you need to enter values for both magnetic declination and offset in your data analysis software. Enter the site's magnetic declination so that your software can compensate for the declination; enter an offset to compensate for the orientation of the vane. If just one offset field is available in your software, such as NRG's Symphonie Data Retriever software, you will need to combine the magnetic declination value with the offset value (if wind vanes are not oriented to true north) and enter the net value. For example, if your wind vanes are oriented to the south instead of north, and your site has a magnetic declination of 15 degrees west, you would enter –195 in the offset field. Declinations to the west of true north are subtracted from the magnetic reading, and declinations to the east of true north are added to the magnetic reading.

Appendix F: ANSI/TIA-222-G Foundation Considerations



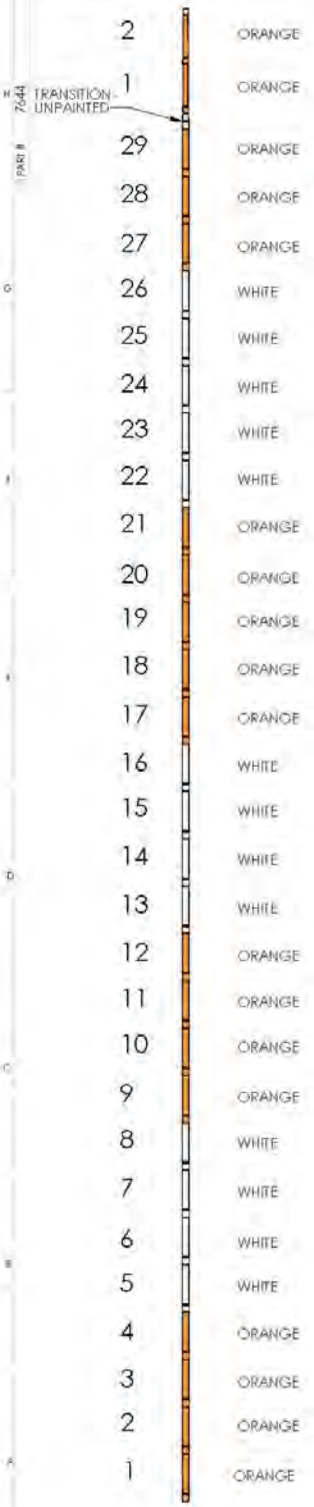
Picture 108: Baseplate

Baseplate Geometry (with ground surface area of 19.5 ft^2)

Per ANSI/TIA-222-G, for design purposes, one can assume Class 6 (Clay) soils. However, the Standard requires that soil parameters and assumptions be validated prior to installing the tower. Prior to tower installation, determine the soil type, preferably through soil sampling.

The baseplate cross-sectional area is 19.5 ft^2. The cross-sectional area was sized to ensure the factored resistance of Clay soil is greater than the reactions from the factored load combinations listed in Section 2.3.2 of ANSI/TIA-222-G. The presumptive soil parameters per ANSI/TIA-222-G assume dry soil conditions. If your soil can develop a significant ice lens (do due poor soil drainage) during freezing, it may be necessary to provide a foundation to ensure adequate bearing strength.
Foundation details must be approved for the specific
application and site by a qualified professional.

Appendix G: Super 60 m XHD TallTower Painted Version



ITEM NO.	PART NUMBER	QTY.
1	4822_BASE TUBE - ASSEMBLY, INSERT & FASTENERS, PAINTED	1
2	4791_TUBE-FLARED, LANCED, SLOTS, 10 ga, 254mm(10in.) x 2.2m(87in.), ORANGE	16
3	4792_TUBE-FLARED, LANCED, SLOTS, 10 ga, 254mm(10in.) x 2.2m(87in.), WHITE	13
4	4824_TUBE-FLARED, LANCED, SLOTS, 10 ga, 203mm(8in.) x 2.2m(87in.), ORANGE	2
5	4558_ADAPTER-TOWER TRANSITION SECTION, SLOTS, HOLES, 10'-8", GALVANIZED	1

SUPER 60m TALLTOWER PAINTED VERSION

NOTES:

1. PAINT SCHEME DERIVED FROM FAA AC70/7460-1K (CANADIAN VERSION CAR 621-19).

NRG SYSTEMS

DO NOT MANUALLY UPDATE

7644_Super 60m XHD NRG TallTower - Painted

7644 A

1 OF 1

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