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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 ASSEMBLED 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 or remote areas where low flying aircraft operate**

> **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 therefore 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. 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 NRG Systems for use with such installations.

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

a. 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.

b. 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.

c. Utilizing several high visibility sleeves (guy guards) on outer guy wires.

d. 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]), and;

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.

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 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)
Tools required continued:

- 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

**WARNING**

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.

**CAUTION**

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.

**Unpack your tower**

**Description of 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 required to unpack the 34 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 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.

Note: 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.

Unpack Sequence – Very Important!

Once you are ready to unpack the contents, follow these steps. With the banding cutters, cut the single horizontal band (#4) and discard.
With the nut driver (or powered screwdriver), remove the 4 wood screws that fasten each end plate assembly down to the wood pallet. Set aside the 2 end plate assemblies. If you can only remove one end plate assembly, that is OK. Remove the end plate and set aside.
The tube contents will now be exposed. 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.

At this point, there should only be 152 mm (6 inch) diameter tubes remaining on the pallet. 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: (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 to identify what type of cellular service is available at the site for those who will be using an RNRG iPack to transmit data. Contact us for more information on RNRG 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 CAUSING 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 MANUFACTURER’S INSTRUCTIONS.
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 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.

NOTE: Extra care will have to be taken while raising the tower if:
- Anchor placement is not perpendicular to the tower as it lays on the ground.
- Anchors are not at the same elevation.
- Side anchors and base plate are not in a straight line.

NOTE: Any of these conditions will affect the side guy wire tension 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. Assemble 4 of the 6 large triangular baseplate sections as shown below, inserting (8) 5/16” x 3/4” carriage bolts in holes closest to the center of each triangular baseplate section. Leave nuts somewhat loose; tighten by hand only.
Flip over the baseplate assembly, and prop up on one edge with a block of wood to allow access to underside of baseplate. Attach vertical pieces to the center of the baseplate as shown below, with bent edges facing outward.

Install the gussets (4) as shown below. Be sure to install the gusset bolts with the carriage bolt head away from the gussets. Tighten all bolts in the baseplate.
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.

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 below for details.

*Figure 4*

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

See Appendix B: Anchoring Guidelines at the end of this manual 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:
### SI Units

Sequence of tubes in each section
A guy ring is placed over the last tube listed in each section.

<table>
<thead>
<tr>
<th>Section 1</th>
<th>Section 2</th>
<th>Section 3</th>
<th>Section 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Tube + (4) 2.2 m, 152 mm dia. tubes</td>
<td>(4) 2.2 m, 152 mm dia. tubes</td>
<td>(4) 2.2 m, 152 mm dia. tubes</td>
<td>(4) 2.2 m, 152 mm dia. tubes</td>
</tr>
<tr>
<td>Lifters attached to this guy ring are color coded: Red</td>
<td>Lifters attached to this guy ring are color coded: White</td>
<td>Lifters attached to this guy ring are color coded: Black</td>
<td>Lifters attached to this guy ring are color coded: Yellow</td>
</tr>
</tbody>
</table>

*Table 1*

### Imperial Units

Sequence of tubes in each section
A guy ring is placed over the last tube listed in each section.

<table>
<thead>
<tr>
<th>Section 1</th>
<th>Section 2</th>
<th>Section 3</th>
<th>Section 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Tube + (4) 87 inch, 6 inch dia. tubes</td>
<td>(4) 87 inch, 6 inch dia. tubes</td>
<td>(4) 87 inch, 6 inch dia. tubes</td>
<td>(4) 87 inch, 6 inch dia. tubes</td>
</tr>
<tr>
<td>Lifters attached to this guy ring are color coded: Red</td>
<td>Lifters attached to this guy ring are color coded: White</td>
<td>Lifters attached to this guy ring are color coded: Black</td>
<td>Lifters attached to this guy ring are color coded: Yellow</td>
</tr>
</tbody>
</table>

*Table 2*
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.

Slide 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. Continue to assemble the tubes and place guy rings over the tubes according to the sequence above. 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.
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.
If you purchased the sensors and booms as part of a NRG-NOW System, cabling was supplied 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. Refer to Appendix E for wind vane alignment tips.

*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.

*Attach the Guy Wires*

*Organize and layout the lifters and guy wires*
Sort out and identify the guy wires and place three sets at each guy ring level. These guy wires are all the same length and are interchangeable. Sort out and identify each lifter wire. The lifter wires are NOT interchangeable. The lifter wires are color coded and are assigned to the guy ring shown in the table below. You will have 12 guy wires and 4 lifter wires. All wires MUST be placed correctly.
Highest level = 4 (yellow)
Identify the lifter wire for each level. It is recommended that back guy wires (the guy wires opposite the winch) are attached to their guy rings, rolled out, and secured to their anchors first, followed by the side guy wires to eliminate crossing.

**Shackle guy wires to the guy rings**
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. Next 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.

**Roll out each guy wire from the tower to its anchor point**
Roll out side and back guy wires from their 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 or unrolled using a “Hankmaster 5000” tool (see Appendix F).

<table>
<thead>
<tr>
<th>Guy Ring Level</th>
<th>Length</th>
<th>Lifter Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10.5 m (34.56 feet)</td>
<td>Red</td>
</tr>
<tr>
<td>2</td>
<td>16.9 m (55.45 feet)</td>
<td>White</td>
</tr>
<tr>
<td>3</td>
<td>24.3 m (79.69 feet)</td>
<td>Black</td>
</tr>
<tr>
<td>4</td>
<td>31.98 m (104.94 feet)</td>
<td>Yellow</td>
</tr>
</tbody>
</table>

*Table 3*
**CORRECT**

Do **not** un-spool cable off the side of the coil as shown below

**NO!**

The Hankmaster can be used to roll the guy wires out to the anchors. See Appendix F for instructions for building and using a Hankmaster.
Pass the split rings through the eye of each shackle bolt to keep the shackle pins from loosening.

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 wires it is recommended that 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.

**Shackle lifter wires to the guy rings**

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.

**Assemble the Gin Pole**

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

**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.
Slide together the 4 tubes that comprise the ginpole

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.
Attach the ginpole top mounting hardware
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.

Also place 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.
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.

**Warning:** 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.

**NOTE:** 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.
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.

<table>
<thead>
<tr>
<th>Lifter #</th>
<th>Lifter Color</th>
<th>Quick Link (number indicates hole)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Yellow</td>
<td>2 (top - away from base of tower)</td>
</tr>
<tr>
<td>3</td>
<td>Black</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>White</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>Red</td>
<td>1 (bottom – toward base of tower)</td>
</tr>
</tbody>
</table>

*Table 4*
Configure the helper ginpole
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. Slide the ¾” x 8” bolts through holes to secure in a vertical position. Secure the bolts with the provided nuts. 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.
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 AND CABLE DAMAGE OR FILL THE WINCH DRUM PREMATURELY. TO AVOID DAMAGE TO THE WINCH CABLE AND PROVIDE FOR SUFFICIENT CABLE LENGTH DURING THE TOWER RAISING PROCESS, HAVE THE WINCH OPERATOR ENSURE EVEN WINDING ONTO THE WINCH DRUM.

Ginpole Tilt-Up
Confirm all lifters and shackles are secure
Carefully double check all connection points to make sure everything is secure before starting to lift the ginpole.

Lift the ginpole
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.

Do not lift the tower yet. Check that the shackles are not twisted at the guy rings.
When the winch cable is free from all of the pulleys in the tube of the helper ginpole, it is safe to remove the helper ginpole.

**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, two people of average size, pulling by hand, can properly tension the guy wires.

MECHANICAL TENSIONING DEVICES SHOULD NEVER BE USED TO ADJUST GUY WIRES ON THE 34 Meter TOWER!!

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 (the “Inchworm” method)

Loosening Guy Wires

As the tower is raised, the side guys may become tight. To adjust the cable, start by making sure the 3 wire rope clips are secure. Tighten using a wrench. Then:

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.

4) Repeat as necessary from step 1 to create the proper cable tension.

**Tightening Guy Wires**

As with loosening, make sure to start with all 3 wire rope clips secure. Tighten using a wrench as shown below. Then:

1. Loosen the lower 2 wire rope clips as shown below.
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 as shown below.

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

4. Finally, tighten the upper clip.
5. Repeat as necessary from step 1 to tighten the cable.

**Lift the Tower**

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**

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.

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

Lift the tower about 1 m (3 feet) off the ground while checking side guy tensions. The lifters are set up to produce a slight bow in the tower, with the top 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.

**Warning:** The tower must remain straight side to side and maintain a positive curve as described above. Failure to maintain the proper shape can cause the tower to collapse, endangering the crew and equipment. This is the highest stress point of the lift.

**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 (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 half way). **STOP.**

Beyond 60 degrees above horizontal, it is absolutely 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.

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, in order 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.

**Warning:** 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.

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.

**Transfer Lifters**

Next, you will transfer the lifting guy wires one at a time from the gin pole to their respective anchors. You will secure each 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.**

As mentioned before, it is normal to have the tower bowed slightly away from the winch. 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.
Transfer the lifters one at a time from the quick links on the ginpole to their anchor. Secure each with wire rope clips. Remember that you will be holding the tower. Maintain tension while transferring the wires. Start with the top lifter level (level 4 yellow). Adjust the guy tension on the lifter and the guy opposite to pull the tower straight and vertical. Working downward, transfer the lower level lifters one at a time to their anchor position. Again, check 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. As you remove the last 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 lowest level guy wires as needed so the base tube is vertical. Working upward, adjust all four guy wires at each level while sighting up the tower from the base to straighten the tower (see picture below).

As you finalize the straightening of the tower, you will need to set the final tension on the guy wires.

**WARNING**
**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 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 20 Nm (15 ft-lb) for 1/4 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.

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 wind storm. Some settling of the tower or anchors may occur, and guy wires can stretch. Loose guy wires can also result when the wire rope clips securing the guys are forced down by the impact of sliding ice.

One of the most important reasons for good tower maintenance, particularly guy tension maintenance, is to avoid a form of tower failure known as “Snap-Through.” Snap-Through typically occurs when the guys are allowed to become loose, and a high wind is blowing on the tower. Even in normal conditions, the upper guys work at a narrower angle to the upper tower than the lower guys, reducing their effectiveness at restraining sideways bending (see 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. Snap through shown in figure 8 below.
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. 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 in order 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.

**NOTICE**

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.

**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.

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: 34 m TallTower Dimensions

Tower Layout

Tower Layout

Tower Specifications:
- Main Tube (with pilot pin hole) 6' x 8'7" (2 tubes)
- Main Tube (with screw pin holes) 6' x 8'7" (2 tubes)
- Base Plate
  - Base Tube (with pilot pin hole) 6' x 8'7" (2 tubes)
  - Main Tube (with screw pin holes) 6' x 8'7" (2 tubes)
- Top Tube (with connector pin hole) 6' x 8'7" (2 tubes)

Tower Dimensions:
- Overall Height: 348.7 ft (106.4 m)
- Level 4:
  - Ladder Length: 50 ft (250"")
  - Elevation Height: 328.96 ft (200"")
- Level 3:
  - Ladder Length: 39 ft (250"")
  - Elevation Height: 242.8 ft (200"")
- Level 2:
  - Ladder Length: 29 ft (250"")
  - Elevation Height: 166.6 ft (200"")
- Level 1:
  - Ladder Length: 20 ft (250"")
  - Elevation Height: 90.4 ft (200"")

Note: Each guy wire should be anchored to the ground with a wire rod, and run from one guy wire to the next. It is important to check the guy wires regularly for any damage or tension loss.
Site Layout

- **Tower**
- **Back anchor should be uphill or downwind**
- **Uphill downwind**
- **Baseplate**
- **Side guy anchor**
- **Winch anchor**
- **Downhill guy anchor**

Dimensions: 94' - 10 1/4'
Baseplate Geometry

\[ 0.867 \text{m} (42.73\text{"}) \]

BASE AREA = 0.94 sq m (10.15 sq ft)
Packaging tube sequence:

NOTES:
1. BASEPLATE REMOVED IN DETAIL A FOR CLARITY.
2. ANCHORS REMOVED IN DETAIL B FOR CLARITY.
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 6: Soil Classes**

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

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

**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 RNRG TallTowers. 203 mm (8.0 inches) diameters screw-in anchors are available upon request.

**Table 7: Specifications for 152 mm (6 inches) diameter Screw-In Anchors**

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

* See Table 6 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 7A: Specifications for 203 mm (8 inches) diameter Screw-In Anchors**

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

* See Table 6 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 8: Specifications for Arrowhead Anchors**

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

* See Table 6 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 9: Specifications for Rock Anchors

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

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 9: 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 10: 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. A 45 degree angle towards the tower is recommended for all anchors used in the 34 meter tower installation.

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: 200M Vane installation and instructions

Introduction
The NRG 200M Wind Vane (introduced January, 2018) has the same form factor as the NRG 200P, and utilizes a new signal transducer which eliminates the dead band and lowers uncertainty. Additionally, sensors are individually serialized, and compatible with NRG SymphoniePRO and SymphoniePLUS3 loggers. For quality traceability, a manufacturing calibration report is available for each individual sensor.

Sensor Identification
The 200M can be identified by the yellow label on the base of the body, which contains the “NRG 200M” model name, serial number (10070-NNNNNNNN), wiring information (“-“, “Signal”, “+”), and barcode.

Power Requirements
The 200M vane requires an excitation voltage of (4.5 to 15) V and consumes 1.5 mA of current. The terminals of the 200M are the same as the 200P, but due to the different power requirements care must be taken when connecting to a SymphoniePLUS3 logger. The EXC terminals found on the SymphoniePLUS3 vane channels 7, 8, vane SCM do not provide enough energy to power the 200M.
<table>
<thead>
<tr>
<th>Logger</th>
<th>2.5V Pulsed EXC</th>
<th>5V Pulsed EXC</th>
<th>5V Constant EXC</th>
<th>12V Constant EXC</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRG SymphoniePLUS3</td>
<td>Do not use*</td>
<td>2.3 mW</td>
<td>N/A*</td>
<td>18 mW</td>
</tr>
<tr>
<td>NRG SymphoniePRO</td>
<td>Do not use*</td>
<td>5.3 mW</td>
<td>7.5 mW</td>
<td>18 mW</td>
</tr>
</tbody>
</table>

*NOTE: DO NOT use the EXC terminal from a SymphoniePLUS3 logger vane channel 7, 8, or vane SCM when connecting a 200M. DO NOT use 200P sensor configuration settings on SymphoniePRO; if you do not see 200M in the sensor drop down list please update your Desktop Software and SymphoniePRO logger Firmware. Please review the logger specific wiring information included in this document!

mounting
The 200M utilizes a new mounting screw arrangement which achieves superior sensor to boom alignment over the previous (200P) design. The mounting process is virtually identical to the 200P.
Install the sensor onto mounting boom:
1. Place the flexible black sensor boot onto the boom.
2. Feed the sensor signal cable up through the boot.
3. Slide the 200M onto the boom such that the set screw of the vane aligns with the flat on the sensor mounting boom. If the boom does not have a flat, position the sensor in the desired orientation.
4. Install and secure the cotter pin.
5. Tighten the sensor set screw using a #1 Philips (+) screw driver.
6. Make your sensor to cable connections as follows (use a ¼ inch nut driver to tighten the nuts)
   a. (‐) to black wire
   b. (signal) to clear wire
   c. (+) to red wire
7. Slide the boot up onto the sensor body.

Note about new NRG mounting boom extension
As of January 2018, standard NRG mounting boom sensor extensions* have been updated to provide a small flat surface for the set screw to land on. This ensures the 200M vane north mark is oriented directly in line with the side mount boom arm pointing at the tower.

*Booms updated for improved 200M Mounting (January 2018)

<table>
<thead>
<tr>
<th>NRG Mounting Boom Item</th>
<th>Description</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>10079</td>
<td>Side Mount Boom (qty. 2), 25x Dia. Height, IEC</td>
<td>200P and 200M vanes, NRG #40C, NRG Class 1 anemometers</td>
</tr>
<tr>
<td>10116</td>
<td>Side Mount Boom (qty. 1), 25x Dia. Height, IEC</td>
<td>200P and 200M vanes, NRG #40C, NRG Class 1 anemometers</td>
</tr>
<tr>
<td>9342</td>
<td>Boom Extension, #40C-200P-Class 1 w Screws, 25 Dia. Height</td>
<td>200P and 200M vanes, NRG #40C, NRG Class 1 anemometers</td>
</tr>
</tbody>
</table>

If using a boom with an older design for the 200P vane, the 200M can be mounted in the same way as a 200P without any modification. A table of boom item numbers has been included for convenience.

symphoniePRO
Compatibility
The NRG 200M Wind Vane is compatible with SymphoniePRO Desktop Application 3.2.X and later; and logger firmware 2.3.1 and later.
NOTE: Please update your desktop software and logger firmware before performing logger configuration and/or data processing tasks. The latest versions of software, firmware and documentation can be downloaded from this page: https://www.nrgsystems.com/services-support/resources/documentation-and-downloads/. 

Wiring

Wiring the NRG 200M to the SymphoniePRO is straight forward and familiar. Please follow the tables below.

**Built in Channels 13-15**

<table>
<thead>
<tr>
<th>200M Connection</th>
<th>Color</th>
<th>SymphoniePRO Logger</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Red</td>
<td>Connect to 13-15 “EXC” terminal</td>
</tr>
<tr>
<td>Signal</td>
<td>Clear</td>
<td>Connect to 13-15 “SIG” terminal</td>
</tr>
<tr>
<td>-</td>
<td>Black</td>
<td>Connect to 13-15 “GND” terminal</td>
</tr>
</tbody>
</table>

**NRG 200M (Ch. 13-15)**

Sensor Wire | Logger
---|---
Red | Excitation EXC
Blk | Ground GND
Wht | Signal SIG
Shield | SHD

- | +
P-SCM Channels 20-26

<table>
<thead>
<tr>
<th>200M Connection</th>
<th>Color</th>
<th>SymphoniePRO Logger</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Red</td>
<td>Connect to 20-26 “EXC” terminal</td>
</tr>
<tr>
<td>Signal</td>
<td>Clear</td>
<td>Connect to 20-26 “SIG” terminal</td>
</tr>
<tr>
<td>-</td>
<td>Black</td>
<td>Connect to 20-26 “GND” terminal</td>
</tr>
</tbody>
</table>

Channel Configuration
Create the following configuration in the SymphoniePRO Desktop Application (Version 3.2.X or later). Note, if you do not see the 200M in the “Load From Defaults” drop-down menu, please update your software from the “Services and Support” section of our website (https://www.nrgsystems.com).

Default Scale Factors (Desktop Application 3.2.X and later)
The SymphoniePRO Desktop Application contains default scaling information for the 200M wind vane. It is also possible to configure using other scaling information such as from an individual sensor’s calibration report.

- Scale Factor: 147.91
- Offset: -1.460
Boom Bearing and Vane Mounting Angle
SymphoniePRO has configuration fields not found in previous NRG loggers such as the SymphoniePLUS3. The **Boom Bearing** field indicates the sensor boom orientation in positive degrees relative to north. This field can also be used to factor in the magnetic declination (site specific variation between magnetic north and true north: [http://www.ngdc.noaa.gov/geomag-web/](http://www.ngdc.noaa.gov/geomag-web/)).

In addition to the Boom Bearing field, there is the option to enter a **Vane Mounting Angle** for wind vane channels. Vane Mounting Angle defines the angle of the “North Mark” on the vane relative to the boom. Zero degrees indicates the mark is facing away from the boom and tower; 180 degrees indicates that the mark is directly facing the boom and the tower.

An explanation of the Boom Bearing and Vane Mounting Angle is available by hovering over the Vane Mounting Angle tooltip in SymphoniePRO Desktop Application.

**Built in Channels 13-15**
The 200M can be installed on logger channels 13-15 without the need for a P-SCM. Choose “NRG 200M Wind Vane” from the “Load From Defaults” drop down menu.
P-SCM Channels 20-26

The 200M vane can be used on channels 20-26 when the logger is equipped with P-SCM item #9130 [P-SCM #9130, (0 to 5) V, SE Input, Pulsed 5V EXC]. This is useful if you need to install more than 3 wind vanes, or if Channels 13-15 are already in use for other sensors. Choose “NRG 200M Wind Vane” from the “Load From Defaults” drop down menu.
Symphonieplus3

Wiring

Channels 7 and 8

- Signal and GND are wired as normal, connect to analog channel 7 or 8.
- EXC can be connected two different ways, depending on your preference and configuration:
  
  - EXC from digital-counter channels 1-3, or 13-15 (this supplies constant 12 V to the 200M)
  
  - EXC from a channel which has a 110S SCM installed (this supplies pulsed 5V to the 200M and uses less power than a 12V source)

**NOTE: Do NOT connect the EXC to channel 7 or 8!**

<table>
<thead>
<tr>
<th>200M Connection</th>
<th>Color</th>
<th>SymphoniePLUS3 Logger</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Red</td>
<td>Connect to channel 1-3, 13-15 “EXC” terminal, or EXC terminal from 110S SCM (5V pulsed output)</td>
</tr>
<tr>
<td>Signal</td>
<td>Clear</td>
<td>Connect to channel 7-8 “SIG” terminal</td>
</tr>
<tr>
<td>-</td>
<td>Black</td>
<td>Connect to channel 7-8 “GND” terminal</td>
</tr>
</tbody>
</table>
Flex Channels 4-6 and Analog channels 9-12
Signal and GND are wired into a channel with wind vane SCM (#3152) present; either a flex channel 4-6, or an analog channel 9-12.
- Signal and GND are wired as normal, connect to analog channel 7 or 8
- EXC can be connected two different ways, depending on your preference and configuration:
  - EXC from digital-counter channels 1-3, or 13-15 (this supplies constant 12 V to the 200M)
  - EXC from a channel which has a 110S SCM installed (this supplies pulsed 5V to the 200M and uses less power than a 12V source)
NOTE:
Do NOT connect the EXC to channel 7 or 8!

Channel Configuration
The 200M has a different default scaling than the 200P. *Do not use the 200P settings found in SDR!*
Instead, configure as follows:

<table>
<thead>
<tr>
<th>200M Connection</th>
<th>Color</th>
<th>SymphoniePLUS3 Logger</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Red</td>
<td>Connect to channel 1-3, 13-15 &quot;EXC&quot; terminal, or EXC terminal from 110S SCM (5V pulsed output)</td>
</tr>
<tr>
<td>Signal</td>
<td>Clear</td>
<td>Connect to channel 4-6, 9-12 &quot;SIG&quot; terminal</td>
</tr>
<tr>
<td>-</td>
<td>Black</td>
<td>Connect to channel 4-6, 9-12 &quot;GND&quot; terminal</td>
</tr>
</tbody>
</table>
- Slope: 0.368
- Offset: -5.3 (see section below about integrating boom direction into offset)

Determining Offset Value

**North Mark Pointing Away from Tower**

If the boom heading is pointing in a direction other than North (0 degrees) and the north mark of the 200M is facing away from the tower, calculate your overall offset as follows:

- **Offset = Boom Heading – 5.3**
  - Example: Boom Heading is 90 Deg (East) and the North Mark on the vane is pointing away from the tower.
  - Offset = 90 – 5.3
    = 84.7

**North Mark Pointing Toward Tower**

If the boom heading is pointing in a direction other than North (0 degrees) and the north mark of the 200M is facing toward the tower, calculate your overall offset this way:

- **Offset = Boom Heading + 180 - 5.3**
  - Example: Boom Heading is 90 Degrees (East) and the North Mark on the vane is pointing toward the tower.
  - Offset = 180 + 90 – 5.3
    = 264.7
## Specifications

Please see nrgsystems.com for up to date product specifications.

<table>
<thead>
<tr>
<th>Description</th>
<th>Sensor type</th>
<th>Continuous rotation wind direction vane</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applications</td>
<td>Wind resource assessment</td>
<td></td>
</tr>
<tr>
<td>Sensor range</td>
<td>360° mechanical, continuous rotation</td>
<td></td>
</tr>
<tr>
<td>Instrument compatibility</td>
<td>All Symphonie Data Loggers</td>
<td></td>
</tr>
<tr>
<td>Measurement range</td>
<td>0 - 360°</td>
<td></td>
</tr>
</tbody>
</table>

### Output signal

<table>
<thead>
<tr>
<th>Signal type</th>
<th>Analog DC voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linearity</td>
<td>0.1°</td>
</tr>
</tbody>
</table>

#### Transfer function

- **SymphoniePRO*:**
  - Default slope = 147.91°/V
  - Default offset = -1.460°
- **SymphoniePLUS3*:**
  - Default slope = 0.368°/V
  - Default offset = -5.3°

Individual sensor transfer function is available via factory calibration certificate.

<table>
<thead>
<tr>
<th>Dead band</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration</td>
<td>Each sensor is individually factory calibrated. Factory calibration certificates provided via electronic download.</td>
</tr>
<tr>
<td>Output signal range</td>
<td>0.007Vdc to 2.5Vdc</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Expanded uncertainty (k=2) 95% confidence [Sensor only]:</td>
</tr>
<tr>
<td><strong>Response characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td><strong>Delay distance</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Power requirements</strong></td>
<td><strong>Supply voltage</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Supply current</strong></td>
</tr>
<tr>
<td><strong>Installation</strong></td>
<td><strong>Mounting</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Tools required</strong></td>
</tr>
<tr>
<td><strong>Environmental</strong></td>
<td><strong>Operating temperature range</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Operating humidity range</strong></td>
</tr>
<tr>
<td><strong>Physical</strong></td>
<td><strong>Connections</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Weight</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Dimensions</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Materials</strong></td>
<td><strong>Wing</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Body</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Shaft</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Bearing</strong></td>
</tr>
<tr>
<td>Magnet</td>
<td>Neodymium</td>
</tr>
<tr>
<td>--------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Boot</td>
<td>Protective PVC sensor terminal boot included</td>
</tr>
<tr>
<td>Terminals</td>
<td>Nickel plated brass</td>
</tr>
</tbody>
</table>
Appendix D: 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 prematurely rather than risk losing data!
### Appendix E: Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anchor eye</td>
<td><img src="image" alt="Anchor eye" /></td>
</tr>
<tr>
<td>Arrowhead anchor</td>
<td><img src="image" alt="Arrowhead anchor" /></td>
</tr>
<tr>
<td>Base tube (Same as Ginpole Base Tube)</td>
<td><img src="image" alt="Base tube" /></td>
</tr>
<tr>
<td>Base tube, Ginpole base tube, and Helper Ginpole bolt and nut: ¾” x 8” bolt</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Baseplate gusset</td>
<td></td>
</tr>
<tr>
<td>Drive rod for arrowhead anchor</td>
<td></td>
</tr>
<tr>
<td><strong>Ginpole base tube (Same as Base Tube)</strong></td>
<td></td>
</tr>
<tr>
<td>------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><img src="image1" alt="Ginpole base tube image" /></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ginpole guy ropes: 45.7 m x 13 mm (150 ft. x ½ in.)</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image2" alt="Ginpole guy ropes image" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Ginpole safety cable</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3" alt="Ginpole safety cable image" /></td>
</tr>
<tr>
<td><strong>Ginpole top tube</strong></td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td><img src="image1.jpg" alt="Ginpole top tube" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Helper Ginpole</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image2.jpg" alt="Helper Ginpole" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Guy ring</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image3.jpg" alt="Guy ring" /></td>
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</tbody>
</table>
Guy wire

Hankmaster

Lifting wires
<table>
<thead>
<tr>
<th><strong>Description</strong></th>
<th><strong>Image</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Quick Link</td>
<td><img src="image1.png" alt="Quick Link Image" /></td>
</tr>
<tr>
<td>Rock anchor</td>
<td><img src="image2.png" alt="Rock anchor Image" /></td>
</tr>
<tr>
<td>Rocker plate</td>
<td><img src="image3.png" alt="Rocker plate Image" /></td>
</tr>
<tr>
<td><strong>Screw-in anchor</strong></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td><img src="image1.jpg" alt="Screw-in anchor" /></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Shackle</strong></th>
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<tbody>
<tr>
<td><img src="image2.jpg" alt="Shackle" /></td>
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</table>

<table>
<thead>
<tr>
<th><strong>Wire rope clip</strong></th>
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<tbody>
<tr>
<td><img src="image3.jpg" alt="Wire rope clip" /></td>
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</table>
Appendix F: 34m TallTower Painted Version

<table>
<thead>
<tr>
<th>Lookup ID</th>
<th>Description</th>
<th>Item Number</th>
<th>Qty.</th>
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<tbody>
<tr>
<td>1</td>
<td>Tube Base Flared, Grilled, 152 4mm (6&quot;) x 2.2m (87&quot;) Aviation Orange</td>
<td>11756</td>
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<tr>
<td>2</td>
<td>Tube Flared Lanced, 152 4mm (6&quot;) x 2.2m (87&quot;) Aviation White</td>
<td>11757</td>
<td>9</td>
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<tr>
<td>3</td>
<td>Tube Flared Lanced, 152 4mm (6&quot;) x 2.2m (87&quot;) Aviation White</td>
<td>11758</td>
<td>7</td>
</tr>
</tbody>
</table>

**34m Painted Version**

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