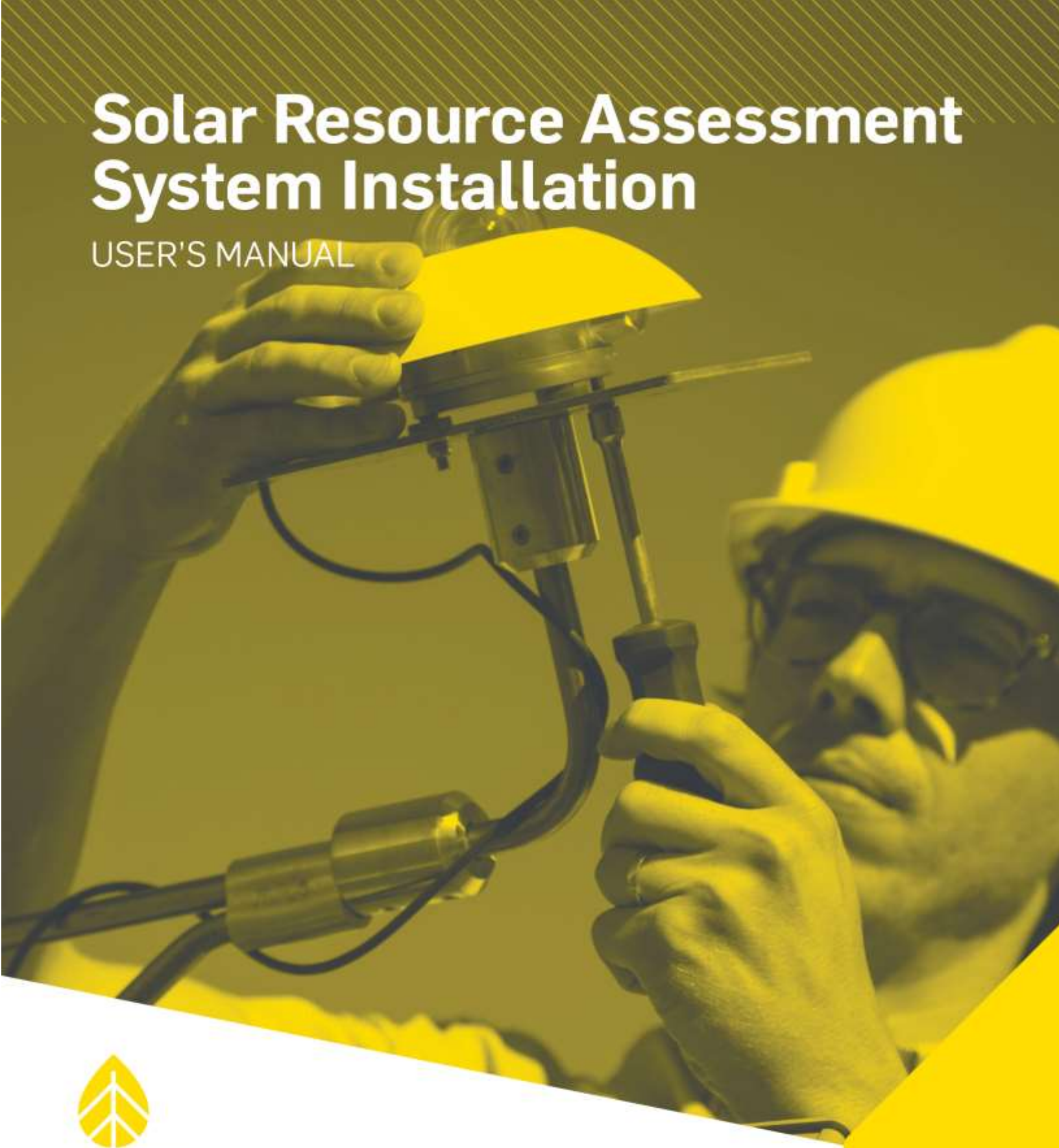
Solar Resource Assessment System Installation

USER'S MANUAL



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Specifications are subject to change without notice.

To minimize risks, read and follow the tower installation instructions explicitly. Do not install during an electrical storm. NRG Systems assumes no responsibility or liability in connection with any act, error, omission, or for any injury, loss, accident, delay, inconvenience, irregularity or damage related to any tower installation.

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INTRODUCTION

Overview

The SRA System from NRG Systems is designed for the professional solar PV developer & operator looking for quick and repeatable deployment, easy and autonomous off-grid operation, and bankable data.

The system is comprised of a 2.2m tower, the SymphoniePRO data logger, Symphonie iPack communications + power modules, meteorological tower components, and reliable sensors. NRG Systems resource assessment equipment is currently used on all continents and in more than 150 countries.

About This Manual

The SRA System is a comprehensive, reliable way to develop prospective solar sites and monitor existing ones. This manual is organized to provide a system overview, followed by installation instructions for the tower, booms, and sensors. The NRG Systems SRA system is intended to be used with the **SymphoniePRO™ Data Logger**.

Users already familiar with previous generation Symphonie loggers and iPacks will notice similar menus and terminology in the SymphoniePRO SRA System. All product manuals are available from the Services & Support area of our website at http://www.nrgsystems.com/.

Typographic Conventions

This type style is used for the general body of this manual.

This style is used to warn users of a potential danger, either to themselves or to the equipment or data.

Note: This style is used to indicate a tip or an important note.

Symbols

For easy reference, this manual uses various symbols to indicate important information and notices.

	**Attention**: Very important step, please read closely and follow directions.
	**Warning**: Indicate[s] a hazardous situation which, if not avoided, could result in death or serious injury. WARNING [signs] should not be used for property damage hazards unless personal injury risk appropriate to this level is also involved.
	**Danger**: Indicate[s] a hazardous situation which, if not avoided, will result in death or serious injury. The signal word "DANGER" is to be limited to the most extreme situations. DANGER [signs] should not be used for property damage hazards unless personal injury risk appropriate to these levels is also involved
	**Caution**: Indicate[s] a hazardous situation which, if not avoided, could result in minor or moderate injury. CAUTION [signs] without a safety alert symbol may be used to alert against unsafe practices that can result in property damage only.
	**Notice**: This is used to address practices not related to personal injury. The safety alert symbol shall not be used with this signal word.

Safety Considerations

	**READ ALL INSTRUCTIONS AND WARNINGS BEFORE BEGINNING ANY TOWER 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.
	**USE ONLY SUITABLE TOWER ANCHORS FOR THE SOIL TYPE AT THE INSTALLATION SITE.** THE LIMIT LOADS OF THE COMPLETED TOWER UNDER VARYING CONDITIONS (*E.G.*, HIGH WINDS AND ICE), AND THE STRENGTH 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 INJURY OR PROPERTY DAMAGE. THE SRA TOWER INCLUDES 4 INCH SCREW-IN ANCHORS. IT IS YOUR RESPONSIBILITY TO DERMINE IF ANOTHER TYPE OF ANCHOR IS NECESSARY FOR A SAFE TOWER INSTALLATION.
	**DO NOT INSTALL SRA TOWER NEAR ELECTRICAL POWER LINES.** METAL TOWER 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 SRA TOWER INSTALLATION IF ANY ELECTRICAL LINES ARE PRESENT. MAINTAIN A DISTANCE OF AT LEAST 100 FEET (30 METERS) BETWEEN THE TOWER AND ANY POWER LINES.
	**DO NOT BEGIN OR CONTINUE SRA TOWER INSTALLATION DURING AN ELECTRICAL STORM.** IF LIGHTNING STRIKES A TOWER 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.

Pre-installation Guidelines

Read the manual in advance and have a thorough understanding of the steps involved in erecting the tower before arriving at the installation site. All crew members should understand the manual.

Follow the steps carefully throughout the installation process.

Assess the soil type at the site to ensure the correct anchors are selected in advance of the installation (see **Appendix A** for more information on anchoring).

For your SAFETY:

Always use appropriate safety gear including leather gloves, safety glasses, hard hat, and steel toe work boots.

Follow safe digging protocol and contact local utilities to understand what utilities may be buried in the installation area to avoid anchors, ground rod, and rain gauge post hitting existing utility lines.

DO NOT climb this tower; always use a stepladder to access the irradiance sensors.

DO NOT erect tower within 30 meters (100 feet) of walkways, roads, or buildings.

Grounding Precautions

***Failure to ground the logger puts the logger and sensors at risk* for electrostatic damage (ESD).**

Whenever coming in contact with the SymphoniePRO logger, either in the field or indoors, it is good practice to first grasp a piece of grounded (earthed) metal before touching the logger to avoid potentially damaging the equipment with electrostatic discharge (ESD).

The copper clad ground rod provides an electrical path for static electricity that builds up on the sensors to dissipate to ground. Failure to use proper grounding protection can damage the equipment and will void the warranty.

Technical Support

NRG Systems offers a variety of support options to help you get the most from your NRG Systems products. If you have questions, first look in the published product documentation. The best places to find information and documents are on the respective product pages of the NRG Systems website.

If you cannot find the answer, contact your salesperson or NRG Systems Technical Support for assistance using the information below. Customer support is available 8:30 AM to 5:00 PM EST, Monday through Friday.

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Fax: 802-482-2272
Email: support@nrgsystems.com

When you call or email, you should have the appropriate product documentation at hand and be prepared to give the following information:

- Customer name & organization
- Original equipment purchaser
- Order number and date
- Item number or description
- Serial numbers of pertinent data loggers and iPack equipment
- Where equipment is installed, including terrain conditions
- Detailed description of the problem
- What events took place leading up to the problem
- What you have tried while attempting to solve the problem

NRG Systems maintains an extensive website which includes an in-depth customer support area. If you need assistance at times other than our regular business hours, we suggest visiting our website, www.nrgsystems.com.

MATERIALS & TOOLS

In the Kits

- NRG Systems SRA Tower Assembly, 2.2m (NRG #9118)
  For complete parts listing and BOM, see Appendix B.
- SRA Sensor package (#9119, 9120, 9121, 9156, or custom configuration)
- SymphoniePRO data logger kit (#9117)
- Symphonie iPack

Exact SRA System contents vary depending on customer requirements and requests. Please visit our website or contact our Sales Team with any questions about sensors or SRA System Packages.

Required Tools

- Ratchet & SAE Socket Set
- Large Adjustable wrench, 1 1/8 max opening capacity or larger
- Small Adjustable wrench
- Needlenose pliers
- Hex key set, SAE
- 5/16” nut driver or Cordless drill/impact driver with 5/16” nut driver bit
- 7/16” nut driver or Cordless drill/impact driver with 7/16” nut driver bit
- Small flathead screwdriver
- Utility knife
- Sledgehammer, 5lb recommended
- Tape measure
- Stepladder, 6ft minimum working height
- Fold-up table or workbench, 6’ x 2.5’ or larger recommended
- Compass or GPS
- Permanent marker
- Laptop with SymphoniePRO Desktop Application installed
- USB-A to USB-B cable
- Digital Voltmeter (optional)
- Wire strippers (optional)
- Bubble level (optional)
- (If using screw-in anchors only) Long iron bar

Personal Protective Equipment

- Gloves
- Safety Glasses
- Safety toe boots
- Hard hat
- Sunscreen

Recommended Additional Documentation

- SymphoniePRO manual
- Individual sensor & accessory manuals, depending on configuration
- All-Weather PVH Instructions (if necessary)
- Soiling Measurement Kit Instructions (if necessary)
- (For BGAN/iPackACCESS communication) BGAN M2M Instructions from NRG

SRA Toolkit (#5372)

This kit is available for purchase separately from the NRG SRA System. It was created to aid in tower installation and adjustment of booms and sensors in the SRA System.

- 1/4-inch nut driver
- 5/16-inch nut driver
- 7/16-inch nut driver
- Small Phillips head screwdriver
- Flat (-) screwdriver
- Electrical tape
- Open-end wrench, 1/2 inch and 3/8 inch
- Protective installation cap

SECTION 1: PLANNING

1.1 Pre-Installation Preparation

Planning your SRA System prior to field deployment is an important part of the installation process and will help move the process along smoothly. Several aspects of the planning process that are highlighted below.

Logger & iPack

Learn and understand the features and functions of the SymphoniePRO logger and accompanying SymphoniePRO Desktop Application software before deployment. To make the installation process go more smoothly, pre-configure your logger and iPack and test that they work properly.

Wireless coverage is necessary in order for the iPackGPS to be able to send data. Identify what type of cellular coverage is available at the site (GSM or CDMA) and bring the appropriate iPackGPS model.

Satellite communication is also an option when sending data from your site if cell coverage is not available or you would like to use a satellite network instead. Please contact our Sales Team for more information.

Soil Type & Anchors

Before ordering your system, research the site soil and be sure to know what soil types exist at your site as part of your pre-installation planning process. If necessary, consult an expert.

Depending on the soil type, anchoring can take varying levels of planning, effort, and time. It is *your* responsibility to determine which type of anchor is appropriate for your specific site.

The SRA Tower ships with (3) Duckbill Model 68 anchors. Other anchors may be acceptable for use with the NRG SRA tower and will vary depending on the characteristics of individual sites. See **Appendix A** for more detailed information about soil type and anchoring.

Site Security

Securing your SRA System is important. It is up to you to determine the best security measures to employ. Fencing, cameras, and frequent site visits are all recommended ways to help protect the SRA System.

1.2 Site Layout

The NRG Systems SRA tower utilizes three Duckbill anchors, equally spaced 120 degrees apart around the tower (example layout, Figure 1-1). Orient the tower as shown.

When installing the anchors, ensure that the anchors are properly embedded into the ground and equidistant from the tower and each other.

Other anchors may be required to secure the SRA tower in some cases.

Note: Once driven into the ground, Duckbill Anchors are extremely difficult or impossible to remove. Double check all anchor locations and soil before beginning to drive the anchors into the ground.

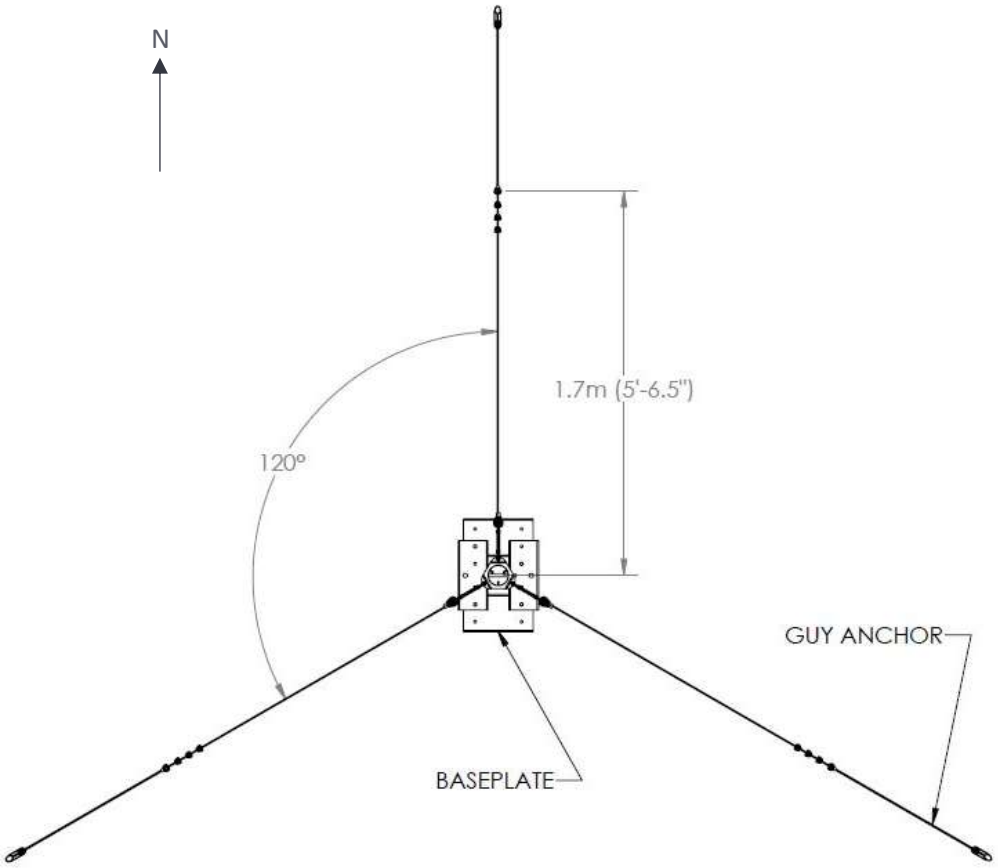


Figure 1-1: Examply layout map, exact distances may vary slightly.

SECTION 2: TOWER ASSEMBLY

2.1 Open and unpack all items.

Your SRA tower kit contains many pieces. Use the checklist in **Appendix B** to verify that they are all present and undamaged.

2.2 Assemble the tower baseplate.

2.2.1 Gather the following (Figure 2-1):

(2) Horizontal baseplate pieces
(2) Vertical baseplate pieces
(4) 3/8-16 x 1” bolts
(4) 3/8-16 nuts

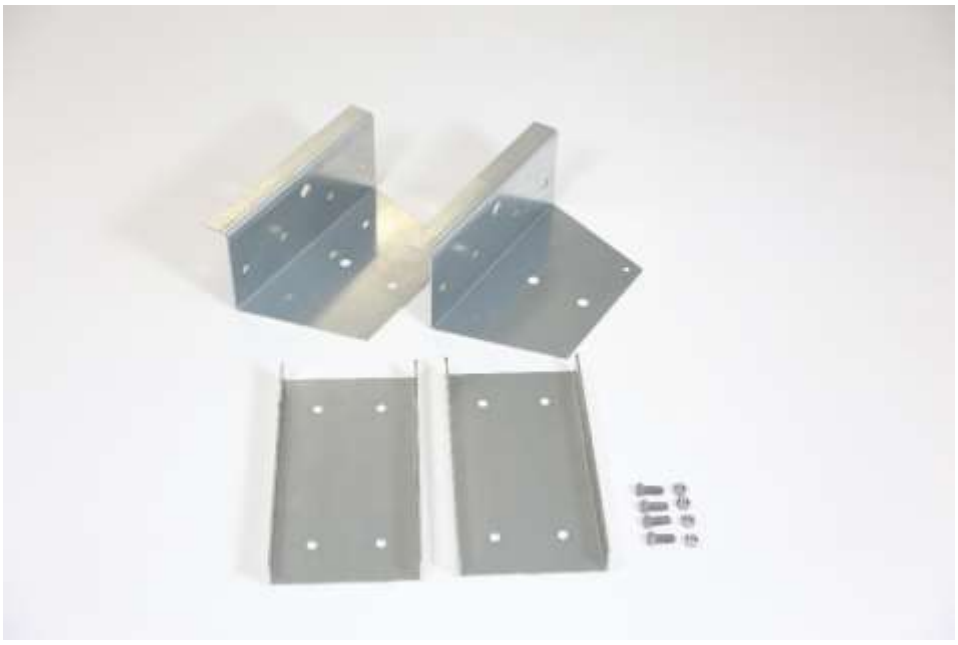


Figure 2-1

2.2.2 Join together the horizontal and vertical pieces using the 3/8" hardware

Holes and orientation are indicated (Figure 2-2).

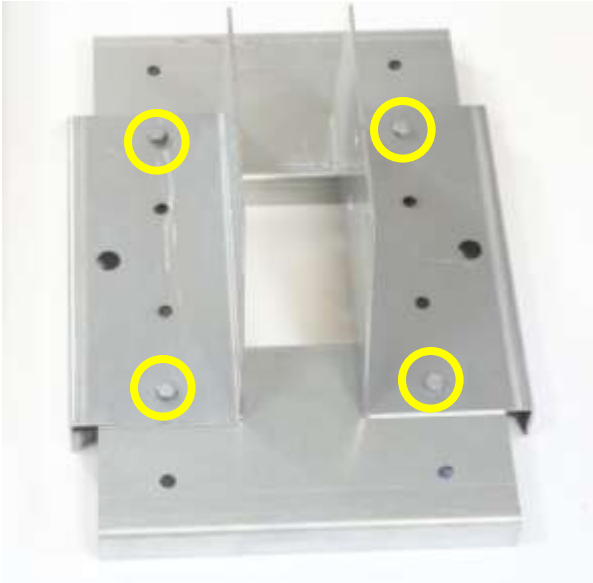


Figure 2-2: Assembled SRA tower baseplate

2.3 Attach and raise the 2.2m tower tube.

2.3.1 Attach the tower tube to the baseplate with (1) bolt.

The SRA tower tube has two 1/2" holes drilled near one end. Place this end in between the vertical portions of the assembled baseplate.

With the tower on the ground, line the bottom holes on the vertical baseplate with the end hole on the tower tube. Slide (1) 1/2-13x5" bolt through the holes and thread (1) 1/2-13 nut on the end to secure the tower and the baseplate together (Figure 2-3).

Figure 2-3

2.3.2 Attach the guy ring and top plate to the tower.

The guy ring and top plate are easier to attach to the tower prior to raising it. While not difficult to attach later, we recommend doing so at this point.

Note: The top plate is used to mount pyranometers and is sold as part of the sensor packages. Not every SRA System includes a top plate.

Slide the guy ring around the top of the tower with the tabs angled downwards and slide it down the tube until it rests on the preinstalled hex head screws (Figure 2-4).

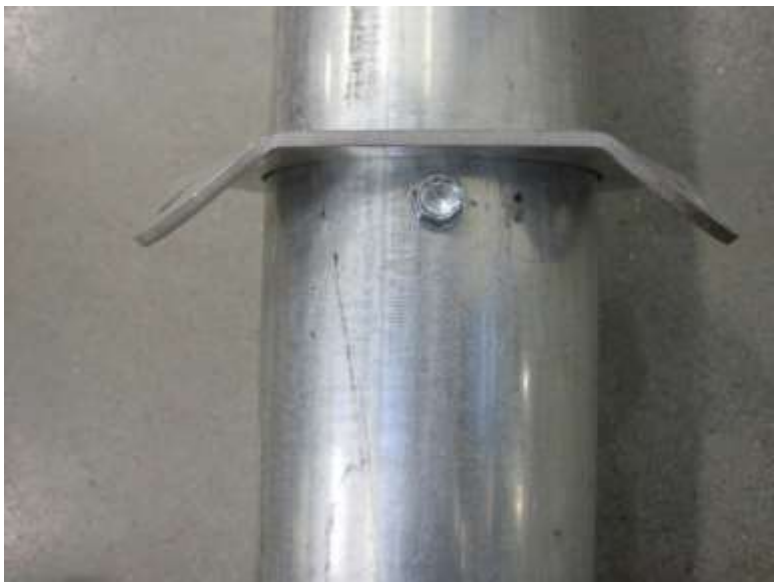


Figure 2-4: Guy ring installed onto tower tube to the preinstalled screws

If a top plate was included, attach it to the top of the tower using the 1/4-20x4.25” bolts and lock nuts (Figure 2-5). If the tower was oriented to match Figure 1-1, the top plate will extend along the East-West axis.

Figure 2-5: Top plate installed

2.3.3 Raise the tower and secure with the second bolt.

Pivot the tower to vertical and secure with the second 1/2-13x5" bolt & nut (Figure 2-6). Tighten both sets of hardware.

NOTICE ***Do not overtighten hardware. Overtightening may cause the tower tube to deform.***

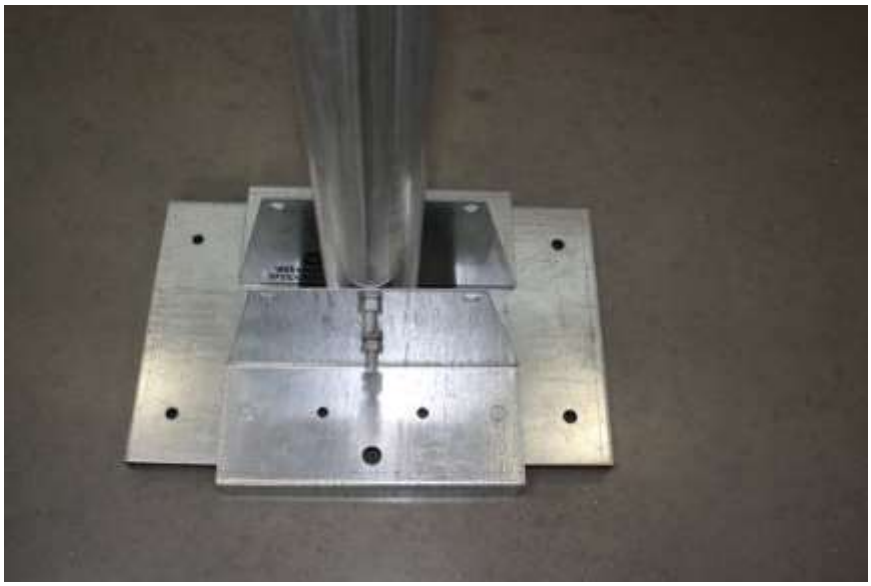


Figure 2-6: Raised & bolted SRA tower

2.4 Install the anchors for the SRA tower.

The NRG SRA tower kit comes with Duckbill 68 anchors. If other anchors are used for your SRA tower, please refer to their individual instructions for installation information. Refer to **Appendix A** for more information about anchor and soil types.

2.4.1 Pound anchors into the ground

To install the Duckbill anchors, measure out from the base of the tower in the direction of each of the three anchors with a tape measure. The anchor wire thimbles should be approximately 67.5" from the base of the tower, so the location to begin pounding the anchor into the ground may vary slightly depending on how much wire is exposed. Duckbill anchors perform best when driven at least 30" into the ground.

Figure 1-1 shows the recommended anchor and guy wire orientation.

Once suitable anchor locations have been found, put the end of the copper-clad ground rod into the hollow cavity of the Duckbill anchor (Figure 2-7).

Figure 2-7: Placing the Duckbill anchor onto the tip of the ground rod

Place the tip of the anchor into the ground, hold the wire taut, and pound the other end of the ground rod with the small sledge hammer to drive the anchor into the ground (Figure 2-8). Continue until the thimble at the end of the anchor wire is approximately 67.5” from the tower, or the anchor cannot be driven any further. Use your best judgement.

Figure 2-8: Pound Duckbill anchors into place using the ground rod

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.

2.4.2 Lock the anchors in place

To lock the anchor in place and perform a pull test, remove the ground rod from the ground and thread it through the wire thimble. Pull towards the tower and in the opposite direction that the anchor was installed. The wire should move about 4-6” as the Duckbill rotates 90 degrees and locks into place in the ground.

Figure 2-9 diagrams the install procedure using arrowhead anchors. Duckbill anchors install in the same manner.

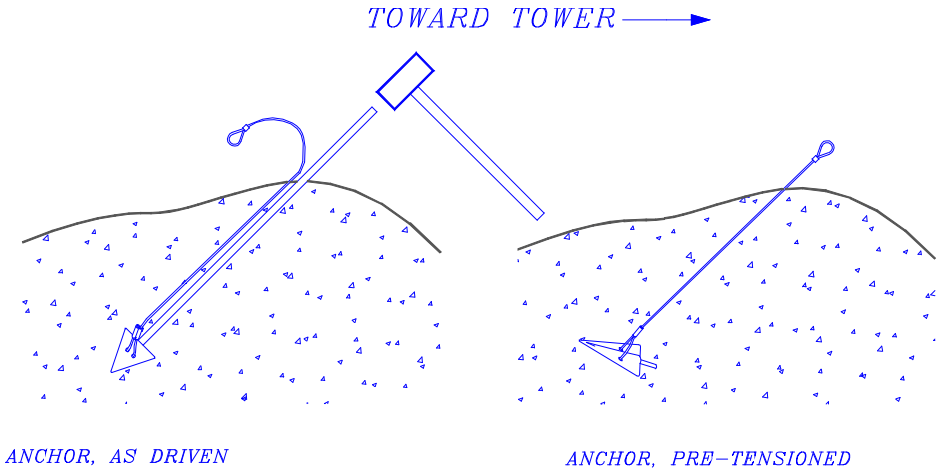


Figure 2-9: Arrowhead & Duckbill anchor installation diagram

2.5 Attach the guy wires between the SRA tower and anchors.

The SRA tower guy wires are attached to the guy ring with turnbuckles and to the anchors through the thimble at the end of the anchor wires.

2.5.1 Install turnbuckles and guy wires to the guy ring.

Loosen all turnbuckles to their maximum length. Secure one end of each turnbuckle to the guy ring (Figure 2-10), and the other end to the guy wire thimble (Figure 2-11).

Figures 2-10 & 2-11: Turnbuckle attachment points to guy ring and guy wires

2.5.2 Secure guy wires to anchors.

Feed the other end of a guy wire through the thimble at the end of the corresponding anchor wire. Pull the guy wire tight and secure with two wire rope clips, using the 7/16" nut driver, socket, or impactor (Figure 2-12).

Begin by making the guy wires moderately tight, then readjust once all three have been attached to their corresponding anchors. Make final tension adjustments with the turnbuckles.

Proper wire rope clip operation
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).

Do not pull excessively on the guy wires to tighten them, especially when first connecting the guys to the anchors. Doing so may cause the tower to fall on you or others nearby.

Note: The turnbuckles have been spec'd to provide an adequate amount of guy wire adjustment for tensioning and plumbing the tower. If you run out of adjustment and the guy wires are still not tight enough, you will have to completely loosen the turnbuckles and start the tensioning process again with the wire rope clips.

Figure 2-12: Guy wire secured by wire rope clips. Duckbill anchor wires have a thimble preinstalled.

2.6 Plumb and straighten the tower.

To straighten the tower, place the magnetic angle finder or bubble level on the tower tube at different locations around the guy ring (Figure 2-13).

Hand-tighten the guy wire turnbuckles while monitoring the angle of the tower. Do not use any tools for added leverage when tightening. Final guy wire tension should be sufficient to prevent substantial movement of the tower, but overtightening the wires can damage the turnbuckles.

Figure 2-13: Plumb the tower with the angle meter

The tower is now completely installed and ready to be utilized in the NRG Systems SRA System.

2.7 Ground the tower.

Grounding your SRA tower is an incredibly vital step in the installation process. Failure to adequately ground the tower may cause sensor and instrument failure due to damage from electrostatic discharge. The NRG Systems SRA tower comes with a 4’ copper-clad grounding rod.

2.7.1 Installing the ground rod through the baseplate.

Drive the ground rod through the hole in the center of the vertical baseplate piece (Figure 2-14). There are holes on both sides of the baseplate; choose one of them.

Figure 2-14: Installed ground rod

2.7.2 Connect the tower to the ground rod with the copper grounding wire.

Attach one end of the 8 AWG grounding wire to the grounding lug and tighten the threaded stud with a flathead screwdriver to secure. Attach the wire and lug to the vertical baseplate piece at one of the top holes. Tighten the bolt to secure.

Feed the other and of the grounding wire through the brass acorn clamp to the desired location, then attach to the ground rod and tighten the clamp to secure. Tuck excess cable out of the way.

2.8 Attach the shelter box to the tower.

To attach the shelter box to the tower, feed a hose clamp through the top and bottom brackets on the backside of the box (Figure 2-15), then wrap around the tower and tighten down.

The recommended mounting location of the shelter box on the tower is approximately 10-16” below the guy ring to give adequate clearance past the guy wires to open the door and access the instruments.

Figure 2-15: Shelter box mounting brackets

SECTION 3: SRA SENSORS & ACCESSORIES

There are a variety of sensors and accessories available for Solar Resource Assessment and Solar Monitoring from NRG Systems, both in predetermined kits and on an individual basis. Please see our website for a complete list of sensors, accessories, and kits available.

This section deals with attaching the booms and sensors to the SRA tower. For information about how to connect the sensor wires to the SymphoniePRO wiring panel, please see Section 4.

Figure 3-1: Secondary Standard SRA sensor kit (# 9121)

3.1 Attaching the booms to the tower

Attach the booms to the tower directly below the top plate using hose clamps (Figure 3-2). If the booms are all located at the same level, they can be mounted to the tower using the same hose clamps.

Tip: The fastest way to secure hose clamps is to use an impact driver or drill with a 5/16" nutdriver bit. Maintain pressure on the worm screw in order to prevent the nutdriver from stripping the hose clamp as is spins.

Use caution when tightening hose clamps. As they tighten to the tower tube, pinch points are created and could cause personal injury.

Do not overtighten hose clamps. Overtightening may cause the metal band to break.

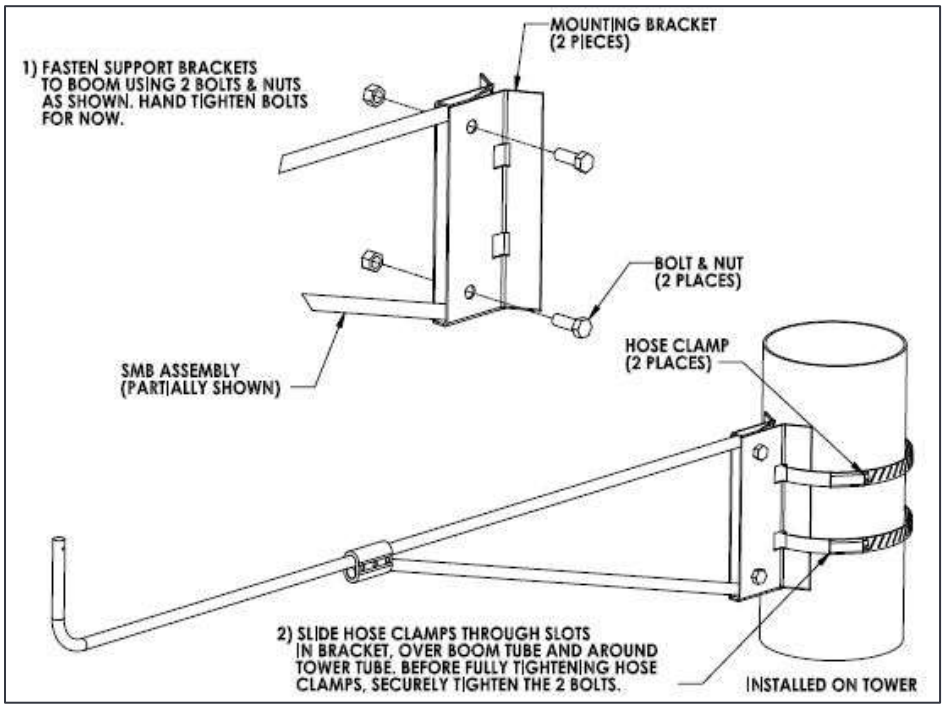


Figure 3-2: Boom assembly and installation reference diagram

3.2 Attaching sensors to the booms and the tower

This section explains how to attach the sensors to the tower. For wiring panel diagrams, see **Appendix C**.

3.2.1 Attaching NRG Systems anemometers and wind vanes to booms

The NRG Systems 40H anemometer and 200P wind vane included in SRA sensor packages mount in the same manner.

Slide the boot and sensor onto the top of the 1/2” boom. Secure the sensor with a cotter pin and set screw. Connect the sensor cable to the appropriate terminals on the sensor body, then slide the boot into place (Figure 3-3, 200P vane). Tape can be added in between the top of the boot and the sensor body as long as the sensor head can still spin freely.

To align the vane properly, please see **Appendix D**.

Note: Do not tape the bottom of the sensor boot around where the wire comes out. It is necessary to keep this clear to drain any moisture buildup inside the boot. If the drain hole is taped shut, water may collect and cause sensor to corrode, which will void the warranty.

Figure 3-3: NRG 200P wind vane properly wired and attached to a boom

3.2.2 Attaching Pyranometers to the SRA tower

There are multiple ways to mount pyranometers to the NRG Systems SRA tower. Table 3-1 displays the compatibility between these mounts and the pyranometers that can be used in the SRA System.

TABLE 3-1: PYRANOMETER MOUNTING COMPATIBILITY

SENSOR	2X GHI MOUNTING PLATFORM (#9104)	PLANE OF ARRAY (#6772)	PYRANOMETER BOOM (#3902)
LI-COR LI-200R	✓	✓	✓
HUKSEFLUX LP02	✓	✓	
HUKSEFLUX SR11/SR12/SR20	✓	✓	
DELTA-T SPN1	✓	✓	
KIPP & ZONEN CMP3/CMP10/CMP11	✓	✓	
HUKSEFLUX VU01 VENTILATOR	✓		

Most pyranometers require a cable from the manufacturer in order to connect to the SymphoniePRO logger. Ensure that you have the appropriate cable for the sensor(s) in your system.

3.2.3 Attaching the NRG Systems BP20 barometric pressure sensor

Attach the BP20 sensor to the SRA tower below the shelter box with hose clamps by wrapping them around the sensor and tower and securing them with the 5/16” nutdriver (Figure 3-4). Multiple sensors can be attached with the same hose clamps, provided that each sensor is adequately secured to the tower.

3.2.4 Attaching the NRG RH5X relative humidity sensor

Attach the RH5X sensor at the same level as the BP20 and 110S sensors with hose clamps (Figure 3-4). Tighten with the 5/16” nutdriver. Multiple sensors can be attached with the same hose clamps, provided that each sensor is adequately secured to the tower.

3.2.5 Attaching the NRG Systems 110S temperature sensor

Attach the 110S sensor at the same level as the BP20 and RH5X sensors with hose clamps (Figure 3-4). Tighten with the 5/16” nutdriver. Multiple sensors can be attached with the same hose clamps, provided that each sensor is adequately secured to the tower.

Figure 3-4: RH5X (left), BP20 (center), 110S (behind, right) sensors attached to the SRA tower with the same hose clamp. A second hose clamp is used for the 110S.

3.2.6 Installing the NovaLynx Tipping Bucket rain gauge

Install the tipping bucket rain gauge by driving the pipe into the ground approximately six feet away from the base of the tower. Once adequately secured into the ground, attach the sensor to the top of the pipe.

Depending on the soil type, a hole may have to be started prior to driving the pipe into the ground. Ensure proper backfill is tamped after installation

See the manufacturer's instructions and user manual for more details and information about maintenance and calibration of the sensor.

3.2.7 Installing other accessories

The NRG Systems SRA tower can accept other accessories, such as the Soiling Measurement Kit and All-Weather PVH Kit. Refer to their instruction manuals for assembly and programming.

APPENDIX A: ANCHORING GUIDELINES AND SOIL TYPES

Determine Site Soil and Anchor Type Before You Install Your Tower

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

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 A-1: Soil Classes*

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

** Charts reproduced by permission, The A.B. Chance Co.*

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

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.

Duckbill Anchors

The NRG Systems SRA tower now includes Duckbill 68 anchors as standard equipment. Detailed installation instructions and figures are located in Section 2.4 of this SRA Manual.

To install, simply use the SRA tower ground rod and a small sledgehammer to pound the anchor into the ground. Once at the appropriate depth, thread the ground rod through the thimble at the end of the anchor wire and pull in the opposite direction that the anchor was driven in. The Duckbill will rotate 90 degrees and lock into place.

Screw-in Anchors

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 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 75 mm (3 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.

Arrowhead Anchors

Arrowhead anchors are similar to Duckbill anchors, but can better penetrate stiff and rocky soils because the unique triangular design threads its way between obstacles such as rocks. 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.

Other Anchor types

There are other anchor types such as rock anchors and site-built concrete anchors. These types are not commonly used for a tower this size. They can be effectively used in locations where screw-in or Duckbill anchors are unsuitable, such as sites where ground penetration is not allowed.

NOTICE

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 possibly tower failure.

NOTICE

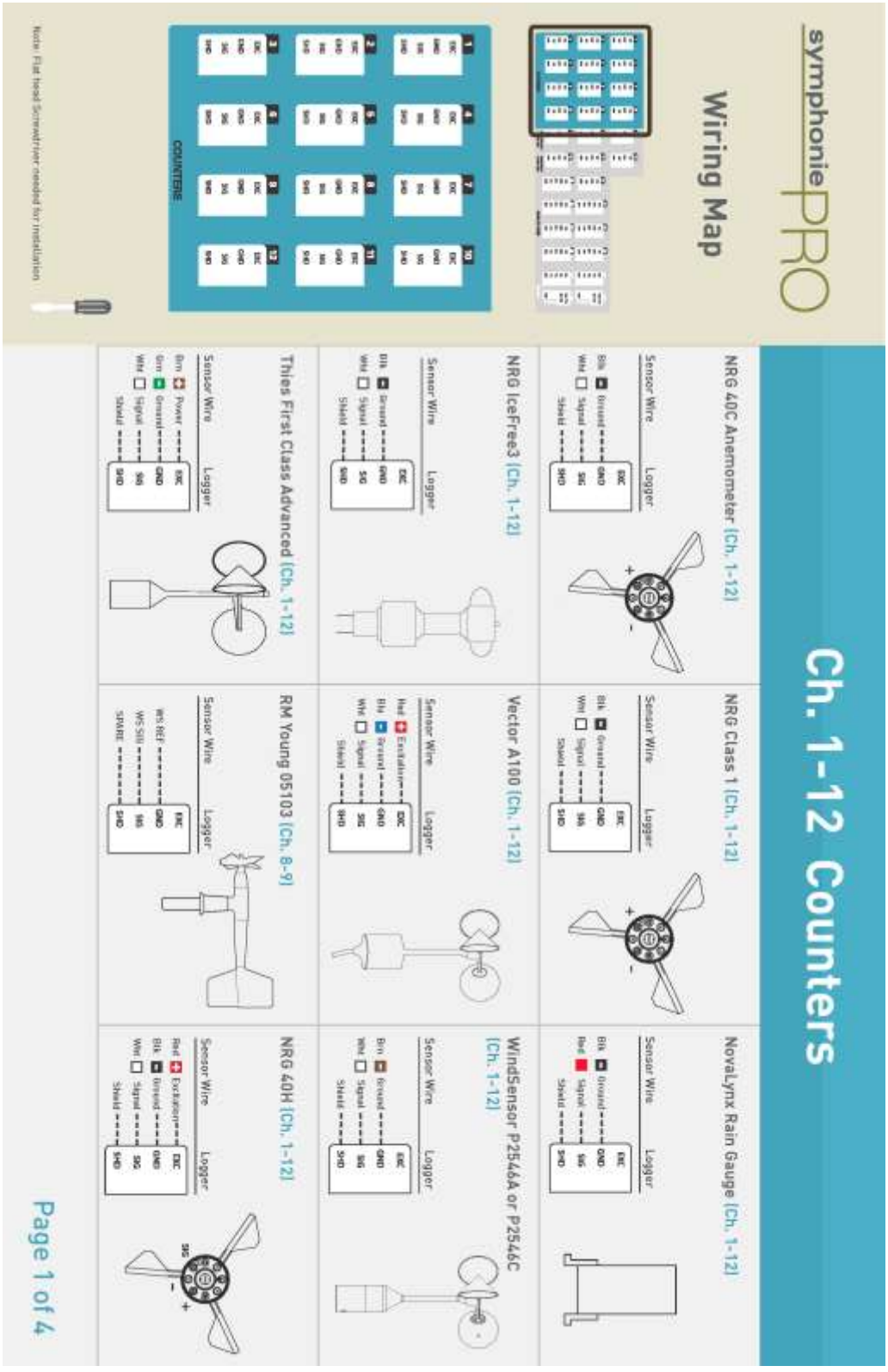
The anchor must be properly pre-tensioned before attaching the tower guys. If it is not, the tower guy wire tension will turn the anchor later, resulting in significant slack in the guy wires and possibly tower failure.

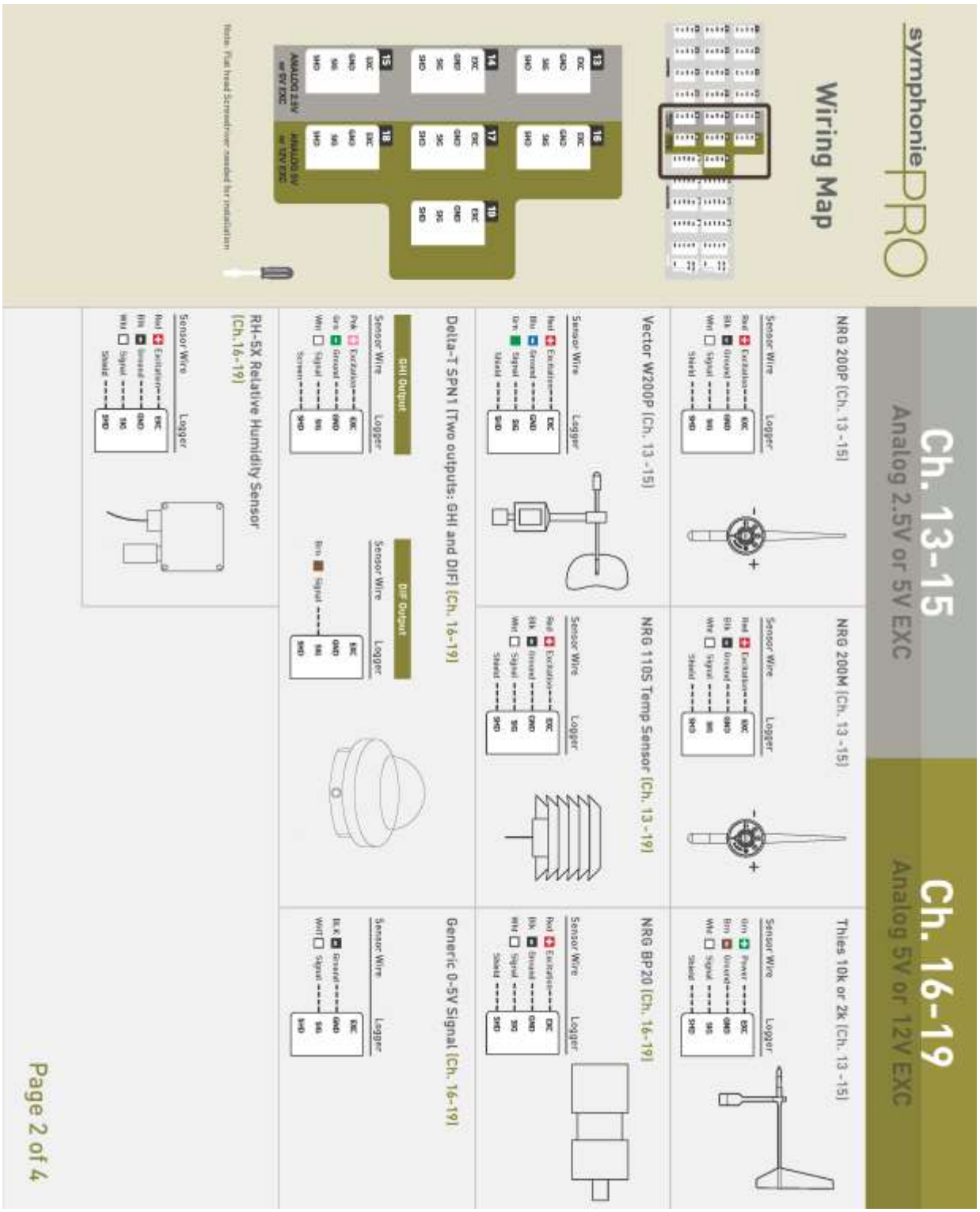
APPENDIX B: SRA TOWER COMPONENTS & PARTS CHECKLIST

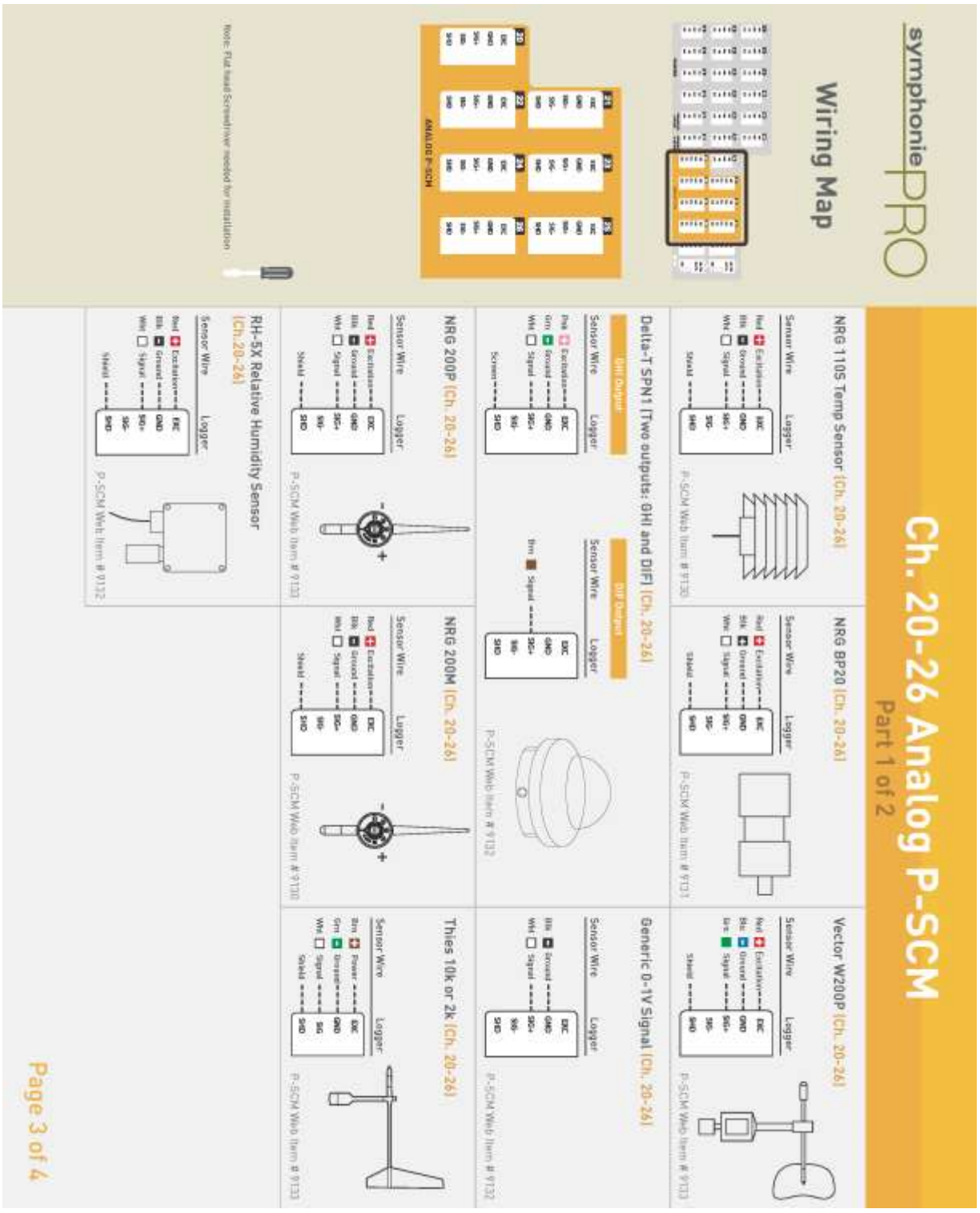
Below are tables for the parts included with the SRA tower. Ensure that you have these parts when installing the SRA tower. Booms & top plate, sensors & wires, data logger & accessories, and other items are not on this checklist.

Part Number	Description	Qty
9013	Tower Tube – 3.5” OD, 87” length, 14ga	1
11143	Anchor – Duckbill Model 68	3
1233	Guy Wire – 3/16”, galvanized	3
1533	Grounding Rod – 5/8” diameter, 48” length, copper-clad steel	1
9012	Vertical Baseplate	2
9018	Horizontal Baseplate	2
8980	Guy Ring - 14ga	1
5270	Turnbuckle - 4.25” max adjustment, 800lb WLL	3
1444	Grounding Wire – 8ga, copper	1
1247	Wire Rope Clip – 3/16”	13
1518	Baseplate Bolts & Nuts – 3/8”-16x1”	4
1547	Tower Mounting Bolts & Nuts – 1/2”-13x5”	2
6792	Magnetic Angle Meter	1
1533	Ground Rod Acorn Clamp	1
4261	Grounding Lug	1

APPENDIX C: SENSOR WIRING




symphonie PRO
Wiring Map
Ch. 13-15
Analog 2.5V or 5V EXC
Ch. 16-19
Analog 5V or 12V EXC
NRG 200P (Ch. 13-15)
NRG 200M (Ch. 13-15)
Thies 10k or 2k (Ch. 13-15)
Vector W200P (Ch. 13-15)
NRG 110S Temp Sensor (Ch. 13-19)
NRG BP20 (Ch. 16-19)
Delta-T SPN1 (Two outputs: GHI and DIF) (Ch. 16-19)
Generic 0-5V Signal (Ch. 16-19)
RH-5X Relative Humidity Sensor (Ch.16-19)
Sensor Wire
Logger
GHI Output
DIF Output
Page 2 of 4


symphoniePRO
Wiring Map
Ch. 20-26 Analog P-SCM
Part 1 of 2
NRG 110S Temp Sensor (Ch. 20-26)
NRG BP20 (Ch. 20-26)
Vector W200P (Ch. 20-26)
Delta-T SPN1 (Two outputs: 0Hi and DiFi) (Ch. 20-26)
Generic 0-1V Signal (Ch. 20-26)
NRG 200P (Ch. 20-26)
NRG 200M (Ch. 20-26)
Thies 10k or 2k (Ch. 20-26)
RH-5X Relative Humidity Sensor (Ch. 20-26)
Page 3 of 4

symphoniePRO

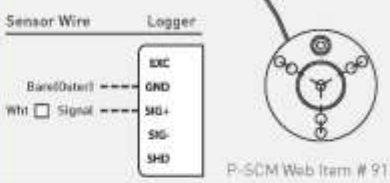
Wiring Map

Note: Flat head Screwdriver needed for installation

Ch. 20-26 Analog P-SCM

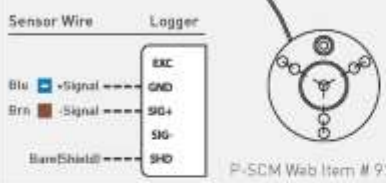
Part 2 of 2

LI-COR LI-200SZ Pyranometer (Ch. 20-26)



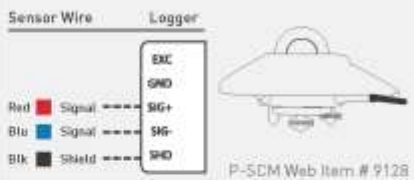
P-SCM Web Item # 9129

LI-COR LI-200R Pyranometer (Ch. 20-26)



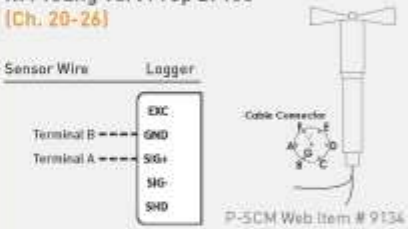
P-SCM Web Item # 9129

Kipp & Zonen CMP3, CMP10, CMP11 (Ch.20-26)



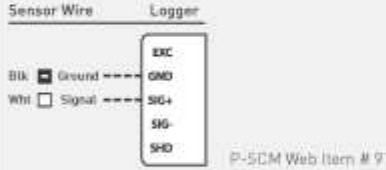
P-SCM Web Item # 9128

RM Young Vert Prop 27106 (Ch. 20-26)



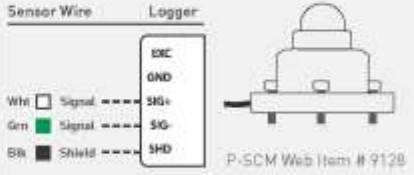
P-SCM Web Item # 9134

Generic 0-20mA Signal (Ch. 20-26)



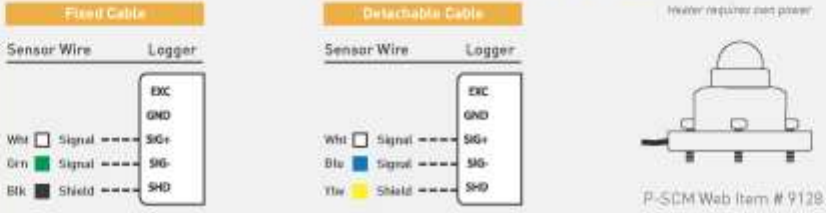
P-SCM Web Item # 9137

Hukseflux SR11, SR12, and SR20 (Ch. 20-26)



P-SCM Web Item # 9128

Hukseflux LP02 (Two options: Fixed or Detachable Cable) (Ch. 20-26)



P-SCM Web Item # 9128

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APPENDIX D: VANE ALIGNMENT

Introduction

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

Magnetic Declination

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

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

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

Mounting and Aligning Wind Vanes

Since a magnetic compass is the simplest direction reference, it is sometimes convenient to orient wind vanes in the field to magnetic north. Most NRG Systems customers, however, align their wind vanes to true north. Before installing your 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 to true north:

Use a transparent orienteering compass with a rotating bezel and magnetic declination markings. In the example in **Figure D-1**, 15 degrees west means that the direction of the compass needle (magnetic north) lies 15 degrees west of true north.

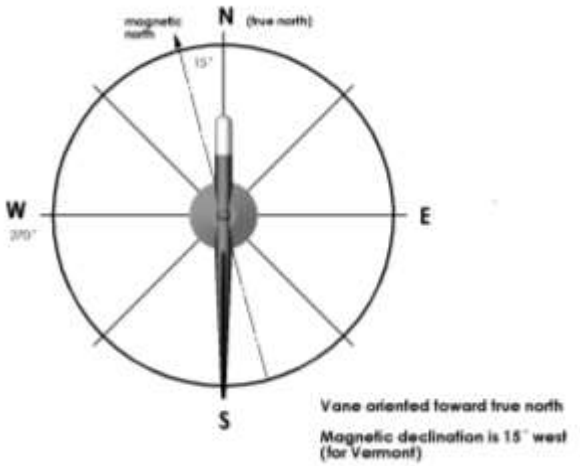

Figure D-1

NOTICE

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.

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 2.2m Tower. 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 D-3**.

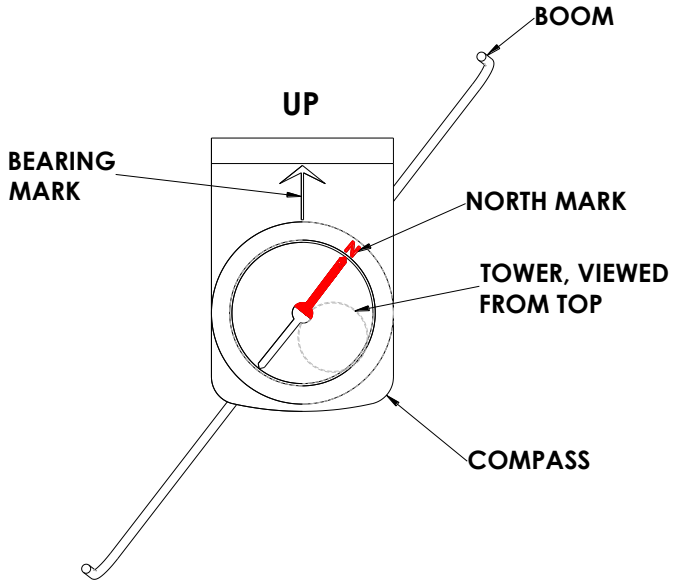

Figure D-2

Rotate the boom until it aligns with the north mark on the compass, and tighten the boom.

Attach the wind vane with the north arrow index mark on the base pointing in the same direction as the north mark on the compass. The 200P wind direction vane is designed to mount with a cotter pin and set screw to a NRG 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 D-4**.

Figure D-3

Use the compass to verify your settings. If necessary, adjust the position of the mounting boom before raising the 2.2m Tower.

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.**

NOTICE

Wind direction vanes have a small range centered about the sensor's north reading that is called the dead band and produces a zero reading. Although 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.

NOTICE

If you orient your wind vane to a magnetic bearing other than magnetic north, you need to enter values for both magnetic declination and offset in your data analysis software. Enter the site's magnetic declination so that your software can compensate for the declination; enter an offset to compensate for the orientation of the vane.
If just one offset field is available in your software, such as NRG Systems SymphoniePRO Desktop Application 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 in the offset field. Declinations to the west of true north are subtracted from the magnetic reading, and declinations to the east of true north are added to the magnetic reading.

APPENDIX G: GROUNDING

Meteorological sensors, loggers, and towers accumulate static electrical charge unless they are properly grounded. High winds, low humidity, and the height of the tower above ground increase the rate of charge accumulation. Charge continues to accumulate until the developed voltage difference, sometimes thousands of volts relative to ground, causes dielectric breakdown and an electrostatic discharge (ESD).

ESD can damage any scientific instrument or sensor, including (but not limited to) data loggers, anemometers, or wind vanes. By attaching an NRG Systems logger or other instrument to a properly grounded SRA tower, and sensors to the logger, the logger and sensors will also be electrically grounded.

Properly grounding your system helps protect your sensors, your measurement instruments, and your data!

It is your responsibility to provide proper earth grounding for the tower, logger, and sensors. All warranties on NRG Systems instruments and sensors are voided if your system is not properly grounded.