10 m TallTower™
Installation Manual & Specifications

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WARNINGS

SPECIAL SAFETY INSTRUCTIONS

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.

SAFETY BULLETIN FOR TOWER INSTALLATIONS IN AGRICULTURAL AREAS

The installation of meteorological evaluation towers (METs) in agricultural areas can pose a serious risk to low-flying agricultural aircraft. ***Physical contact between an agricultural aircraft and any part of a MET or its guy wire system can result in serious injury or death.*** It is therefore imperative that landowners, developers, wind energy consultants and installers each consider this serious safety risk for any wind energy project where a MET is proposed for installation in an agricultural area.

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

If the installation of a MET is being proposed for an agricultural area, Renewable NRG Systems strongly recommends those involved in the project do all of the following:

1. Become familiar with any and all applicable Federal Aviation Administration (FAA) tower visibility and lighting requirements, including FAA Advisory Circular AC70/7460-1K "Obstruction Marking and Lighting" as revised, and ensure the installation complies with those standards;

2. 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;

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

4. 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;

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

6. 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]), and;

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

Introduction

TallTower History

Renewable NRG Systems 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 10 m TallTower™ is of galvanized steel tube construction and is guyed at one level 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 (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 wires. The baseplate is hinged so both the tower and gin pole can pivot to the erected position.

Required Parts to Erect Tower System

The 10 meter TallTower is supplied complete with ready to assemble tubes, baseplate, guy ring, pre-cut 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 are also required to raise the tower.

The ginpole for the 10m TallTower is NOT compatible with other Renewable NRG Systems TallTowers. The ginpoles from other Renewable NRG Systems TallTowers are not compatible with the 10 m TallTower.

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 Renewable NRG Systems TallTowers. Each member of the lift crew should have a good understanding of the tasks they are required to perform during the lift.

Three 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.

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.

Tools Required for various tasks

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 baseplate 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)
Gloves
Band cutters (for unpacking)
8 wood posts (10 cm x 10 cm x 1 m / 4 in. x 4 in. x 3 ft.) to support tower
Sawhorse or wooden blocks to support ginpole
Wire cutters

Unpack your tower

Description of the packaging

The 10 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 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.

Tools required to unpack the 10 m TallTower

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

Access and 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 10 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 10 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.

Unpacking Sequence

You will need to remove the two 2" x 6" wood pieces from the ends of the tubes by cutting the horizontal band that wraps around the tower. This will expose the contents inside the tube.

Remove all contents inside the tubes before cutting the remaining bands. This will lessen the weight of each tube, making it safer to cut the remaining bands.

The 4 sections that make up the baseplate assembly are sandwiched between the 2"x12" wood pieces which are essentially the pallet - 2 sections at each end.

Unpacking your tower

The following checklist details the contents of your 10 m TallTower. Make sure you review the contents of your packages before heading out to the field.

Part: Tube, flared/lanced 152.4mm (6-inch) x 2.2m (87-inch) (1) drilled for the base tube –
Qty: 3

Part: Top Tube, fared/lanced 152.4 mm (6 inch) x 1.82 m (72inch)
Qty: 1

Part: Base Tube, flared/lanced 152.4mm (6-inch) x 2.2m (87-inch) Drilled at the bottom
Qty: 1

Part: Guy Ring, 6-inch
Qty: 1

Part: Guy-wire, 3/16-inch diameter x 10-feet
Qty: 4 -(1) is the lifter

Part: Ginpole Tube, flared/lanced 152.4mm (6-inch) x 2.2m (87-inch)
Qty: 1

Part: Ground Rod, 5/8-inch x 7'2" Copper clad steel
Qty: 2

Part: Ground Wire, Copper, 8-gauge, 9-feet
Qty: 1

Part: Ground Rod Clamp (Acorn), 5/8-inch bronze and brass
Qty: 2

Part: Ground Lug, copper
Qty: 1

Part: Baseplate
Qty: 4

Part: Bolt, 3/4-inch-10 x 8-inch
Qty: 2

Part: Carriage Bolt, 5/16-inch - 18x3/4-inch
Qty: 18

Part: Nut, 5/16-inch
Qty: 18

Part: Gusset -Baseplate 6”
Qty: 4

Part: Shackle- 3/8” Screw pin 7/16” 2000# rated
Qty: 4

Part:	Anchor, Screw In, 6-inch helix
Qty:	5

Part:	Wire Rope Clip, 3/16-inch
Qty:	13

Part:	Quick Link
Qty:	1

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.

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: (5) 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.

Tip: Cellular Coverage

This is also a good opportunity for those who will be using a Renewable NRG Systems iPack to transmit data to identify what type of cellular service is available at the site. Contact us for more information on Renewable NRG Systems 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 anchor. Verify that the anchor radii and the diagonal distances between anchors are correct.

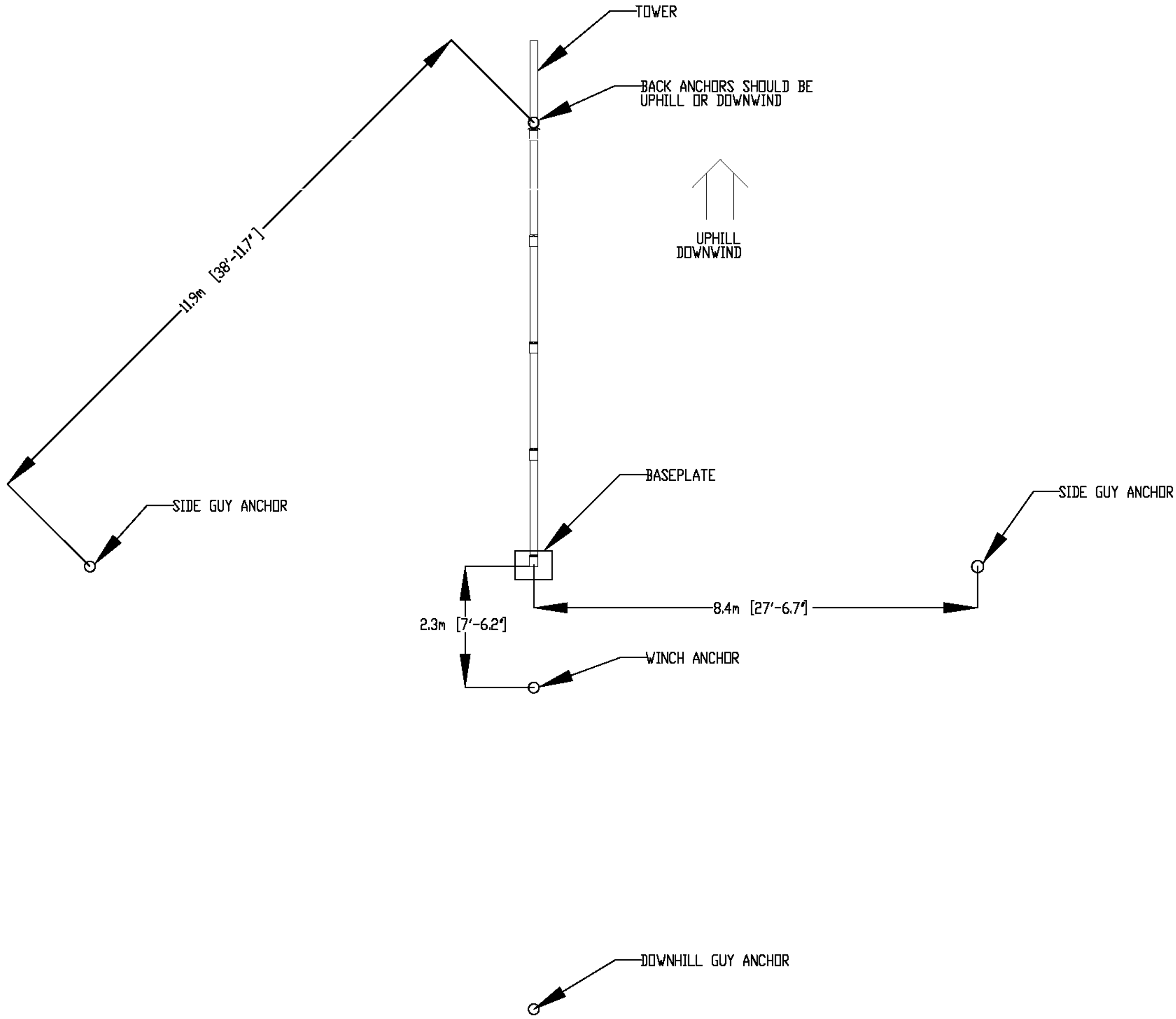


Figure 1: Site Layout Map (bird's eye view)

NOTE: 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.

NOTE: The side guy anchors and the baseplate 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.

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

- Anchor placement is not perpendicular to the tower as it lies on the ground.
- Anchors are not at the same elevation.
- Side anchors and baseplate are not in a straight line.

NOTE: 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

Assemble the 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.

It will be helpful to assemble baseplate parts on a flat surface.

Place 2 sections vertical with the shorter side down and the larger side up, flat sides facing towards each other.

Lay the other 2 sections across the vertical sections with the flat side down and short sides facing each other. (See pictures below).

Assemble all 4 of the large triangular baseplate sections as shown below, inserting (4) 5/16” x 3/4” carriage bolts in holes of the 2 horizontal sections running through into the 2 vertical triangular baseplate sections. Leave nuts somewhat loose; tighten by hand only. Once all carriage bolts are inserted, go ahead and tighten completely with a wrench.

Assemble the (4) baseplate sections by placing two sections on the ground, with the shorter of the parallel sides facing each other, and the bent edges facing into the ground as shown in Figure 2.

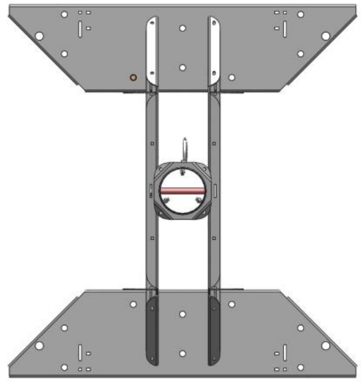


Figure 2: Horizontal Baseplate Sections

Attach the (2) vertical baseplates to the horizontal baseplates by threading (4) 5/16 inch carriage bolts from underneath the horizontal baseplates as shown in Figure 3. Secure each bolt with a 5/16 inch nut. Two sections provide vertical support for the tube, and the other two sections provide stability on the ground.

Figure 3: Attach Vertical Baseplates to Horizontal Baseplates

Attach the gusset to the inside of the vertical baseplate using (2) 5/16 inch carriage bolts and (2) 5/16 inch nuts as shown below in Figure 4.

Figure 4: Attach the Gusset to the Vertical Baseplate

Thread a 5/16 inch carriage bolt through the inside of the horizontal baseplate and secure with a 5/16 inch bolt as shown in Figure 5.

Figure 5: Secure Gusset to Horizontal Baseplate

Attach the remaining four gussets as indicated in Figure 4 and Figure 5. The final baseplate assembly appears in Figure 6.

Figure 6: Final Baseplate Assembly

At the beginning of a lift, particularly for the gin pole, 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.

Typically, rods are driven through the baseplate into the soil. Drive your two grounding spikes into *firm*, deep soil through the holes in the baseplate. Angle them away from the winch along the baseplate front edge (farthest from the winch) as shown in Figure 7.

Figure 7   Install the Base Tube

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.

Figure 8 **Figure 9**

Slide the 3 middle tube sections together until the end of the interior tube is inserted all the way into the outer tube's flare. The inner tube will be stopped. Aligning the weld seams (visible in interior of tube) of each tower section will make it easier to slide the sections together. The top tube is assembled last. The 73 inch (1.82 m) tube is your top tube. After installing the top tube, slide the guy rings over the top tube all the way down to the flare where it will stop. 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.

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

Figure 10

Attach the Guy Ring

Slide the guy ring over the top tube until it comes to rest against the flare of the tube. Adjust the guy ring so one of the holes is facing up.

Figure 11

Attach sensors and booms

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

Figure 12

Spiral wrap your sensor cables

Spiral wrap sensor cables around the tower, 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. 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 below (Figure 13).

Figure 13

Attach the Ginpole

Install the ginpole to the baseplate. The ginpole is the single tube (87 inch/ 2.2 m) that is drilled as a base tube on the bottom and drilled on the top to accept the bolt and rocker plates. Attach the ginpole to the baseplate assembly on top of the tower base tube. The ginpole tube is set back from the tower base tube and attached using 1 -3/4 inch 10 X 8 inch bolt with nut (Figure 14).

Figure 14

At the top of the ginpole tube, attach the 2 rocker plates with the supplied ¾ inch- 10 X 8 inch bolt and nut. The bottom of the rocker plates, where they come together, will accept the pear shaped Quick-Link. The small end loops through the 2 holes while the large end attaches to the lifter wire (Figure 15). At the top of the rocker plates, the winch cable is attached using the supplied 3/8" shackle (Figure 15).

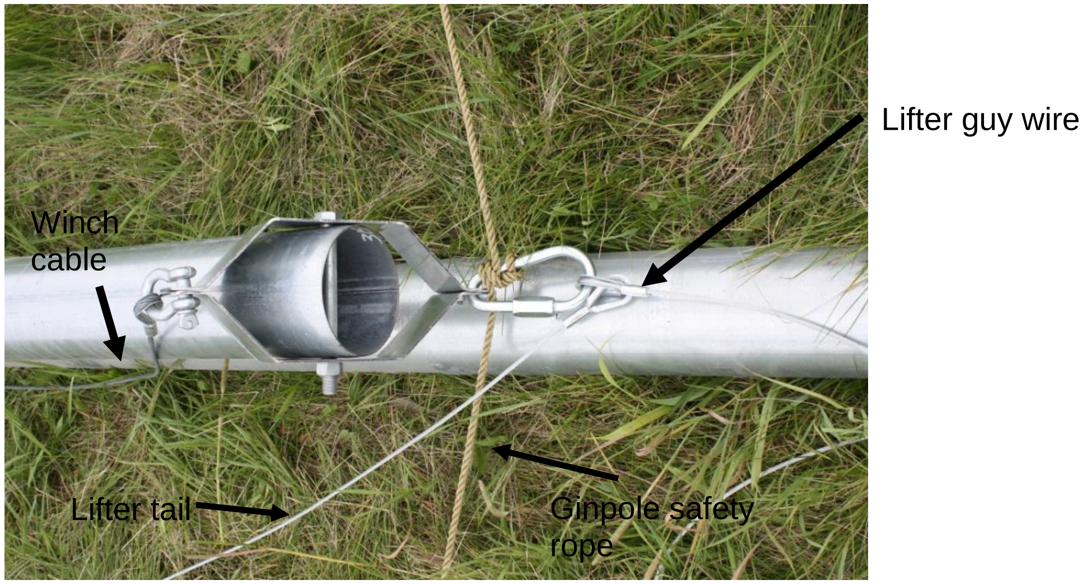


Figure 15

Attach the Guy Wires

Organize and layout the lifter and guy wires

Sort out and identify the guy wires and place the set at the guy ring attached to the top tube. These guy wires are all the same length and are interchangeable. Sort out and identify the lifter wire. The lifter guy wire has 2 thimbles at the mid-point of the wire that will be used to raise the tower then are transferred for use as a guy wire when the tower is fully erect. The lifter wire is NOT interchangeable. You will have 3 guy wires and 1 lifter wire. All wires MUST be placed correctly.

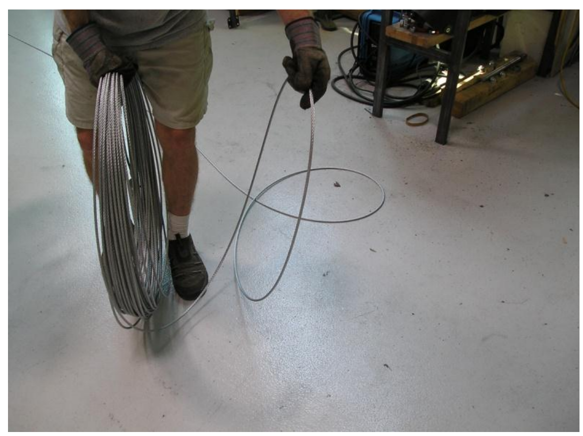
Shackle guy wires to the guy ring

Secure the back guy wire first to the corresponding guy ring using the shackle. Attach the guy wire to the guy ring hole under the tower tube. Roll out the back guy wire to its anchor point and secure as described below. Next secure the side guy wires to the corresponding guy ring 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.

Figure 16

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

Roll out side and back guy wires from the guy rings to their anchor points. 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.



Yes **NO**

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. **For the back guy wire it is recommended that the distance to the side guy wire anchors be used as a reference distance for attaching to the back anchor**. 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).

Figure 17

Figure 18

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 wire to the guy ring

Secure the lifter wire to the guy ring hole on the top of the tower tube. The lifter wire is the one that has the 2 thimbles that are attached to the wire at the mid-point. Carefully lay out the lifter in an orderly fashion. Make sure that all back and side guy wires are underneath the lifter guy wire. Keeping the lifter wire organized will avoid having to stop during the lift process to untangle the lifters. The tail of the lifter that does not have a thimble attached remains loose until the tower is fully erect. This tail will ultimately become the front guy wire.

Figure 19

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.

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 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. 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, pulling by hand, can properly tension the guy wires.

MECHANICAL TENSIONING DEVICES SHOULD NEVER BE USED TO ADJUST GUY WIRES!!

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.

Lift the Tower

At the beginning of the lift it is required for 1 or 2 people to hold the ginpole tube up in the air 15-20 degrees (approx. 4 feet off the ground). Take in the slack of the winch cable until the ginpole is held in this position. **Failure to do this will result in the baseplate sliding towards the winch without the ginpole rising towards vertical.**

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.

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.

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.

If everything looks OK, continue to lift the tower a little at a time, checking 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. 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 half way). **STOP**.

Beyond 60 degrees above horizontal, it is absolutely essential that tension is maintained on the back guy wire during the last part of the lift. 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 wire to take out the excess slack. If you have already measured the distance to the side anchors using the back guy wire, this distance, minus a small amount, will be good to bring the tension to the back guy wire before the tower is vertical.

At this point, hold with your hands onto the back guy wire and pull to the side to add tension to the wire.

Figure 20

Figure 21

Continue the lift, keeping tension on the back guy wire until the tower approaches 85 degrees. At this point the tension should be on the back guy wire completely. If there is still slack in the back guy wire, adjust the tension through the anchor and tighten wire rope clips.

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 wire   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).

Re-check that the tension in the back guys and in the side guy wires is set up correctly to about 23 kgf (50 pounds) of tension, allowing some slack in each guy wire. Check that wire rope clips are secure.

Transfer Lifter

Next, you will transfer the lifting guy wire from the gin pole to the respective anchor. You will secure the lifter guy wire with wire rope clips. Remember that while the lifter is disconnected, you will be holding the tower! **Maintain tension while transferring the guy wires** (Figures 22 & 23).

Figure 22

Figure 23

Transfer the lifter from the quick link on the ginpole to the anchor. Secure with wire rope clips. Remember that you will be holding the tower. Maintain tension while transferring the wire.   Adjust the guy tension on the lifter and the guy opposite to pull the tower straight and vertical. After you remove the lifter, lower the ginpole to the ground.

Plumb and Straighten

Make final adjustments to the guy wires. Using a carpenter's level on the base tube, adjust the guy wires as needed so the base tube is vertical. Adjust all four guy wires while sighting up the tower from the base to straighten the tower. As you finalize the straightening of the tower, you will need to set the final tension on the guys.

Final Inspection and Maintenance

Tighten all wire rope clips on each guy wire now, with about 100 mm to 200 mm (4 inches to 8 inches) between clips. Re-check that all wire rope clips are tight. Final torque on wire rope clips should be 10 Nm (7.5 ft-lb) for 3/16 inch wire rope clips. 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 and one to the winch anchor as shown below.

Figure 24

Figure 25

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.

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 will have to be tended in order to maintain proper guy tension.

If the ginpole was removed, set up the ginpole as described previously. 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 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 in order for the winch brake to work properly.***

Transfer the lifter guy wire from the anchor to the ginpole. Tension must be applied to the back guy wire 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.

Using one crew member, by hand on the back guy wire and walk backwards as the tower is lowered to keep tension on the wire.

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 wire. 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.

With the tower on the ground; lower the ginpole to 20 degrees or approximately 4 feet off the ground. At this point you will need to stop the winch and detach the winch cable from the ginpole. 1 or 2 people will need to lower the ginpole to the ground by hand. **Failure to do this will result in the winch pulling the baseplate when the ginpole reaches the ground.**

Warning:
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.

Appendix A: 10 m TallTower Dimensions

Tower Layout

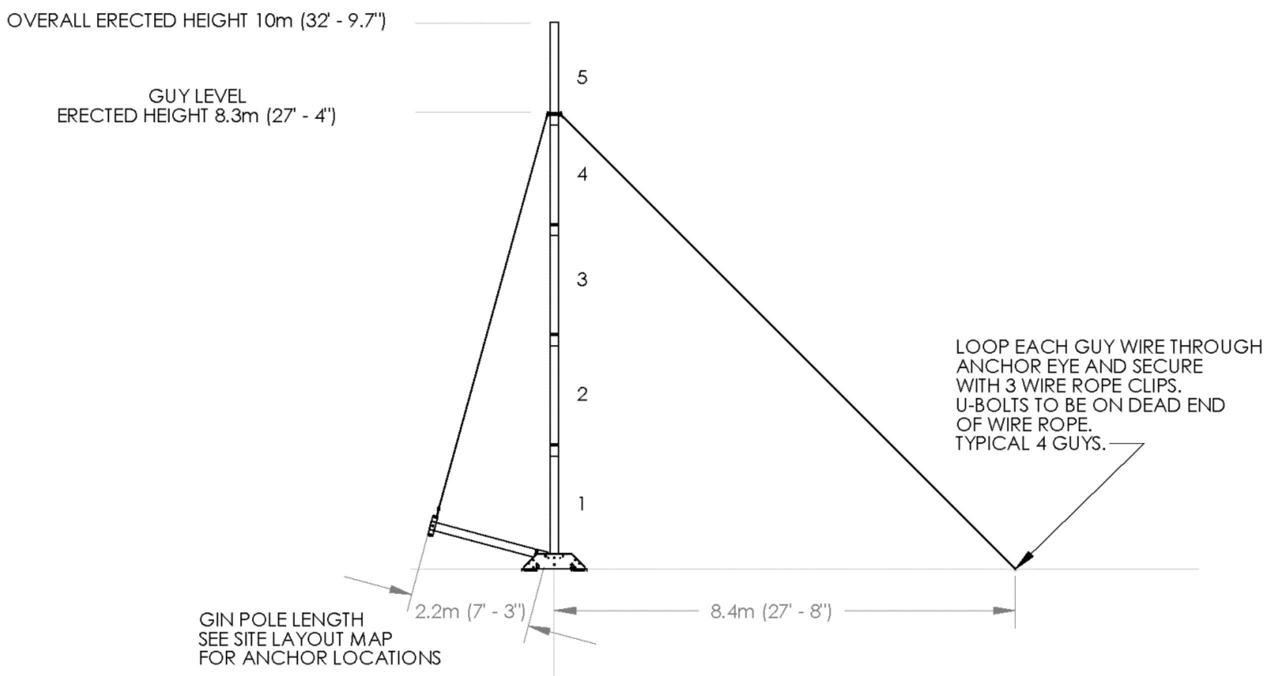
TUBE SPECS (in order of assmbly):

Tower:

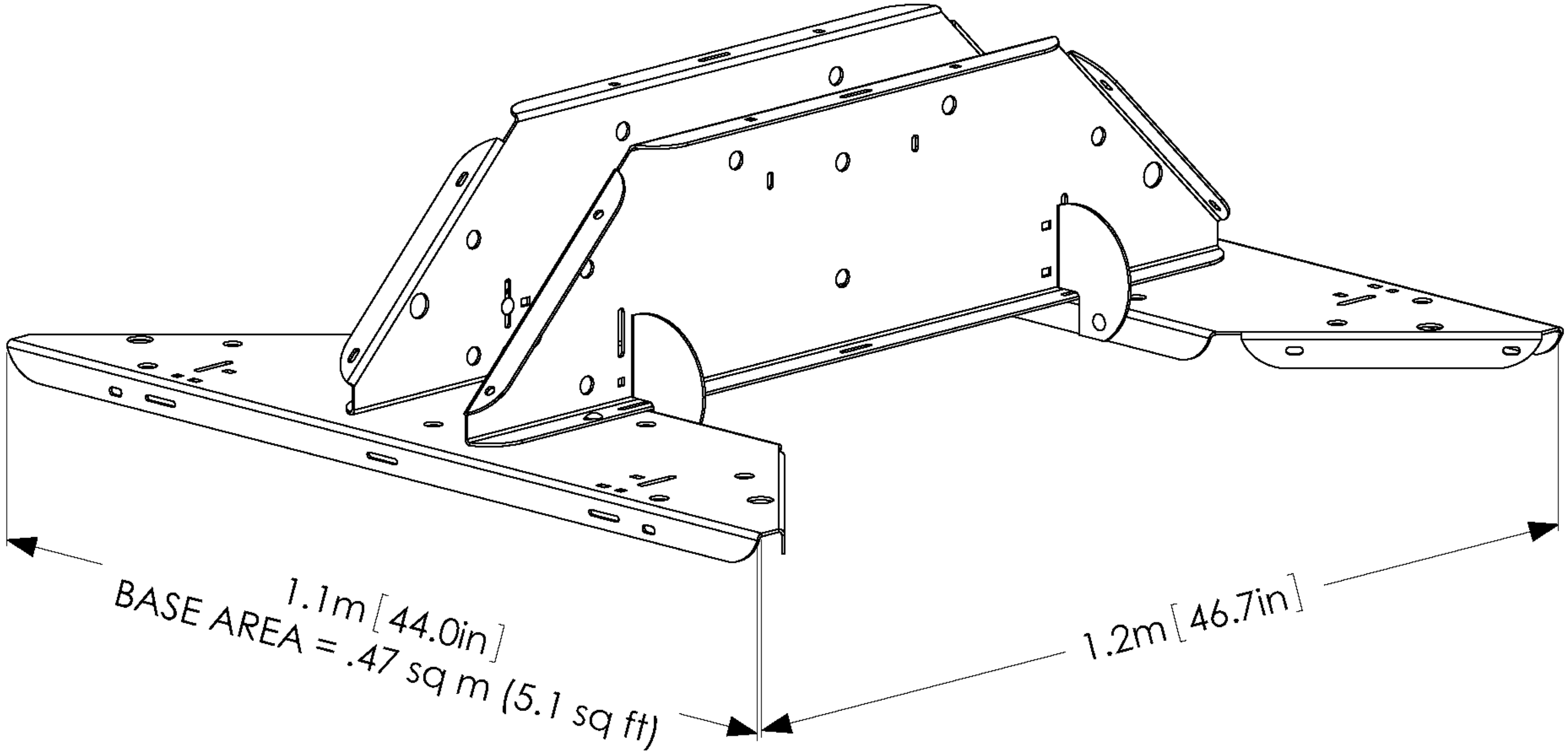
Base Tube (with pivot pin hole)	6" Ø x 87"L (1 tube)
Plain Tubes	6" Ø x 87"L (3 tubes)
Top Tube	6" Ø x 74"L (1 tube)

Gin Pole:

Tube (with pivot pin holes)	6" Ø x 87"L (1 tube)



Baseplate Geometry



Appendix B: Anchoring Guidelines

Determine site soil and anchor type before you order your tower

Before the tower is ordered, the soil type should 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.

Table 1: Soil Classes

Class	Common Soil Types	Geological Soil Classification
3	Dense clays, sands and gravel; hard silts and clays	Glacial till; weathered shale's, 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 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. 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 Renewable NRG Systems TallTowers. 203 mm (8.0 inches) diameters screw-in anchors are available upon request.

Table 2: Specifications for 152 mm (6 inches) diameter Screw-In Anchors

	150 mm (6 inches) Anchor
Helix diameter:	152 mm (6.0 inches)
Length Overall:	1.65 m (66 inches)
Rod diameter:	19 mm (0.75 inches)
Material:	Galvanized steel
Holding Power: (These anchors are not suitable for soils denser than class 5.)	
Class 5 soils *	3,000 kg (6,500 pounds)
Class 6 soils *	1800 kg (4,000 pounds)
Class 7 soils **	909 kg (2,000 pounds)

* See **Table 1** for soil class descriptions
** In class 7 soils, it is advisable to place anchors deep enough to penetrate to underlying class 5 or 6 soil.

Table 2A: Specifications for 203 mm (8 inches) diameter Screw-In Anchors

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

Arrowhead Anchor description

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.

Table 3: Specifications for Arrowhead Anchors

Length Overall:	1.22 m (48.0 inches).
Arrowhead Length:	203 mm (8.0 inches)
Materials:	6.35 mm (0.25 inches) galvanized (7x19) steel cable; breaking strength - 1905 kg (4200 pounds); with malleable iron head.
Holding Power:	
Class 3 soils *	1905 kg (4200 pounds)
Class 4 soils *	1361 kg (3000 pounds)
Class 5 soils *	907 kg (2000 pounds)
Class 6 soils *	544 kg (1200 pounds)
Class 7 soils *	272 kg (600 pounds)

* See **Table 1** 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 4: 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

Concrete Anchor description

The most common alternative anchoring system is to place site-built concrete anchors. A hole is excavated at the anchor position. Reinforcing steel is placed in the hole. A screw-in anchor is 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 back-filled.

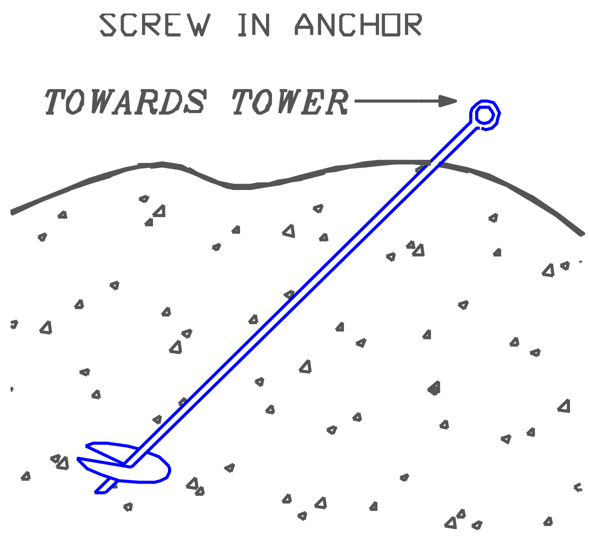
The anchors must be placed carefully to provide anchor points at the proper locations for the tower. **The holding power of concrete anchors is essentially due to their weight. The weight of concrete placed must exceed the required anchor holding force. Concrete anchors still depend on the soil to prevent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

As with all anchoring systems, it is your responsibility to ensure that the anchors will perform as required. If in doubt, seek professional advice for anchor design.

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. 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.

Figure 26: 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.

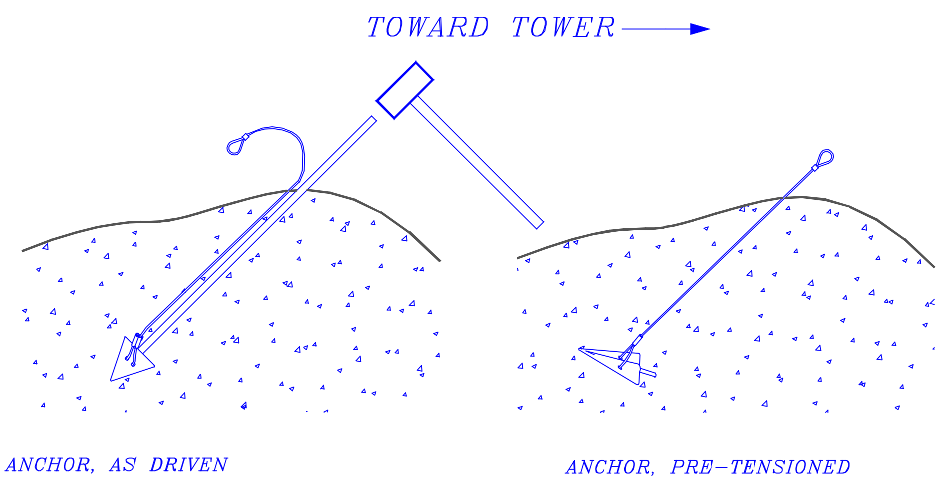
Installing Arrowhead Anchors

Arrowhead anchors are designed for all soils but are especially effective in rocky soils. The arrowhead anchor is driven into the soil with a drive rod. The rod is removed and the anchor is left in the ground. Then the anchor must be pre-tensioned which will cause the anchor to rotate in the ground and develop its full holding potential.

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 the Appendix to determine the angle of the tower guys from the ground.

Note: 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.

Figure 27: Installing Arrowhead Anchors



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

After the anchor is driven, remove the drive rod, leaving the anchor in the ground. The anchor must now be pre-tensioned by applying strain to the cable. This can be done using 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 as the pre-tensioning is complete.

Note: 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.

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. 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!

Appendix D: 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 Renewable NRG Systems customers, however, align their wind vanes to true north. Before installing your Renewable NRG Systems 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 1, 15 degrees west means that the direction of the compass needle (magnetic north) lies 15 degrees west of true north.

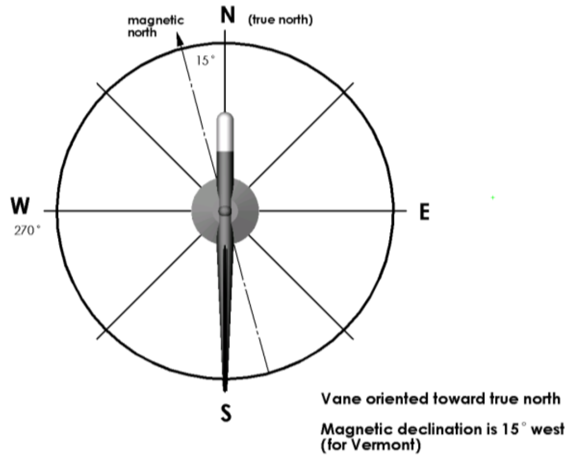


Figure 1

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 2 is 270 degrees.

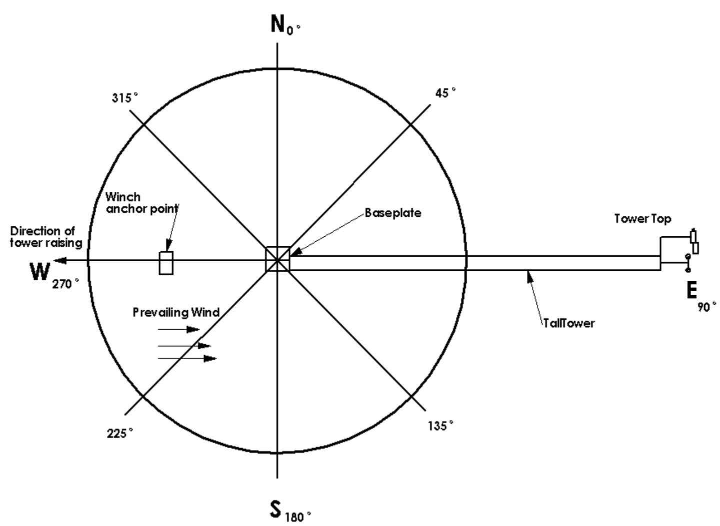


Figure 2

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 3.

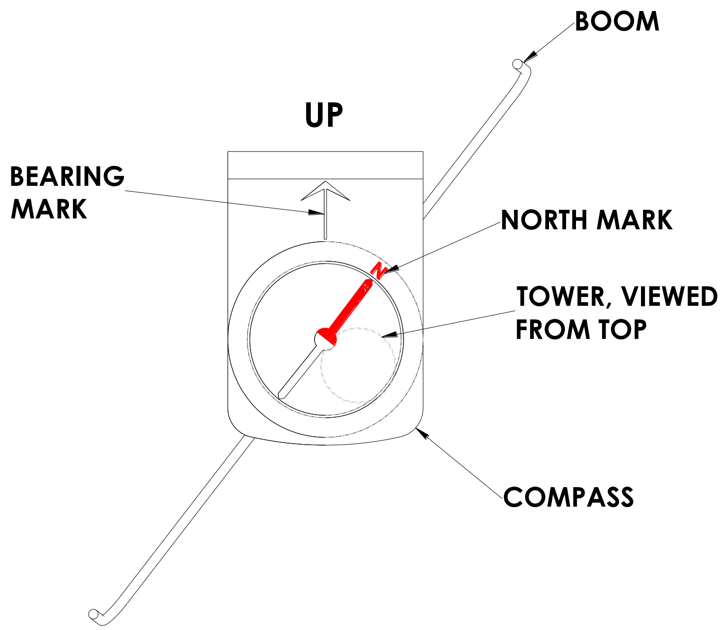


Figure 3

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 Renewable NRG Systems sensor mounting boom. The cotter pin installs horizontally through drill 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 4.

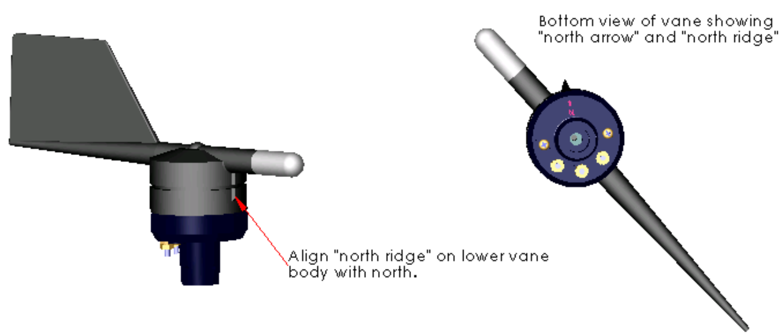


Figure 4

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.

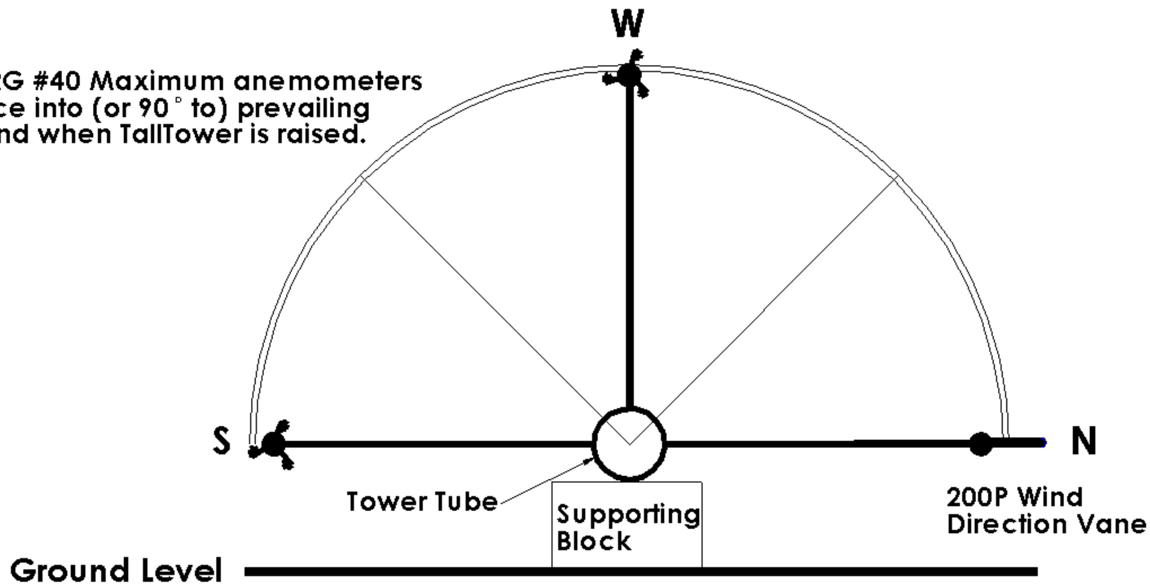


Figure 5

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. **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 Renewable NRG Systems 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 Renewable NRG Systems' 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

165 (or -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.