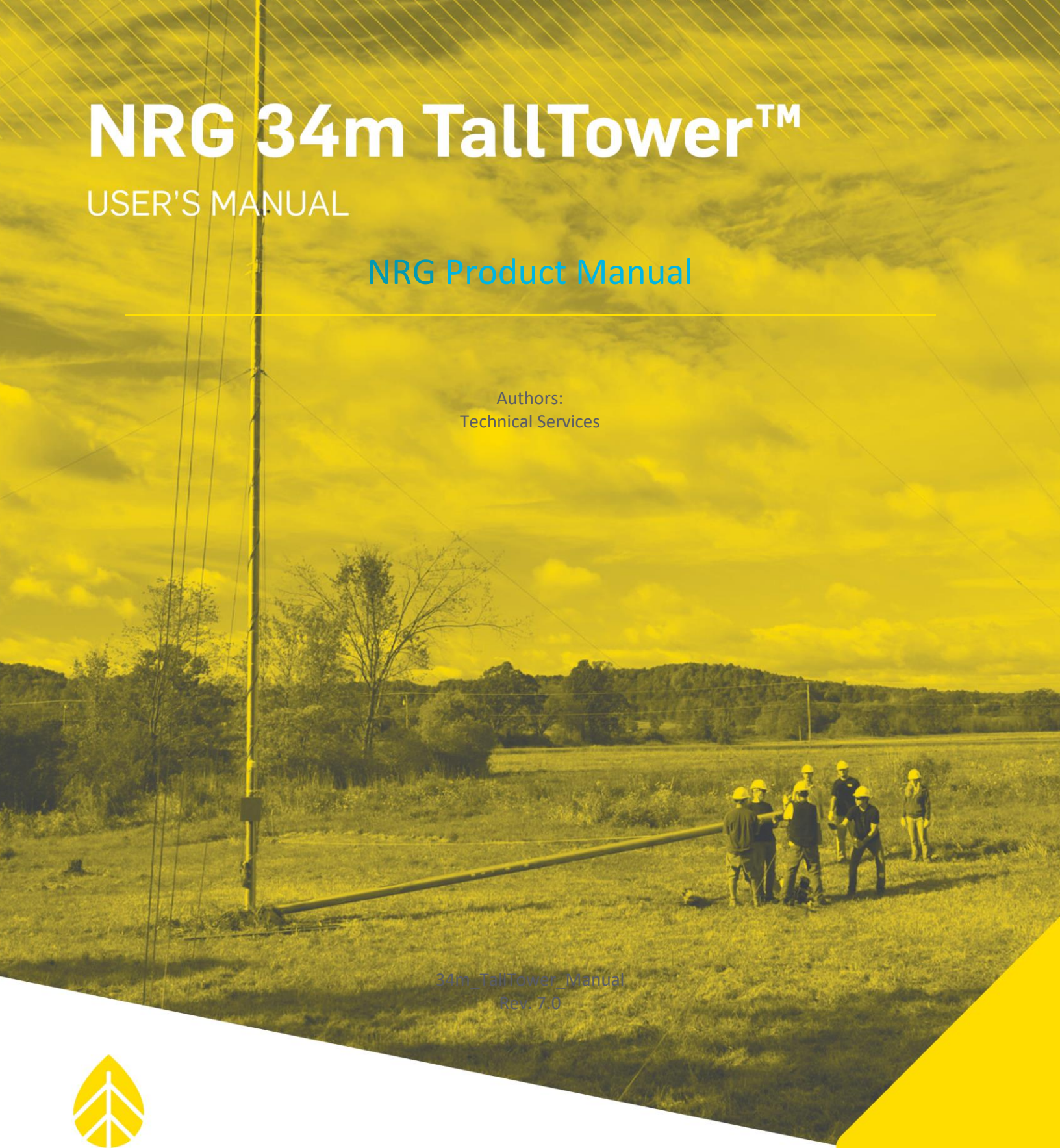
NRG 34m TallTower™

USER'S MANUAL

NRG Product Manual

Authors:
Technical Services



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SAFETY CONSIDERATIONS & WARNINGS

READ ALL INSTRUCTIONS AND WARNINGS BEFORE BEGINNING ANY TOWER INSTALLATION. TOWER COMPONENTS CONSIST OF HEAVY OBJECTS OFTEN UNDER SIGNIFICANT TENSION AND SERIOUS INJURY OR DEATH CAN OCCUR IF EXTREME CAUTION IS NOT USED DURING EVERY ASPECT OF THE INSTALLATION. EVERY INSTALLATION CREW MEMBER SHOULD CAREFULLY READ AND UNDERSTAND ALL WARNINGS, INSTRUCTIONS AND OTHER INFORMATION IN THIS INSTALLATION MANUAL, INCLUDING THE GLOSSARY OF TERMS.

ONLY EXPERIENCED INSTALLERS SHOULD PERFORM TALLTOWER INSTALLATIONS. DO NOT ATTEMPT TO INSTALL A TALLTOWER IF YOU ARE INEXPERIENCED OR UNTRAINED. TALL, GUYED TOWERS AND THEIR COMPONENTS CAN POSE DANGERS THAT CAN LEAD TO SERIOUS INJURY OR DEATH TO YOU OR OTHERS AROUND YOU. DO NOT BEGIN A TALLTOWER INSTALLATION UNLESS YOU HAVE ASSEMBELD AN EXPERIENCED AND QUALIFIED CREW.

USE ONLY SUITABLE TOWER ANCHORS FOR THE SOIL TYPE AT THE INSTALLATION SITE. STABILITY OF THE COMPLETED TOWER UNDER VARYING CONDITIONS (*E.G.*, HIGH WINDS AND ICE), AND STABILITY DURING INSTALLATION, DEPENDS ON THE USE OF PROPER ANCHORS FOR THE SOIL TYPE AT THE INSTALLATION SITE. FAILURE TO USE PROPER ANCHORS COULD CAUSE THE TOWER TO FALL RESULTING IN SERIOUS INJURY OR DEATH OR PROPERTY DAMAGE. CONSULT WITH THE APPROPRIATE PROFESSIONALS TO FIRST DETERMINE SOIL CONDITIONS AND THEN SELECT THE PROPER ANCHOR SYSTEM BEING SURE TO FOLLOW ALL ANCHOR MANUFACTURERS' INSTRUCTIONS.

DO NOT INSTALL A TALLTOWER NEAR ELECTRICAL POWER LINES. METAL TALLTOWER COMPONENTS EFFICIENTLY CONDUCT ELECTRICAL CURRENT AND CAN RESULT IN SERIOUS INJURY OR DEATH IF THEY COME IN CONTACT WITH HIGH VOLTAGE ELECTRICAL LINES. SURVEY THE PROPOSED INSTALLATION SITE AND DO NOT BEGIN ANY TALLTOWER INSTALLATION IF ANY ELECTRICAL LINES ARE PRESENT.

DO NOT BEGIN OR CONTINUE A TALLTOWER INSTALLATION DURING AN ELECTRICAL STORM. IF LIGHTNING STRIKES A TALLTOWER OR ITS METAL COMPONENTS, SERIOUS INJURY OR DEATH COULD OCCUR TO THOSE WORKING WITH OR AROUND IT. DO NOT BEGIN AN INSTALLATION, OR CONTINUE ONE, DURING AN ELECTRICAL STORM OR IF ONE IS IMMINENT.

WEAR APPROPRIATE PROTECTIVE GEAR AND USE CAUTION WHEN UNPACKING TALLTOWER COMPONENTS. WEAR GLOVES AND EYE PROTECTION WHILE UNPACKING THE ENVIROCRATE TO PREVENT CUTS AND OTHER INJURIES FROM BANDS AND SHARP OBJECTS. HEAVY COMPONENTS CAN SHIFT IF NOT UNPACKED CAREFULLY AND IN THE PROPER SEQUENCE. FOLLOW ALL UNPACKING INSTRUCTIONS.

CARELESSNESS DURING TOWER INSTALLATION CAN CAUSE SERIOUS INJURY OR DEATH. AN IMPROPERLY INSTALLED TALLTOWER CAN ALSO CAUSE SERIOUS INJURY OR DEATH. FOR YOUR SAFETY AND THE SAFETY OF OTHERS ON THE INSTALLATION CREW, AS WELL AS THOSE IN THE VICINITY OF A COMPLETED TOWER:

ALWAYS DO THE FOLLOWING:

- Only install or remove TallTowers using experienced installation crew members who are familiar with all TallTower components and safe installation and removal procedures.
- Always follow all instructions and warnings in the TallTower Installation Manual, as well as all other technical information necessary for the safe installation in a specific location.
- Always consult with appropriate professionals to determine soil type at the installation site and then the most appropriate anchor system for use at that site. Follow all anchor manufacturers' instructions.
- Always stand to the side of any guy wire under tension so that you are not in the path of a guy wire that breaks or comes loose.
- Always consult with appropriate authorities (*e.g.*, the Federal Aviation Administration, local building or zoning departments, etc.) and surrounding land owners if a TallTower is being installed in an agricultural area to determine installation and tower marking requirements so as to minimize risk to low flying agricultural aircraft.

NEVER DO THE FOLLOWING:

- Never begin an installation with an inexperienced or untrained installation crew.
- Never allow installation crew members to commence work unless and until each crew member has thoroughly read and understands the information contained in the TallTower Installation Manual.
- Never stand in a direct line with any guy wire under tension as it could cause serious injury or death if it breaks or comes loose.
- Never climb a TallTower.
- Never erect a TallTower in an area where electrical power lines pose a hazard.
- Never allow unauthorized persons in the area where a TallTower is being installed.
- Never begin or continue a TallTower installation during high winds.
- Never begin or continue a TallTower installation during an electrical storm or when one is imminent.
- Never use parts for one TallTower to create a shorter TallTower; this cannot be done safely.

Aircraft Safety Bulletin

For tower installations in agricultural areas or remote areas where low-flying aircraft operate.

DANGER

ALWAYS USE VISIBILITY ENHANCING DEVICES ON TALLTOWERS INSTALLED IN AGRICULTURAL AREAS WHERE LOW FLYING AIRCRAFT OPERATE.

THE INSTALLATION OF TALLTOWERS IN AGRICULTURAL AREAS CAN POSE A SERIOUS RISK TO LOW-FLYING AIRCRAFT**. PHYSICAL CONTACT BETWEEN AN AGRICULTURAL AIRCRAFT AND ANY PART OF A TALLTOWER OR ITS GUY WIRE SYSTEM CAN RESULT IN SERIOUS INJURY OR DEATH.**

IT IS IMPERATIVE THAT LANDOWNERS, DEVELOPERS, WIND ENERGY CONSULTANTS AND INSTALLERS EACH CONSIDER THIS SERIOUS SAFETY RISK FOR ANY WIND ENERGY PROJECT PROPOSED FOR INSTALLATION IN AN AGRICULTURAL AREA.

NRG Systems manufactures FAA-compliant painted towers for use in agricultural areas. A variety of visibility-enhancing accessories including FAA-compliant aviation obstruction lighting kits, high-visibility cable ball kits, and guy wire guards are available from NRG Systems for use with such installations.

If the installation of a MET is being proposed for an agricultural area or in remote areas where low flying aircraft operate, NRG Systems strongly recommends those involved in the project do ALL the following:

Become familiar with any and all applicable Federal Aviation Administration (FAA) tower visibility and lighting requirements, including FAA Advisory Circular AC 70/7460-1L “Obstruction Marking and Lighting” dated December 4, 2015 and as revised, and ensure the installation complies with those standards and any recommendations contained therein, including but not limited to the following:

- Voluntary marking of meteorological towers less than 200 feet (61 m) AGL in accordance with marking guidance contained in the FAA Advisory Circular AC70/7460-1L.
- Painting with alternate bands of aviation orange and white paint in accordance with Chapter 3, paragraphs 3.1 through 3.4 of the FAA Advisory Circular AC70/7460-1L.
- Utilizing several high visibility sleeves (guy guards) on outer guy wires.
- Attaching spherical marker (cable) balls to the guy wires. Aviation orange marker balls should be installed according to Chapter 3, paragraph 3.5 of the FAA Advisory Circular AC70/7460-1L.

- Contact the FAA's Obstruction Evaluation/Airport Airspace Analysis (OE/AAA) office (http://oeaaa.faa.gov) to discuss whether a "Notice of Proposed Construction or Alteration" form (FAA Form 7460-1) is required.

- Contact the nearest FAA Regional or District Office regarding installation reporting requirements (www.faa.gov/airports/news_information/contact_info/?s);

- Become familiar with any and all state and local statutes, ordinances, zoning or other regulations regarding tower visibility and lighting requirements, as some states have enacted statutes or regulations – as have many local jurisdictions – which may affect tower visibility and lighting and which may differ from FAA requirements.

- Contact local regulatory agencies (*e.g.*, city and county building departments) to determine if there are any local zoning regulations relating to the installation.

- Investigate whether agricultural aviation is present at or around the installation site(s) under consideration, including contacting state and local farm bureaus and/or state or national agricultural aviation organizations (*e.g.*, National Agricultural Aviation Association [http://www.agaviation.org]).

- Contact local landowners, farming operations and agricultural operators and notify them of a proposed or completed installation, including specific GPS coordinates.

INTRODUCTION

TallTower History

NRG TallTowers™, the original tilt-up tubular towers, were first introduced in 1982 and soon 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.

Construction and Assembly

The NRG TallTower™ is of galvanized steel tube construction and is guyed at four levels in four directions. Sections slide together without the use of bolts or clamps. The tower is tilted up from the ground with a gin pole and winch (winch is not included). Lifting of the tower is done by one set of guy wires (lifting wires) attached to the gin pole. The tower is stabilized sideways with two side 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 34 meter TallTowers are supplied complete with ready to assemble tubes, baseplate, guy rings, precut guy wires, screw-in anchors, grounding kit, and associated hardware. Screw-in earth anchors are included and are suitable for many soil types. Other anchor types are available. It is your responsibility to determine which type of anchor is appropriate for your specific site.

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

A winch and ginpole (ginpole is included with the purchase of this tower) are also required to raise the tower.

The ginpole for the 34m TallTower is NOT compatible with other NRG TallTowers. The ginpoles from other NRG TallTowers are not compatible with the 34 m tower.

Please see the Glossary for pictures and descriptions of tower parts, hardware, and accessories.

Experience Required

If you have no prior experience with TallTower installation, seek assistance from a qualified installer.

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.

Five Member Crew:

- **Crew Leader:**
  This person will operate the winch and 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.
- **Side Guy Wire Tenders:**
  These two people will attend to each side guy anchor and adjust side guy wires. They must be familiar with taking in and letting out guy wires. See the pictures describing the “inchworm” technique for safely adjusting guy wires.
- **Observers:**
  Two people to assist adjusting side guys, tending the back guy wires at the end of the lift, and otherwise observing guy wires.

MASTER TOOL LIST

- ¼ inch nut driver (for sensor installation)
- 5/16 inch nut driver (for hose clamps)
- 7/16 inch (11 mm) socket wrenches (for wire rope clips) – one per crew member
- Large adjustable wrench (for large bolts)
- 1/2 inch wrench, socket or open (for base plate assembly and unpacking
- Piece of rebar or similar (for turning anchors)
- Hand sledge (for ground rods)
- 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)
- Knives (to cut electrical tape) – one per crew member
- Level, preferably with a magnetic base (to straighten the tower)
- Compass (for aligning direction sensors)
- Permanent marker (for labeling lower ends of cables)
- (2) 12 V deep cycle marine battery (for electric winch)
- Hankmaster 5000™ guy wire tool (optional)
- Gloves
- 2-way radios or walkie talkies
- Electric drill with 5/16 inch bit (for unpacking and attaching top tube)
- Band cutters (for unpacking)
- 2.5 m (8 feet) stepladder (for reaching end of ginpole on sloped sites)
- Rebar, rock bolts, or steel cable to secure tower base
- 8 wood posts (10 cm x 10 cm x 1 m / 4 in. x 4 in. x 3 ft.) to support tower
- Sawhorse to support ginpole
- Wire cutters

UNPACKING THE TOWER

USE EXTREME CAUTION WHEN UNPACKING HEAVY TALLTOWER COMPONENTS. LOOSE TALLTOWER COMPONENTS CAN CAUSE SERIOUS CRUSHING INJURIES DURING UNPACKING IF CARE IS NOT TAKEN. ALWAYS FOLLOW UNPACKING INSTRUCTIONS CAREFULLY, AND USE SUFFICIENT INSTALLATION CREW MEMBERS TO REMOVE TALLTOWER COMPONENTS FROM THE ENVIROCRATE PACKAGING IN THE PROPER SEQUENCE.

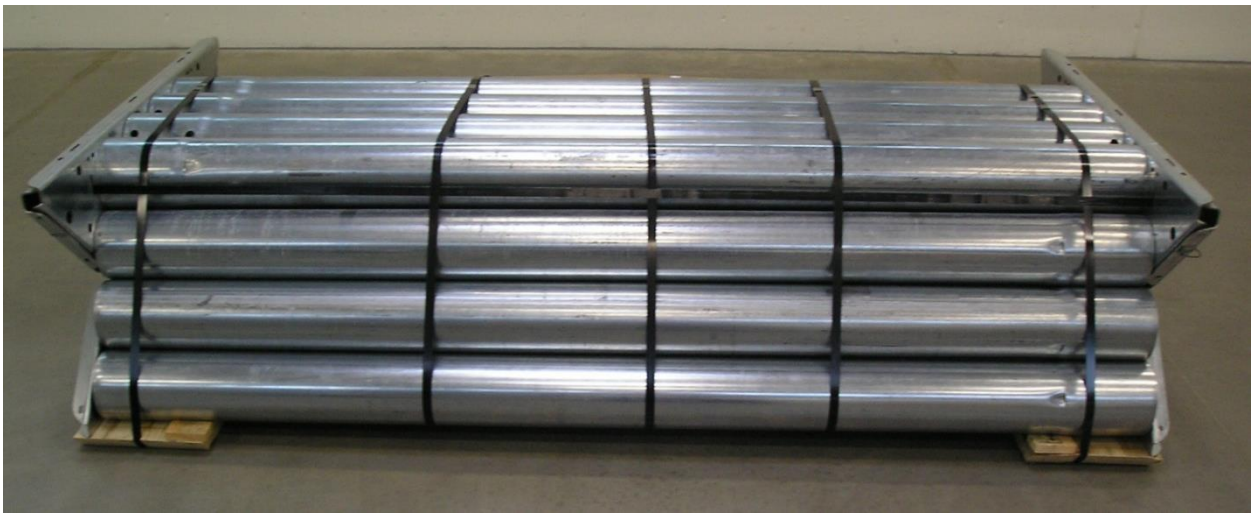
WEAR APPROPRIATE PROTECTIVE GEAR AND USE CAUTION WHEN UNPACKING TALLTOWER COMPONENTS. WEAR GLOVES AND EYE PROTECTION WHILE UNPACKING THE ENVIROCRATE TO PREVENT CUTS AND OTHER INJURIES FROM BANDS AND SHARP OBJECTS. HEAVY COMPONENTS CAN SHIFT IF NOT UNPACKED CAREFULLY AND IN THE PROPER SEQUENCE. FOLLOW ALL UNPACKING INSTRUCTIONS.

About The Packaging

The 34 m TallTower packaging was designed to reduce cardboard waste, protect the tower components and allow for more economical shipment. All the tower components including anchors and ground kit are now included in one package. If you purchased this tower as part of an NRG-NOW System, the electronics, sensors and associated accessories are packaged separately.

It is very important that you understand how to unpack the contents of the packaging safely. The recommended sequence to unpack the tower is described in this section of the manual.

The tubes may shift position suddenly when bands are cut, so please read this section carefully to avoid serious injury.



Tools For Unpacking

- 5/16 inch nut driver or electric drill with 5/16 inch bit
- 1/2 inch wrench for bolts
- Band cutters
- Gloves

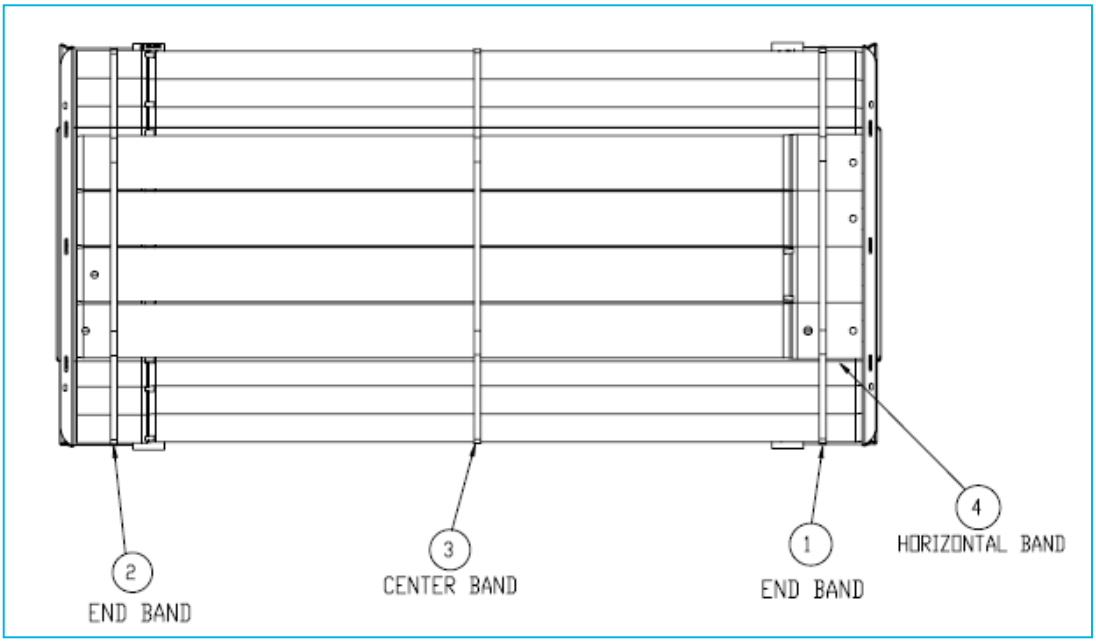
Access & Orientation

Ideally, you will want access to both ends of the packaging to unpack the contents. If a forklift is available, that is also ideal. Remove the 34 m TallTower package from the truck with the forklift and set it on an unobstructed flat area before unpacking.

It is also possible to unpack the contents with access to only one end of the tower packaging. For example, the 34 m TallTower 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 it 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.

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

Procedure for Unpacking



Refer to the image on the previous page..

1 Cut the single horizontal band (#4) and discard.

2 With the nut driver (or cordless drill), remove the four wood screws that fasten each end plate assembly down to the wood pallet. Set aside the two end plate assemblies.

It is ok if you can only remove one end plate assembly.

3 Beginning at the top, remove the contents of the tubes.

These contents will include: screw-in anchors, coils of cable, ground rods, guy rings, rocker plates, and the hardware kits.

4 Ensure that all tubes on the pallet are empty.

With the band cutters, cut the outer bands (#2 & #1) and center band (#3) as shown. Remove tubes.

SITE LAYOUT

Pre-Installation Planning

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.

During the first lift of a tower, the many slip joints will settle to the full engagement. During this settling, the distances from the base to any given point on the tower will shorten, and the individual tubes may rotate. Therefore, it is recommended that the tower be "pre-lifted" before the sensors are permanently attached. The "pre-lift" can be only a few feet, but the entire tower should leave the ground. Doing this also is a good way to avoid endangering the booms, sensors, and cabling should there be an unforeseen problem.

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.

Note: Five 6-inch diameter screw anchors are included with the tower. Other anchor types must be ordered separately. Please refer to the anchoring guidelines in Appendix B of this manual for more information.

Cellular Coverage

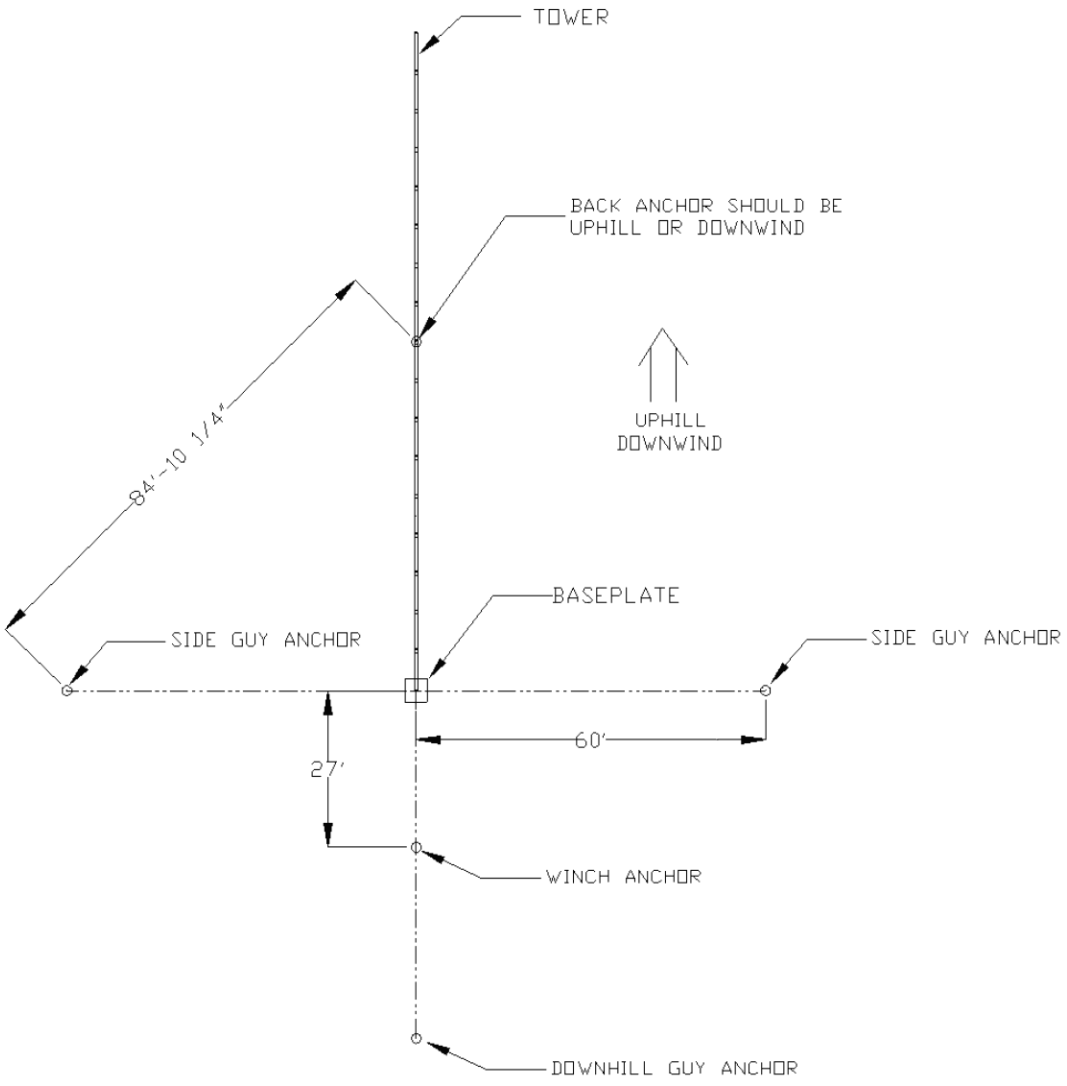
This is also a good opportunity to identify what type of cellular service is available at the site for those who will be using an NRG iPack to transmit data. Contact us for more information on NRG iPacks.

Site Layout Map

Lay out locations for the tower baseplate, guy anchors and the winch anchor. Lay out the site so that the tower is laid out downwind of the baseplate so that the tower will be lifted into the wind. If the site is on a steep slope, lay out the site so that the tower is laid out uphill of the baseplate. Unless the slope is steep, it is more important to have the tower lifted into the wind.

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.

USE ONLY SUITABLE TOWER ANCHORS FOR THE SOIL TYPE AT THE INSTALLATION SITE. STABILITY OF THE COMPLETED TOWER UNDER VARYING CONDITIONS (*E.G.*, HIGH WINDS AND ICE), AND STABILITY DURING INSTALLATION, DEPENDS ON THE USE OF PROPER ANCHORS FOR THE SOIL TYPE AT THE INSTALLATION SITE. FAILURE TO USE PROPER ANCHORS COULD CAUSE THE TOWER TO FALL RESULTING IN SERIOUS INJURY OR DEATH OR PROPERTY DAMAGE. CONSULT WITH THE APPROPRIATE PROFESSIONALS TO FIRST DETERMINE SOIL CONDITIONS AND THEN SELECT THE PROPER ANCHOR SYSTEM BEING SURE TO FOLLOW ALL ANCHOR MANUFACTURERS' INSTRUCTIONS.



Important Site Notes

- TallTowers can be installed on slopes up to 10°. 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 cut long enough to allow for installation on slopes up to 10° while maintaining the ideal angle between the tower and the guys.
- **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 m (3 feet) off the line, although some sites may require a compromise because anchors may not be able to be located at the preferred spot.
- 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.
- Any of these conditions will affect the side guy wire tension as the tower is raised. Tension will have to be adjusted periodically as the tower is lifted.
- **Placement of the winch anchor is critical.** Make sure that you measure carefully and set the anchor heads close to ground level. Angle all the anchors toward the tower at 45 degrees.

All this is important for proper distribution of forces and for clearance and proper operation of the ginpole. See *Site Layout Map* and *Anchor the Winch* for more information.

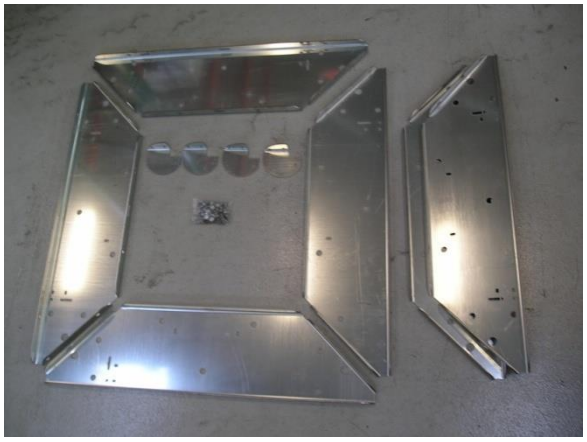
TOWER ASSEMBLY

Tools for Assembly

Baseplate

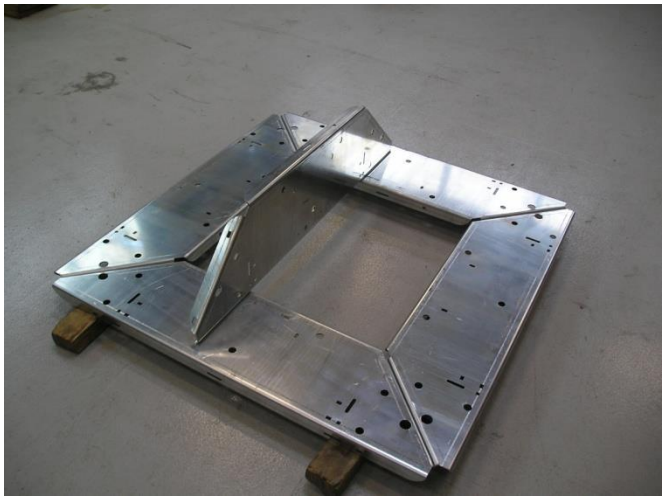
The baseplate will be located according to the site layout map described in the previous section. It is often easiest to assemble the baseplate in this location.

1 Assemble four of the six large trapezoidal baseplate sections by inserting (8) 5/16” x 3/4” carriage bolts in holes closest to the center of each triangular baseplate section. Thread on the nuts and hand tighten only.

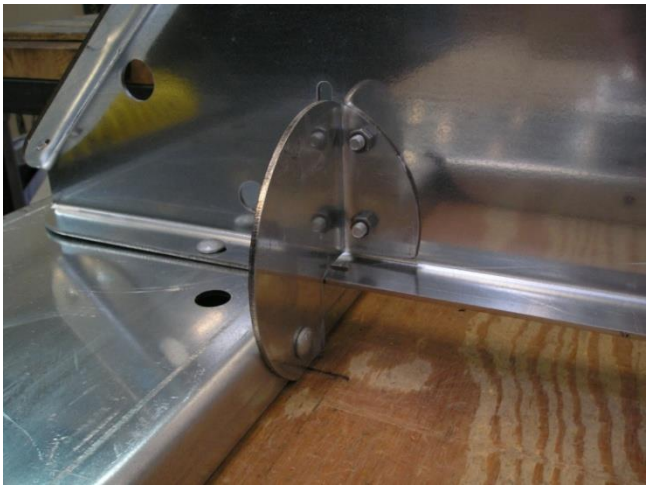


2 Flip the baseplate over and prop an edge with a block of wood to allow access to the underside.

Attach the remaining two baseplate pieces vertically.



3 Attach the four baseplate gussets with the carriage bolt head facing away from the gussets.



4 Tighten all hardware in the assembled baseplate.

5 Drive ground rods through the baseplate holes so they can provide additional anchoring for the baseplate.

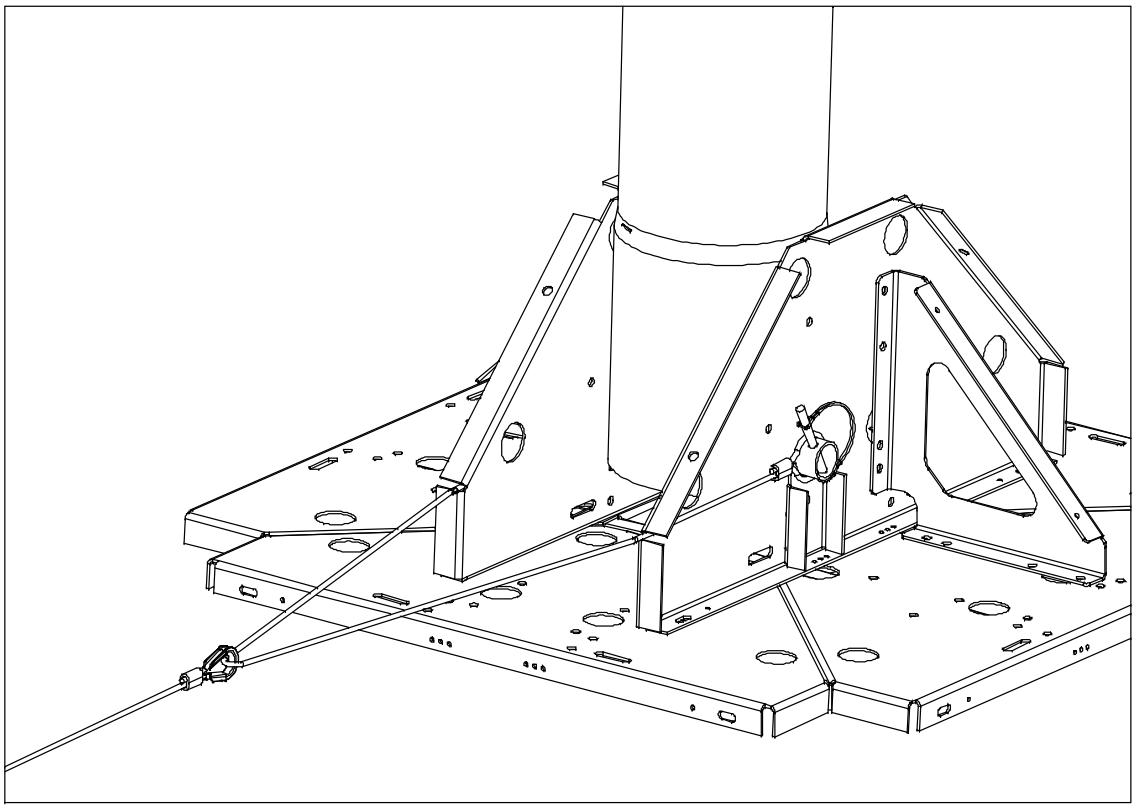
Securing the Baseplate for Lifting

At the beginning of a lift, the winch forces are largely horizontal. These forces tend to slide the baseplate toward the winch and/or tip the baseplate up on edge. To counteract these forces, it is highly recommended that the baseplate be anchored against sliding and tipping. There are several possible techniques depending on the terrain, soil, and subsequent operations under the tower.

Rods driven through the Baseplate into the soil – With *firm*, deep soil, drive several pieces of rebar through the holes in baseplate into the soil. Angle them away from the winch and place as many as practical along the baseplate front edge (farthest from the winch). T-Posts can also be used along this edge to hold the baseplate in place.

Rock anchors to the Baseplate – On rock, or shallow soils, attach rock anchors to the baseplate, particularly along the front edge. These should be positioned and attached to hold the edge of the baseplate down as well as keep it from sliding.

Cable to the Guy Anchor – A cable made up as a bridle connected to the tower bolt can be run to the inner anchor opposite the winch or to an anchor nearer the baseplate. See image below.



Anchor Installation

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 screw-in anchors about 150 mm (6 inches) above ground.

Tube Layout

Lay out the disassembled tube sections on the ground according to sequence described below:

Section	SI Units	Imperial Units	Lifter Color Code
1	– Base Tube – (4) 2.2m, 152mm dia. tubes – Guy ring (placed onto last tube)	– Base Tube – (4) 87”, 6” dia. Tubes – Guy ring (placed onto last tube)	Red
2	– (4) 2.2m, 152mm dia. tubes – Guy ring (placed onto last tube)	– 4) 87”, 6” dia. Tubes – Guy ring (placed onto last tube)	White
3	– (4) 2.2m, 152mm dia. tubes – Guy ring (placed onto last tube)	– 4) 87”, 6” dia. Tubes – Guy ring (placed onto last tube)	Black
4	– (4) 2.2m, 152mm dia. tubes – Guy ring (placed onto last tube)	– 4) 87”, 6” dia. Tubes – Guy ring (placed onto last tube)	Yellow

Base Tube Installation

Identify the base tube. The base tube has a hole drilled through the flared (wider) end. Attach the base tube to the baseplate using the ¾” x 8” bolt through the lower holes in the center of the baseplate sides. Secure the bolt with the provided nut.

Joining Tower Tubes

1. Slide tube sections together until the end of the interior tube is inserted all the way into the outer tube's flare, until it stops.
   Aligning the weld seams (visible in interior of tube) of each tower section will make it easier to slide the sections together.
2. Continue to assemble the tubes and place guy rings over the tubes according to the sequence in the Tube Layout table.
   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.
3. 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.

Do not use lubricants on tower joints. This can cause tower failure if the tubes self-flare.

Sensor & Boom Installation

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

Sensor cabling is provided with NRG-NOW Systems for (1) 34 m level direction vane, (2) 34 m level anemometers, and (1) 20 m level anemometer. It is always easiest to run the cables from the sensor and booms down the tower.

Spiral wrap the sensor cables around the tower from the sensors to the data logger. Use one wrap per tube joint. The spiral promotes vortex shedding and reduces natural frequency oscillations of the tower. Use electrical tape to tape the sensor cables and ground cables to the tower every few meters.

Be sure to tape cables to the tower above and below each guy ring where the cables cross each guy ring. To protect the cables from the guy rings, wrap them with a thick layer of electrical tape as shown below.

GUY WIRES

Organizing Guy Wires & Lifters

1. Sort out and identify the guy wires from the lifter wires.
   All guy wires for the 34m TallTower are identical in length and cable thickness, while the lifter wires are color-coded for the corresponding level.
2. Place three guy wires at each guy ring level.
3. Place each lifter wire at the correct level indicated by color.

All wires MUST be placed correctly.

Section	Length (m)	Length (ft)	Lifter Color Code
1	10.5	34.56	Red
2	16.9	55.45	White
3	24.3	79.69	Black
4	31.98	104.94	Yellow

Attaching & Rolling Out Guy Wires

Secure the back guy wires first to their corresponding guy rings using the shackles. Attach the guy wires to the guy ring holes under the tower tube. Starting from level 1 near the base of the tower, roll out the back guy wires to their anchor points and secure as described below. Best practice on a flat site is to roll out the back guy wires to the side anchor to measure the correct distance. Mark the point on the wire where it meets the side anchor when stretched and straight. Walk your guywire and attached it to the correct back anchor at the mark you have made using wire rope clips.

Secure the side guy wires to their corresponding guy rings using the shackles. These guy wires will attach to the side guy ring holes. Roll the side guy wires out to their anchor points and secure as described below.

While rolling, 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 or unrolled using a "Hankmaster 5000" tool.

CORRECT

NO

Securing Guy Wires to 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.

For the back guy wires- the distance to the side guys for each corresponding level be used as a reference distance for attaching to the back anchors.

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).

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.

Lifter Wires

Secure the lifter wires to the guy ring holes on the top of the tower tube. Carefully lay out the lifters in an orderly fashion. The unattached ends can easily become entangled around each other and the other guy wires lying on the ground. Make sure that all back and side guy wires are underneath the lifter guy wires. Keeping the lifter wires organized will avoid having to stop during the lift process to untangle the lifters.

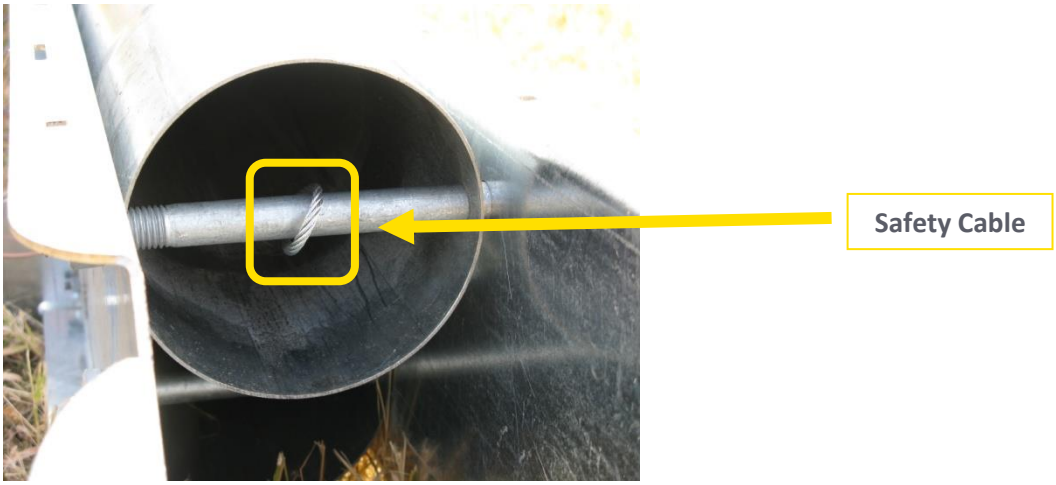
GINPOLE ASSEMBLY

1 **Lay out the ginpole tubes.**

Identify the ginpole and helper ginpole tubes and hardware. Refer to Appendix D | Glossary for pictures and descriptions of ginpole parts.

2 **Attach the ginpole base tube to the baseplate.**

The ginpole base tube will lie on top of the tower base tube. Place the ginpole base tube with hole between the baseplate's vertical channels. Insert the safety cable into the ginpole base tube. Line up the holes in the ginpole base tube with the holes in the baseplate's vertical channels and insert the ¾" x 8" bolt through the baseplate holes and the eye in the safety cable. Secure the bolt with the provided nut.



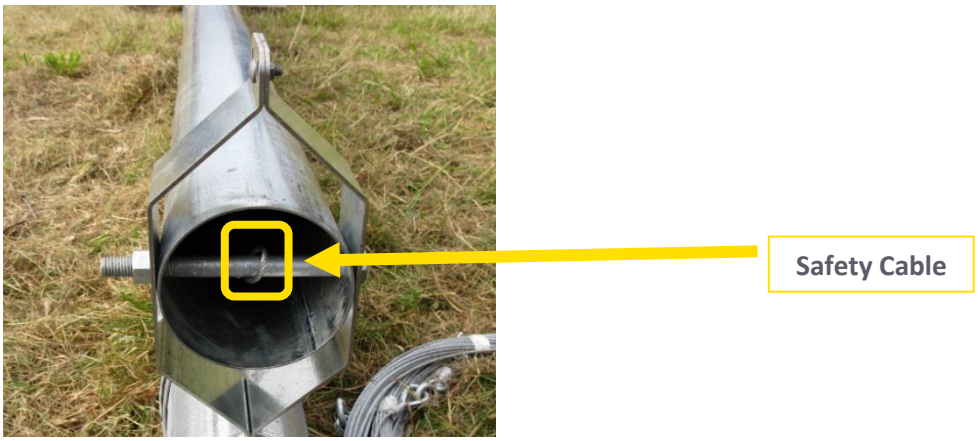
3 **Slide together the (4) ginpole tubes.**

Slide sections together until a hard stop is reached, and thread the safety cable through each tube as it is assembled. 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 3rd or 4th section to slightly raise the ginpole from the tower.

Slide the top ginpole section on so that the holes in the ginpole top are parallel to the ground.

4 **Attach ginpole top-mounting rocker plates.**

Bolt the rocker plates to the top section of the ginpole with the large bolt (3/4 inch x 8 inches), making sure that the bolt goes through the eye of the ginpole safety cable.



5 **Attach the rocker plate hardware.**

Attach the (2) supplied graded 5/16“x 3/4“ bolts at the ends of the rocker plates. Attach the (2) quick links to the holes on the bottom (side towards tower) of the rocker plate.

Using a two-part line to lift the tower is optional.

If lifting the tower with a single part line, the turning block and one of the shackles are not needed. Simply attach the thimble end of the winch cable to the shackle on the rocker plate as shown below.

If using a two-part line to lift the tower, shackle the winch cable turning block (not supplied) to the rocker plates using the (2) shackles (not supplied) placed through the rocker plate hole shown in the picture below.

6 Your tower was supplied with a 45.7 m length of 12 mm (1/2 inch) diameter brown polypropylene rope. Cut the rope in half to make two 22 m (75 ft.) pieces. Tie one piece from each side anchor to the top of the ginpole to stabilize the ginpole while it is being raised.

Failure to use the ginpole ropes could cause the ginpole to fall over to either side during the lift. Be sure to tie the safety ropes securely to the side anchors; the ginpole is very heavy, and the safety ropes can't be controlled by hand.

The greatest load seen by the end of the ginpole (and the winch) is 907 kg (2000 lbs.).
The winch cable must be 6 mm diameter and at least 24 m (80 ft.) long so that it can reach the end of the ginpole. Size your winch and rigging accordingly.
An extra anchor has been supplied with the 34m tower to anchor the winch.

7 **Attach the lifter wires.**

Attach each of the four lifter wires to the ginpole using the supplied quick links. Be sure to connect them in the proper order and make sure they are not tangled with each other or side or back guy wires.

Section	Quick Link Hole	Lifter Color Code
1	2 (top)	Red
2	2	White
3	1 (bottom)	Black
4	1	Yellow

Helper Ginpole

The helper ginpole is used to redirect the winch line at the start of the ginpole tilt-up procedure and enable the ginpole to lift off its assembly position.

1. Secure the pulleys just inside the top of the helper ginpole using a 3/4-10 x 8” long bolt & nut. The hardware kit contains two 5” diameter pulleys and an axle bolt to be used on the top of helper ginpole. If you are only using a one-part line from the winch, the second pulley is not needed.
2. Put the helper ginpole standing vertically (pulleys pointing towards the sky) on the baseplate behind the main ginpole. Line up the holes in the helper ginpole with the holes in the baseplates’ vertical channels.
3. Slide two 3/4-10 x 8” bolts through holes to secure in a vertical position. Secure the bolts with the provided nuts.

Winch

The minimum winch rating required to lift the 34m TallTower is 4500 lbs. NRG Systems sells the Mile Marker SEC4500 for lifting the 34m TallTower in kit #4284, shown above.

1. Connect winch to winch anchor.
2. Reeve winch cable through pulleys at the top of the helper ginpole.
3. Connect to the rocker plates at the top of the ginpole.

DANGER

ALWAYS SECURE THE WINCH TO A WINCH ANCHOR. FAILURE TO USE A WINCH ANCHOR COULD CAUSE EXCESSIVE LOADS ON THE VEHICLE USED TO SUPPORT THE WINCH AND WINCH PLATE. EXCESSIVE LOADS CAN RESULT IN THE VEHICLE BEING HOISTED IN THE AIR CAUSING SERIOUS INJURY OR DEATH OR PROPERTY DAMAGE. NEVER RELY ON AN UNSECURED WINCH AND SUPPORT PLATE – ALWAYS USE A WINCH ANCHOR.

Always monitor the winch cable to ensure it winds onto the winch drum evenly. *Uneven winding could result in cable crossover, subduction, or premature filling of the drum.*
To avoid damage to the winch cable and provide sufficient drum space for the complete tower lift, have the winch operator ensure that the cable wraps evenly onto the drum.

TOWER TILT-UP

Ginpole

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.

Make sure the ginpole remains centered side to side and that the brown ropes are both snug. If the ginpole is off center, carefully adjust the ropes to re-center. As the ginpole comes up, remove the helper ginpole when the winch cable is no longer in contact with the pulleys on the end of the helper ginpole.

Pay attention to the lifters to make sure they are not caught on objects in the area (stumps, debris, rocks, equipment, etc.). Also check that they are not crossed over each other or the other guy wires. As the lifter wires tighten, **stop the winch**.

While stopped, check that all guy wire shackles are not twisted at the guy rings.

When the winch cable is free from all the pulleys in the tube of the helper ginpole, it is safe to remove the helper ginpole.

Tower

Understanding Guy Wire Tensioning While Raising

Unless the anchors are placed in precisely their correct positions, and unless the site is perfectly level, guy wire tension will vary 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.

A 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 fall, endangering the tower installation crew and possibly damaging any vehicles or equipment nearby. Do not let the tower be bowed to the side more than two tube diameters away from a straight line. If the tower is bowed more than this, the side guys should be adjusted to straighten the tower.

It is critically important that proper tension be always maintained on side guy wires 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. There must always be visible slack in the guy wires. If no slack is visible, the tension is too great.

Once the tower is vertical, two people of average size, pulling by hand, can properly tension the guy wires.

Never use mechanical devices to adjust guy wires on the 34m TallTower.

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 on all but the most flat and level sites.

Adjusting Guy Wires ("Inchworm" Method)

Loosening

1 Loosen the upper clip and pull a length of the tail through the clip, creating a loop as shown below. Tighten the upper clip to "trap" the loop between the upper clip and the lower clips.

2 Now loosen the lower clips, loosening the lowest clip slowly, allowing the loop to slide, which will slacken the guy wire.

3 Retighten the lowest wire rope clip.

Tightening

As with loosening, make sure to start with all 3 wire rope clips secure.

---

1 Loosen the lower 2 wire rope clips.

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2 Pull the 2 cables apart to form a loop (similar to the loop made while loosening), then tighten the lowest rope clip to trap the loop between the upper and lower rope clips.

---

3 Loosen the upper rope clip and pull the tail to remove the loop.

---

4 Finally, tighten the upper clip.

Lifting

When all crew members are ready, the winch operator will begin to lift the tower. Remember that most electric winches are designed for intermittent use, and frequent rests must be taken to prevent the winch motor from overheating. Help the cable to wind evenly by using the winch control handle to move the winch motor from side to side.

CAREFULLY MONITOR ANY WIND DURING THE LIFT AS WIND BLOWING IN THE DIRECTION OF THE LIFT (TOWARD THE WINCH) CAN CAUSE DANGEROUS INSTABILITY AND A LOSS OF CONTROL OF THE TOWER. *IF THE TOWER BECOMES UNSTABLE DURING THE LIFT, SERIOUS INJURY OR DEATH CAN OCCUR. ALWAYS MONITOR BACK GUY WIRE TENSION DURING THE LIFT TO ENSURE PROPER RESISTANCE IS PROVIDED TO PREVENT INSTABILITY.*

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.

1 **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 0.15 m to 0.3 m (6” to 1 foot) 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 collapse. Adjust the side guy wire tensions to prevent the tower from either falling off to one side or bowing which could damage the tower.

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. This is the highest stress point of the lift.

2 **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 will not hold, either the anchor was not installed correctly, 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 either the winch anchors won't hold or the baseplate slips, immediately lower the tower.

3 If everything looks OK, continue to lift the tower a little at a time.

Check side guy tension along the way. At times, it may be necessary to adjust the side guy wire tension. Do this ONLY when the winch is stopped.
Readjust with wire rope clips, letting cable out or pulling loose cable in (see "inchworm" technique). 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 halfway). **STOP**.

Beyond 60 degrees above horizontal, it is essential that tension is maintained on the back guy wires during the last part of the lift, particularly the guy wires at levels 2 and 3. Excess tension on level 4 will remove the positive curve shape from the tower and potentially cause a collapse. The tower will lift very easily at this point because the weight of the ginpole and winch will be enough to tip the tower without powering the winch, causing total loss of tower control. Any wind blowing in the direction of the lift will also help reduce the load on the winch. ***Therefore, the crew must control the lift from this point on using the back guy wires.***

Before continuing the lift, adjust the back guy wires to take out the excess slack.

4 Continue the lift by alternately powering the winch and smoothly and incrementally (a few feet of guy wire at a time) letting out on the back guy wires (in order from top to bottom) using the inchworm technique.
Do not completely remove slack in back guy wires by running the winch too long.

Continue this process until the **top** of the tower is directly over the base (sight with a carpenter's level).

An alternative to using the inchworm method is to provide pressure to the back guy wires using ropes. Keep the back guy wires attached to their anchor at the estimated correct distance when the tower is vertical.
Using ropes with a quick link carabiner (not supplied) hook the carabiner onto levels 2 & 3 back guy wires and pull to opposite sides to provide pressure to the back of the tower.
While the tower is being raised slowly with the winch, the technicians holding the cable using a rope will need to smoothly walk away from the tower as it is being lifted to keep constant pressure on the guy wire.
During this process it is very important to always keep pressure on the back guy wires you are holding. This adds stability to the tower as its approaching vertical.

Avoid winching in too much cable (to the point where the pulley collides with the winch). If the pulley and winch are winched tightly together, the winch cable can break, causing total loss of tower control. Please note that the winch's motor has a slightly delayed response after the switch is released, and while coasting to a stop may produce enough force to break the winch cable.

5 When the tower is vertical, re-check that the tension in the back guy wires and in the side guy wires is set up correctly to about 23 kg (50 pounds) of tension, allowing some slack in each guy wire.

Check that wire rope clips are secure.

Transferring Lifters

Because the lifter wires double as the front guy wires, they need to be transferred to the front anchors once the tower is vertical. You will secure each lifter guy wire with wire rope clips.

---

6 **Transfer the lifters one at a time from the quick links on the ginpole to their anchor.** Secure each with wire rope clips. Start with the top lifter level (level 4 yellow).

Maintain tension while transferring the guy wires. *Remember that while the lifter is disconnected, you will be holding the tower!*

As you transfer the lifters, you may have to add a little slack to the middle level back guy wires to allow the tower to straighten; It is normal to have the tower bowed slightly away from the winch.

---

7 Working downward, transfer the lower level lifters one at a time to their anchor position.

---

8 Recheck the tension on the lifter and its opposite guy wire as each is transferred.

To keep the tower straight, it may be necessary to winch out slightly and or adjust the opposite guy wires as the lifters are transferred.

---

9 As you remove the last lifter, lower the ginpole to the ground.

Plumbing & Straightening

10	Using a carpenter's level on the base tube, adjust the lowest level guy wires as needed so the base tube is vertical.
11	Work upwards and adjust all four guy wires at each level while sighting up the tower from the base to straighten the tower.
12	As you finalize the straightening of the tower, set the final tension on the guy wires.

PROPER GUY WIRE TENSION IS CRITICAL. FAILURE TO ENSURE PROPER GUY WIRE TENSION CAN CAUSE A FAILURE OF THE TOWER, GUY WIRES OR GUY ANCHORS RESULTING IN SERIOUS INJURY, DEATH OR PROPERTY DAMAGE. ONCE LIFTED, ALWAYS READ AND FOLLOW INSTRUCTIONS FOR MEASURING AND REACHING PROPER GUY WIRE TENSION.

Final Inspection

Perform a final check on the tower before concluding the lifting procedure.

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13 Torque all wire rope clips on the guy wires to 15 ft-lbs (20 Nm). Wire rope clips should be spaced 4-8” (10-20 cm) apart on each guy wire.

---

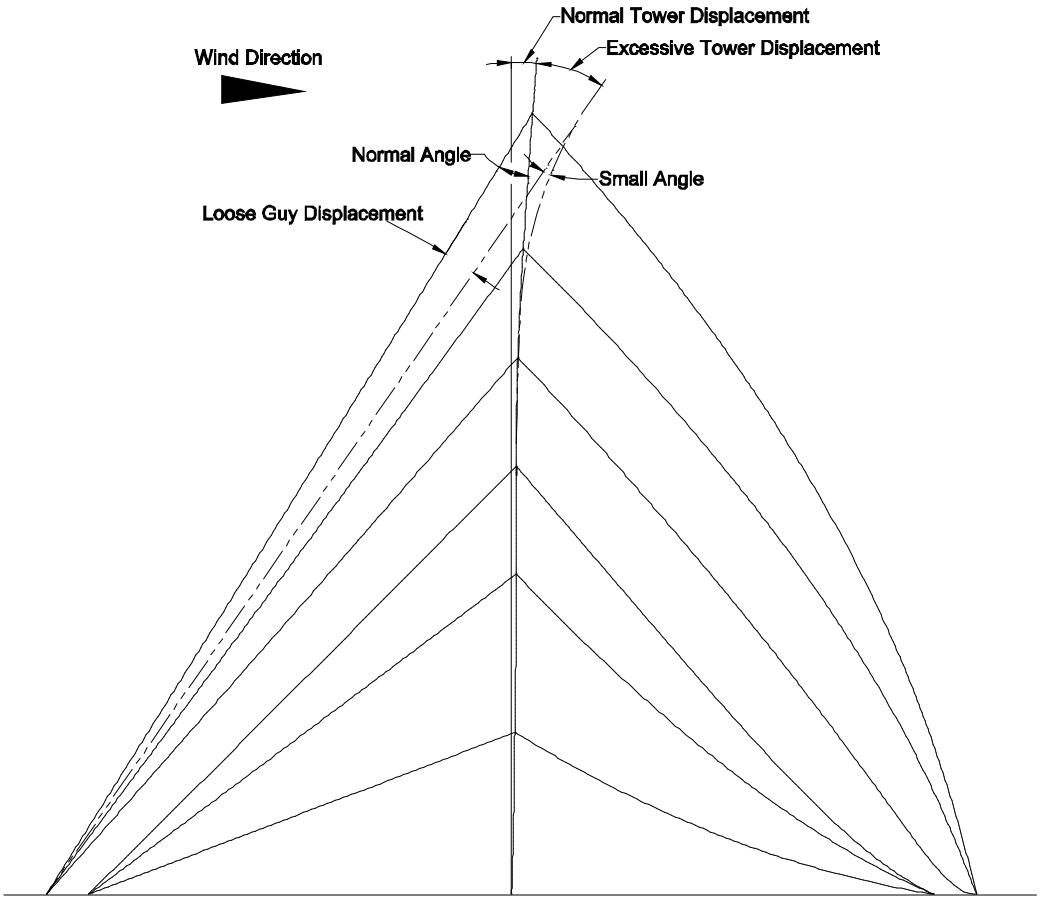
14 Attach guy guards to the base of each guy wire and to the winch anchor.

Tower Maintenance

Ongoing maintenance is crucial to the health of the tower.

Check the tower in 2 or 3 weeks; tighten loose guy wires 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 windstorm. 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 in high winds.
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 figure below). 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.**



TOWER LOWERING

Lowering the tower is the reverse of raising the tower, though there are a few additional precautions to be taken.

- Just as side guy wire tension may vary during the lifting process, the same is true as the tower is lowered.
  Side guy wires must be tended to maintain proper guy tension.

- If the ginpole was removed, set up the ginpole as described previously.
  Remember that the extensions of the coupler plate will now be facing the ground. If the tower will be lowered onto blocking, place the blocking now while it is still safe to work under the tower. Lift the ginpole and transfer the lowest level lifting guy wire from the anchor to the ginpole.
  Remember you will be holding the tower: maintain tension while transferring the wires.
  Winch in or out as needed to maintain the correct amount of tension in the guy wire when it is transferred. ***The winch cable must always spool and unspool from the bottom of the cable drum for the winch brake to work properly.***

- Transfer the lifter guy wires from the anchor to the ginpole, in order from lowest to highest.
  Tension must be applied to the back guys to pull the tower away from the winch as you begin lowering. This keeps 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 safest way to do this is by tying a rope around the guy wire. This allows the crew members to maintain tension by hand without being under the tower.

- Maintain tension on a minimum of one mid-level and one top level guy wire during lowering.
  Use two crew members to tend two top level and two mid-level guy wires. These crew members should maintain tension in the back guys and take up the slack in the guy wire as the tower lowers toward them.

ALWAYS MAINTAIN PROPER TENSION ON GUY WIRES DURING THE LOWERING PROCESS, ESPECIALLY WHEN THE TOWER IS BETWEEN 90° AND 75°. FAILURE TO MAINTAIN PROPER GUY WIRE TENSION CAN CAUSE DEFORMATION OR OTHER DAMAGE TO THE TOWER. ALWAYS READ AND FOLLOW LOWERING INSTRUCTIONS FOR INCREMENTAL LOWERING AND CAREFULLY UTILIZE THE "INCH-WORM" METHOD SET FORTH IN THE INSTALLATION MANUAL.

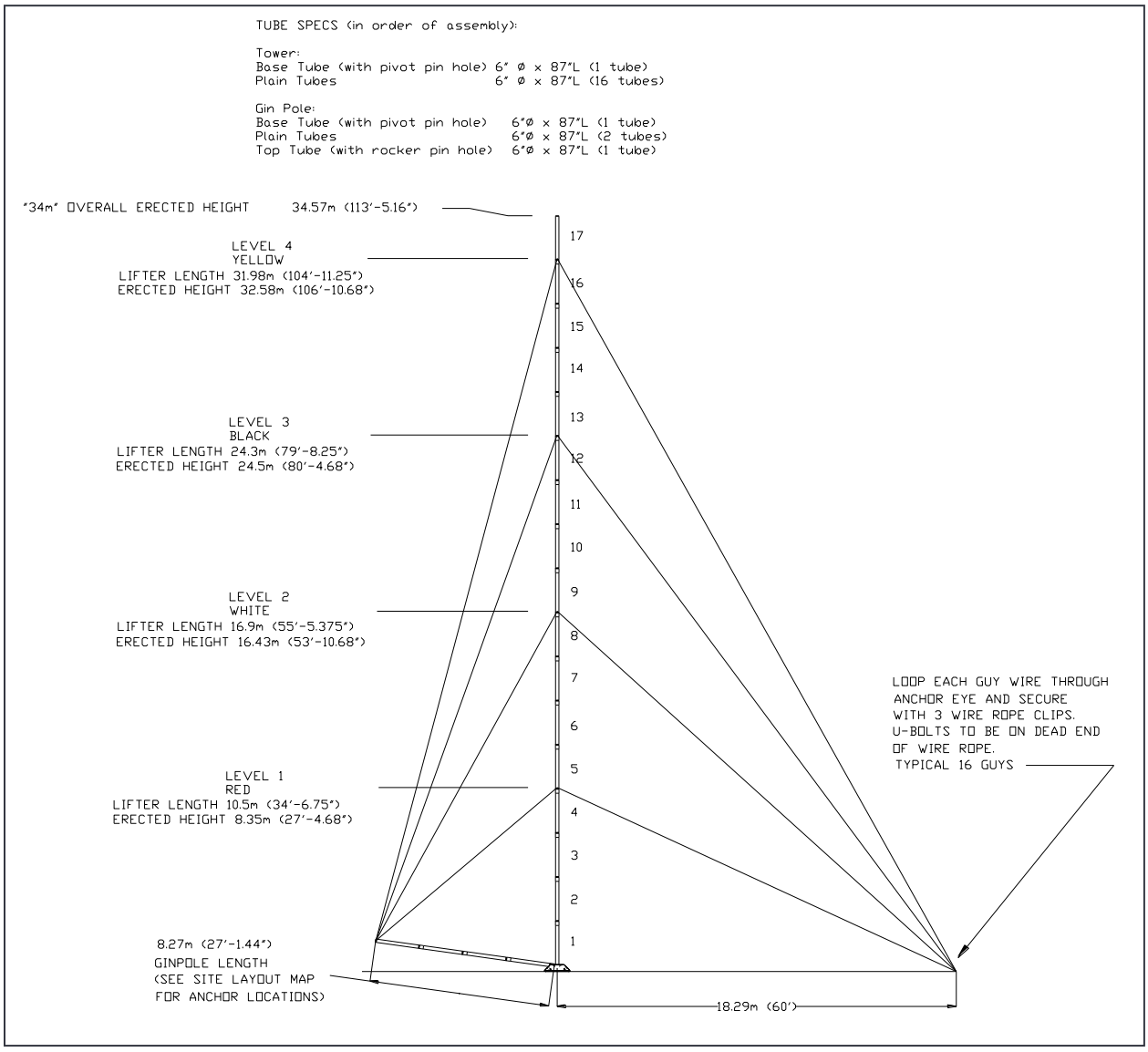
- As the tower is lowered and reaches an angle of between 75 and 60 degrees, it will no longer be necessary to maintain tension on the back guy wires.
- Stop the winch at least as often as each 20 degrees to re-check side guy wire tension and to allow the winch to cool for a minute.

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

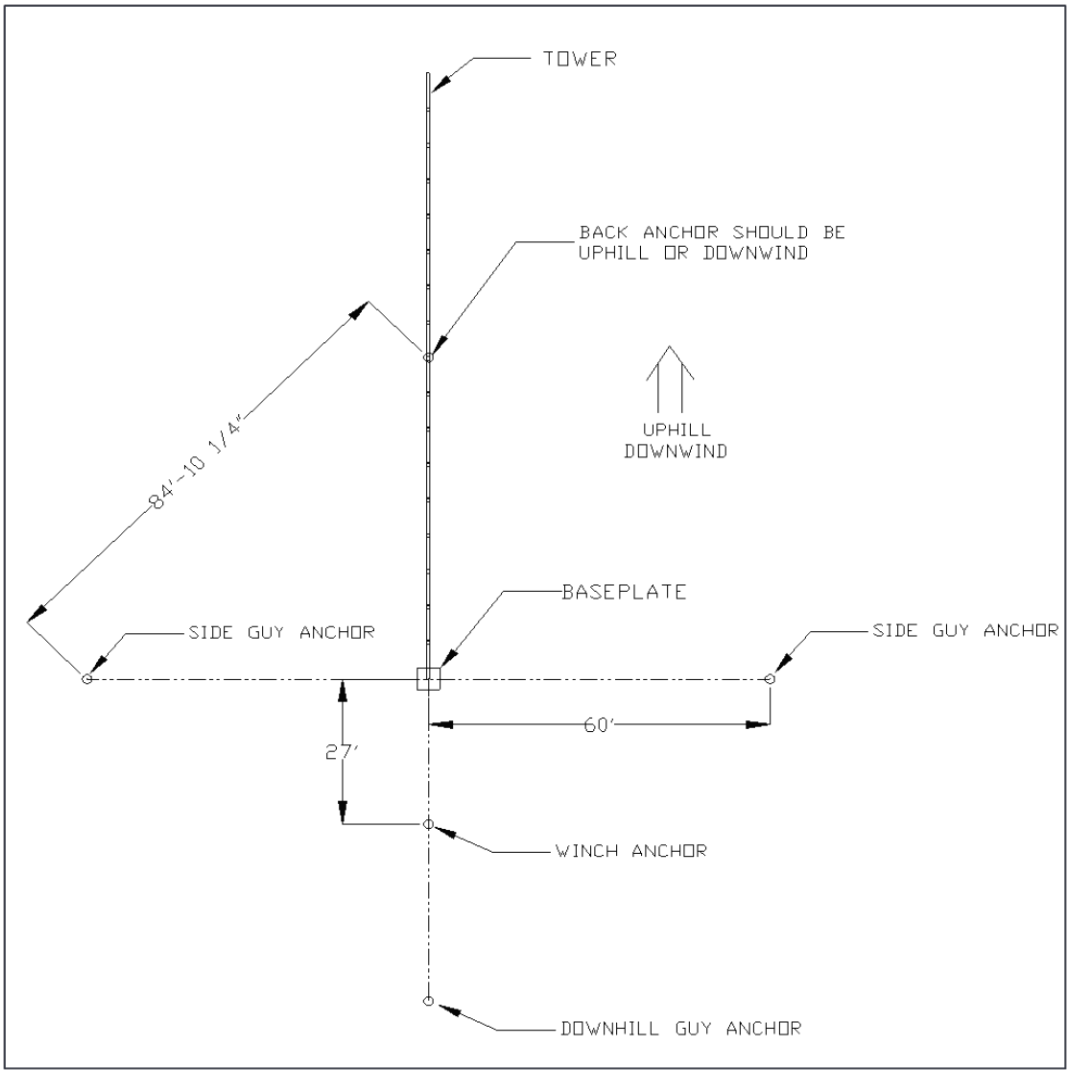
- To lower the ginpole, put the helper ginpole in place.
  As the ginpole nears the ground, place the winch cable (both strands if using a two-part line) in the 2 pulleys on the top of the helper ginpole. The ginpole can then be lowered to the ground.

APPENDIX A | 34M TALLTOWER DIMENSIONS

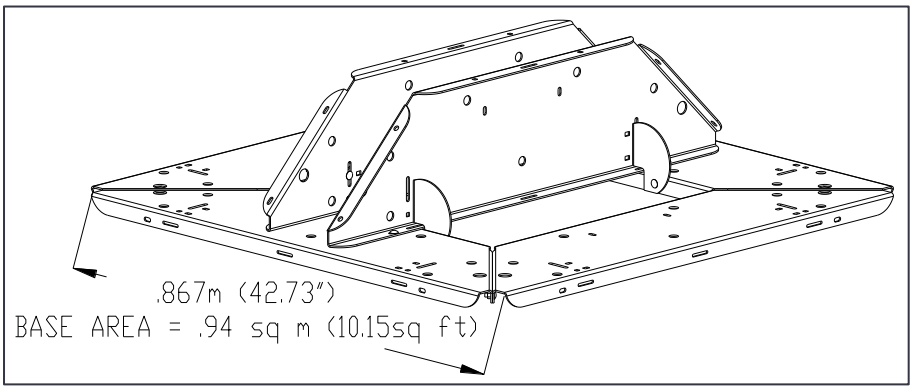
Tower Layout



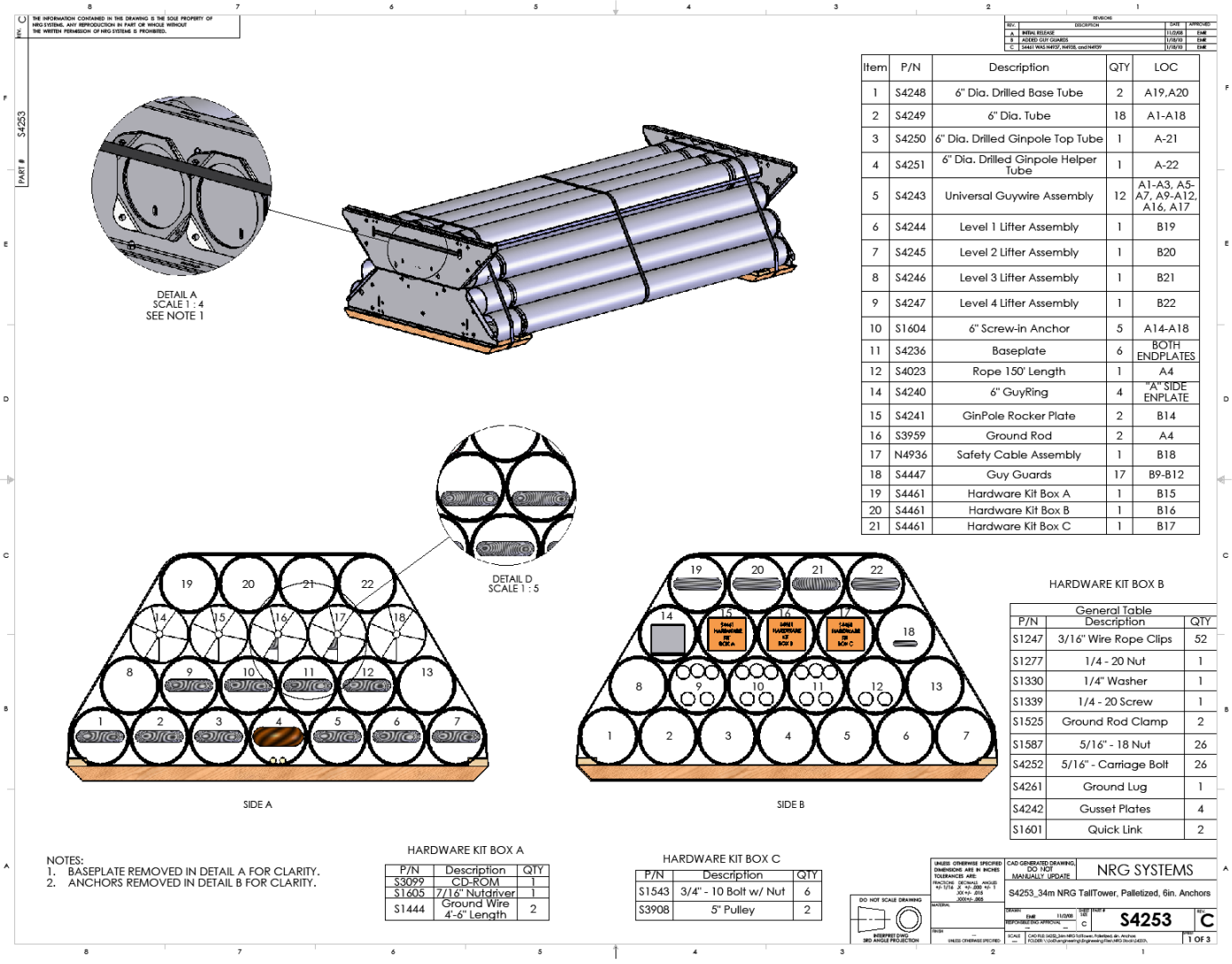
Site Layout



Baseplate Geometry



Tower Packaging



Item	P/N	Description	QTY	LOC
1	S4248	6" Dia. Drilled Base Tube	2	A19,A20
2	S4249	6" Dia. Tube	18	A1-A18
3	S4250	6" Dia. Drilled Ginpole Top Tube	1	A-21
4	S4251	6" Dia. Drilled Ginpole Helper Tube	1	A-22
5	S4243	Universal Guywire Assembly	12	A1-A3, A5-A7, A9-A12, A16, A17
6	S4244	Level 1 Lifter Assembly	1	B19
7	S4245	Level 2 Lifter Assembly	1	B20
8	S4246	Level 3 Lifter Assembly	1	B21
9	S4247	Level 4 Lifter Assembly	1	B22
10	S1604	6" Screw-in Anchor	5	A14-A18
11	S4236	Baseplate	6	BOTH ENDPLATES
12	S4023	Rope 150' Length	1	A4
14	S4240	6" GuyRing	4	"A" SIDE ENPLATE
15	S4241	GinPole Rocker Plate	2	B14
16	S3959	Ground Rod	2	A4
17	N4936	Safety Cable Assembly	1	B18
18	S4447	Guy Guards	17	B9-B12
19	S4461	Hardware Kit Box A	1	B15
20	S4461	Hardware Kit Box B	1	B16
21	S4461	Hardware Kit Box C	1	B17

HARDWARE KIT BOX B

General Table		
P/N	Description	QTY
S1247	3/16" Wire Rope Clips	52
S1277	1/4 - 20 Nut	1
S1330	1/4" Washer	1
S1339	1/4 - 20 Screw	1
S1525	Ground Rod Clamp	2
S1587	5/16" - 18 Nut	26
S4252	5/16" - Carriage Bolt	26
S4261	Ground Lug	1
S4242	Gusset Plates	4
S1601	Quick Link	2

HARDWARE KIT BOX A

P/N	Description	QTY
S3099	CD-ROM	1
S1605	7/16" Nutdriver	1
S1444	Ground Wire 4'-6" Length	2

HARDWARE KIT BOX C

P/N	Description	QTY
S1543	3/4" - 10 Bolt w/ Nut	6
S3908	5" Pulley	2

NRG SYSTEMS

S4253_34m NRG TallTower, Palletized, 6in. Anchors

S4253 C

APPENDIX B | ANCHORING GUIDELINES

Soil Types

Before the tower is ordered, the soil type must be determined and the correct anchors ordered. The purpose of this section is to give you the information needed to provide suitable anchoring for your TallTower.

Because anchor requirements are site-specific, it is the responsibility of the customer to determine anchor requirements. 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.**

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.*

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Anchor Types

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
- Locations with potential for flooding or periodic soaking of the soil
- Soil erosion
- Icing

Screw-In Anchors

Screw-in anchors are the most-used anchors for normal clay soils without rocks. They are installed by hand, using a cross bar to screw them into the earth like a corkscrew.

Screw-in anchors can also be used to provide the anchoring rod and eye for site-built anchors, such as concrete. Refer to the information on concrete anchors below.

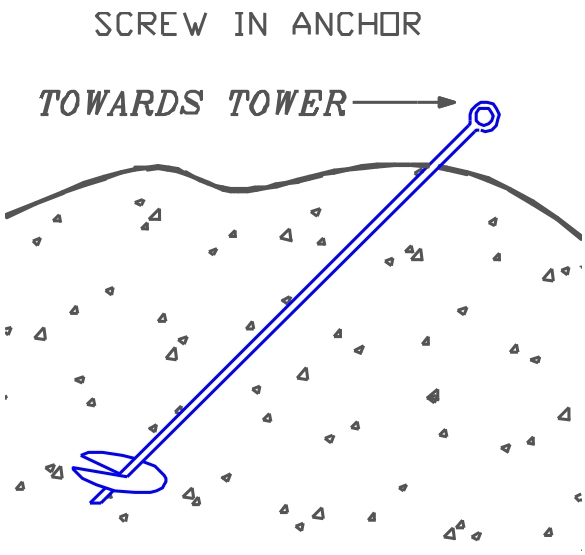
150 mm (6.0 inches) diameter screw-in anchors are the standard anchors supplied with NRG TallTowers. 203 mm (8.0 inches) diameters screw-in anchors are available upon request.

Screw-in Anchor Specs

Helix Diameter	152 mm (6.0 inches)	203 mm (8.0 inches)
Length Overall	1.65 m (66 inches)	1.65 m (66 inches)
Rod Diameter	19 mm (0.75 inches)	25 mm (1.0 inch)
Material	Galvanized steel	Galvanized steel
Holding Power: These anchors are not suitable for soils denser than class 5.		
Class 5 Soils	28.9 kN (6500 lbs)	44.5 kN (10,000 lbs)
Class 6 Soils	17.8 kN (4000 lbs)	31.1 kN (7,000 lbs)
Class 7 Soils	8.9 kN (2000 lbs)	17.8 kN (4,000 lbs)

Screw-in Anchor Installation

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.
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 Appendix A | 34m TallTower Dimensions *to determine the angle of the tower guys from the ground.*



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. Screw 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 up to 1 m (3 feet) from its ideal position to avoid the obstacle or replace the screw-in anchor with a more suitable anchor for the soil.

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.

Arrowhead Anchors

Arrowhead anchors can penetrate stiff and rocky soils because the unique triangular design threads its way between obstacles such as rocks, which can prevent successful installation of screw-in anchors.

Arrowhead anchors are driven into the ground with a hardened steel drive rod. Once in the ground, upward force on the attached cable rotates the anchor perpendicular to the cable for maximum holding power.

Arrowhead Anchor Specs

Length Overall	1.22 m (48 inches)
Rod Diameter	203 mm (8.0 inches)
Material	6.35 mm (0.25 inch) galvanized steel cable MBS 18.7 kN (4200 lbs) Malleable iron head
Class 3 Soils	18.7 kN (4200 lbs)
Class 4 Soils	13.3 kN (3000 lbs)
Class 5 Soils	8.9 kN (2000 lbs)
Class 6 Soils	5.3 kN (1200 lbs)
Class 7 Soils	2.6 kN (600 lbs)

Arrowhead Anchor Installation

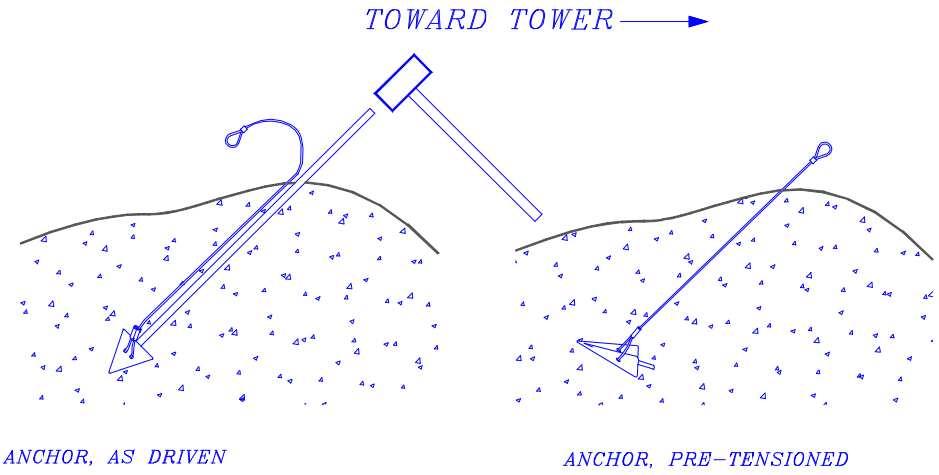
Arrowhead anchors are designed for all soils but are especially effective in rocky soils.

Like screw-in anchors, the arrowhead anchor must be placed so the force from the guy wires pulls directly on the anchor. Drive the arrowhead anchor away from the tower at an angle into the ground. Refer to the appropriate stamped drawing in *Appendix A | 34m TallTower Dimensions* to determine the angle of the tower guys from the ground.

It is important to drive the anchor at an angle. If the anchor is incorrectly installed straight into the ground, the load will result in the anchor cable cutting through the ground until the angle is correct, resulting in significant slack in the tower guys and possible tower failure.

To install the anchor, place the drive rod over the anchor's shank and drive the anchor into the soil using a sledgehammer, fence post driver, or power jackhammer. Stop when the cable eye attached to the anchor is 50-100 mm (2-4 inches) above the surface of the ground.

After the anchor is driven remove the drive rod, leaving the anchor in the ground. Pre-tension the anchor by applying strain to the cablewith a lever, come-along, jack, or winch. Pre-tensioning causes the anchor to rotate in the ground and develop its full holding power. The pull distance will be approximately the length of the anchor head, 203 mm (8 inches). The tension should become significantly higher when pre-tensioning is complete.



The anchor must be properly pre-tensioned before attaching the tower guys. If it is not, the tower guy wire tension will turn the anchor later, resulting in significant slack in the guy wires and possible tower failure.

Rock Anchors

Rock anchors are placed into solid 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 increases the wedging force, developing holding power equal to the full tensile strength of the rod.

Rock Anchor Specs

Length Overall:	1.22 m (48 inches)
Holding Power:	89 kN (20,000 lbs)
Rod Length Overall:	0.38-0.76 m (15-30 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

Rock Anchor Installation

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.

Install the anchor at an angle so the eye of the anchor is toward the tower and the expanding part points away from the tower.
If the anchor is incorrectly installed straight into the ground then the load will bend the rod and pull it through the ground, allowing the guys to go slack. A 45-degree angle towards the tower is recommended for all anchors used in the 34m TallTower installation.

To install the anchor, drill a 50mm (2 inch) hole in the rock. The walls of the hole should be smooth and the hole should be cleared of any dust.

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. Always grout rock anchors to prevent water from collecting and freezing in the drilled hole and to increase the anchor's holding strength.

Concrete Anchors

The most common alternative anchoring system is to place site-built concrete anchors.

A hole is excavated at the anchor position and reinforcing steel is placed in the hole. A screw-in anchor is then often tied into the reinforcing steel to provide a rod and eye above ground to attach the guys. Concrete is poured in place to form the anchoring mass, and the hole is then backfilled.

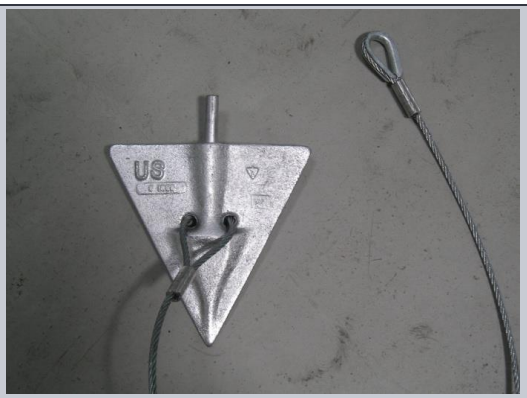
The anchors must be placed carefully to provide anchor points at the proper locations for the tower. **The holding power of concrete anchors is essentially due to their weight. The weight of concrete placed must exceed the required anchor holding force. Concrete anchors still depend on the soil to prevent the concrete mass from shifting toward the tower under load.**

APPENDIX C | SITE VISIT RECOMMENDATIONS

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.**
  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 – it's better to change them prematurely rather than risk losing data!

APPENDIX D | GLOSSARY

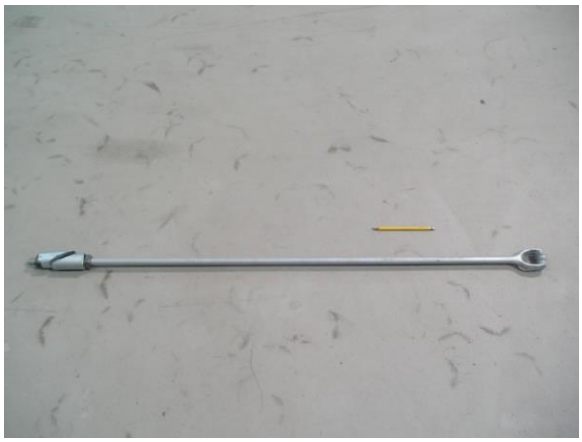
Anchor eye	
Arrowhead anchor	
Base tube (Same as Ginpole Base Tube)	

Base tube, Ginpole base tube, and Helper Ginpole bolt and nut: ¾" x 8" bolt	
Baseplate gusset	
Drive rod for arrowhead anchor	

Ginpole base tube (Same as Base Tube)	
Ginpole guy ropes: 45.7 m x 13 mm (150 ft. x ½ in.)	
Ginpole safety cable	

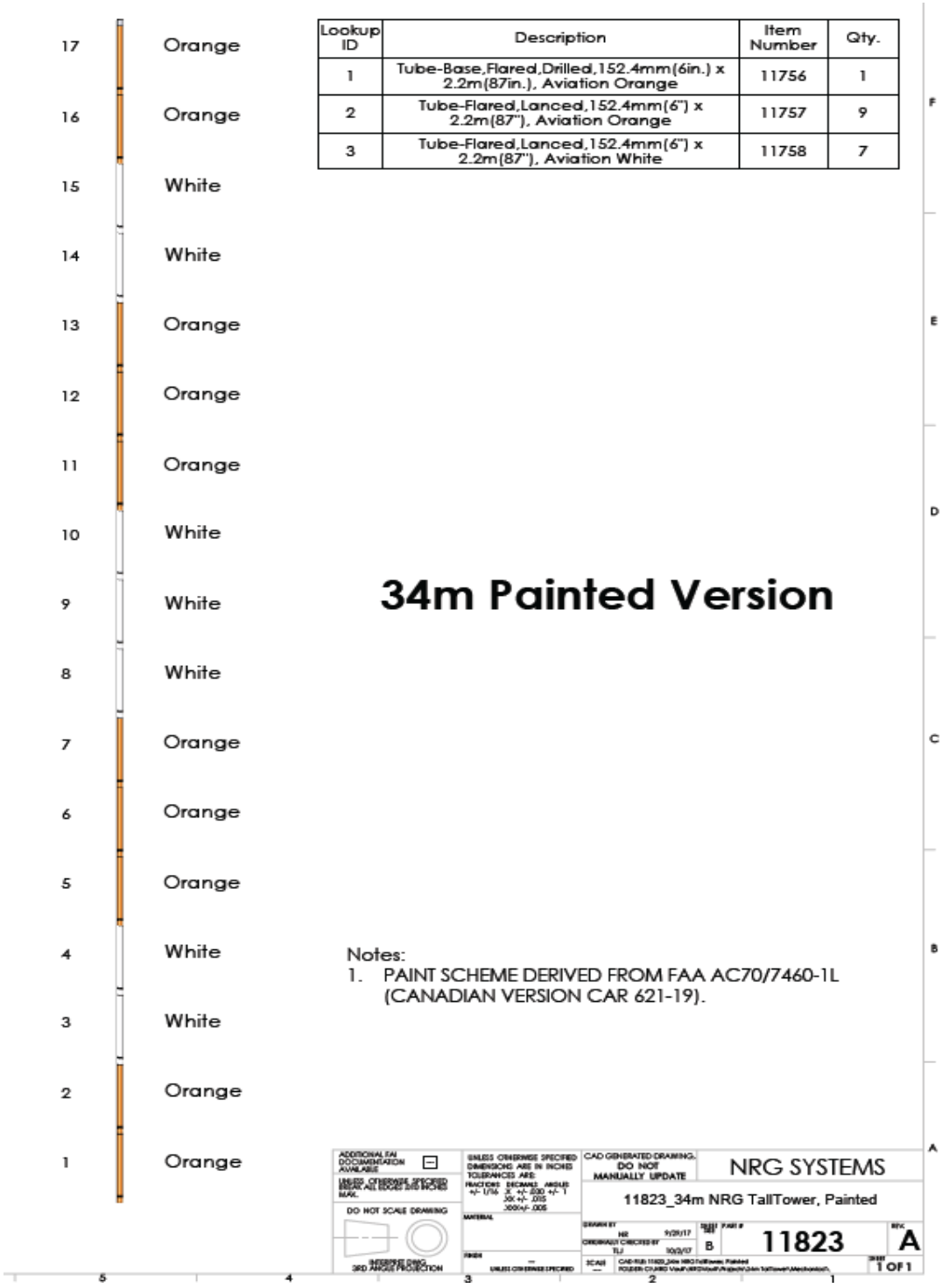
Ginpole top tube	
Helper Ginpole	
Guy ring	

Guy wire	
Hankmaster	
Lifting wires	

Quick Link	
Rock anchor	
Rocker plate	

Screw-in anchor	
Shackle	
Wire rope clip	

APPENDIX E | 34M TALLTOWER PAINTED VERSION



Lookup ID	Description	Item Number	Qty.
1	Tube-Base,Flared,Drilled,152.4mm(6in.) x 2.2m(87in.), Aviation Orange	11756	1
2	Tube-Flared,Lanced,152.4mm(6") x 2.2m(87"), Aviation Orange	11757	9
3	Tube-Flared,Lanced,152.4mm(6") x 2.2m(87"), Aviation White	11758	7