



Foundation Manual

Part Number: 150002

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775-831-9463

www.mariahpower.com

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Dear Customer,

Thank you for your purchase and congratulations on becoming a new owner of a Windspire!

We are excited that you have just chosen to participate in renewable energy generation, with a revolutionary wind turbine designed for operation where we live and work. The Windspire energy appliance is the result of creative thinking combined with years of engineering and collaboration with several major universities in the United States and Canada. The Windspire was developed to let you produce your own electricity in a clean, attractive and cost effective way.

We welcome you to the Mariah Power family and hope that you will be satisfied for years to come. It is our wish that you will eventually spread the word that harnessing wind energy can be fun, exciting and rewarding.

Thank you,

Mariah Power Team

Model Number _____
Serial Number _____

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Chapter 1: Introduction

1.1 List of Parts Supplied by Mariah Power

Before you start the installation, please verify that no parts are missing or damaged. Table 1-1 lists all the items that Mariah Power supplies. The items are shipped as two separate packages.

Table 1-1: Parts Checklist

✓	Item	Size		Weight	
		Empirical (ft/in)	Metric (m)	Empirical (lbs)	Metric (kg)
	1. Foundation Kit Box 1—This item contains the following components: <ul style="list-style-type: none"> • Four M20 x 2.5 x 1m threaded foundation rods • 24" long ¾" PVC conduit • 18" long ¾" PVC conduit 	3.3' x 2" diameter	1.0 x 0.05 diameter	19	8.6
	2. Foundation Kit Box 2—This item contains the following components: <ul style="list-style-type: none"> • 8' (2.4 m) piece of 8AWG copper grounding wire • Copper grounding plate • 16 nuts, M20 Grade 5 • Two ¾" PVC conduit couples • ¾" 90 degree conduit elbow • 4 washers, 2.1 cm ID x 5 cm OD x 3 mm, Grade 5 • Foundation template • Foundation Installation Manual 	1.0' x 1.0' x 0.5'	0.3 x 0.3 x 0.2	12	5.4

1.2 List of Parts Supplied by Customer

Table 1-2 lists all the items that the customer must supply to install the Windspire foundation.

Table 1-2: Customer-Supplied Parts Checklist

✓	Item
	1. 3' (91 cm) length of 2' (61 cm) diameter Sonotube (this will serve as the foundation tube)
	2. Four 3 foot lengths of 2x4 lumber (3' x 1.5" x 3.5") (91 cm x 3.8 cm x 8.9 cm)
	3. Two 1 foot lengths of 2x4 lumber (1' x 1.5" x 3.5") (30.5 cm x 3.8 cm x 8.9 cm)
	4. Two 3 foot lengths of 2x2 lumber (3' x 1.5" x 1.5") (91cm x 3.8 cm x 3.8 cm)
	5. Sixteen 2" (5.1 cm) screws
	6. UFB wire (the length depends on the distance from your Windspire to your residence or business)
	7. Tarp or similar weather protection for the concrete

1.3 Tools Required

Table 1-3 lists the tools you require to install the Windspire foundation.

Table 1-3: Required Tools Checklist

✓	Tool
	1. One level
	2. One wire brush
	3. One drywall knife
	4. One cement spade or trowel
	5. One pair of wire cutters
	6. One 30mm wrench (provided)
	7. One screw gun with Phillip's head screw tip
	8. Wire to tie conduit to the foundation template
	9. Masking tape to wrap around foundation rod threads to shield them from cement during pouring

1.4 Services Required

You require the following services to install your Windspire foundation:

- 24 inch (0.61 m) diameter post-hole digging service
- 1 cubic yard (0.77 cubic m) of concrete delivered

1.5 Shipping Weights

Table 1-4 lists the shipping weights of Windspire components:

Table 1-4: Shipping Weights

Item	Weight	
	Empirical (lbs)	Metric (kg)
Base Pole	185	83.9
Generator	100	45.4
Bottom Shaft	154	69.9
Top Shaft	122	55.3
Rotor Struts	24	10.9
Airfoils	58	26.3
Rotor Rings	16	7.3
Inverter	18	8.2
Hardware	55	25
Gin Pole	71	32.2
TOTAL weight shipped, excluding weight of any pallets	793	359.7

1.6 Technical Support

If you have questions about the products and procedures in this manual, please contact Mariah Power's technical support at (775) 857-4888.

Chapter 2: Windspire Foundation Installation

2.1 Overview

Installing the foundation for your Windspire involves the following steps, which this manual describes in detail.

1. **Siting**—Determine the location for your Windspire, including the foundation, the trench (where the UFB wire will lie) and the space that the base pole will occupy before erection. You must verify that digging in your chosen location will not disrupt anything already in the ground.
2. **Digging the post hole**—Have a post-hole digging service dig a hole for the foundation.
3. **Preparing the Sonotube**—Attach wood braces and ground rest boards to the Sonotube.
4. **Inserting the Sonotube in the hole**—Insert the Sonotube in the hole and stabilize it with vertical support boards and horizontal crossboards.
5. **Assembling the foundation rods and template**—Attach the foundation rods to the foundation template.
6. **Placing the grounding plate and wire**—Attach the ground wire to the grounding plate and place them in the foundation hole.
7. **Inserting the foundation rods and template**—Place the foundation rods and foundation template into the hole with the template at the top.
8. **Connecting the PVC conduit**—Assemble the PVC pipes that will serve as a conduit for the UFB wire and insert them into the Sonotube.
9. **Pouring the concrete**—Pour the concrete into the hole, level it, and let it cure for a week.
10. **Finishing the foundation**—Remove the Sonotube boards and cardboard, back fill the dirt around the Sonotube, and ensure the concrete is level.
11. **Laying the UFB wire**—Dig a trench from the Windspire to your residence or business, insert the UFB wire into the foundation, and bury the remaining UFB wire in the trench.

2.2 Siting


Simply put, you should install your Windspire wherever you have good wind. Trees and buildings can obstruct prevailing winds. Considerate siting will help you generate more energy for years to come.

Generally, higher is better for wind energy generation because wind speed increases with height above the ground. However, in most areas where we live and work, we are usually limited to the height that the municipal government will accept. Therefore, the Windspire was specifically designed to work at a maximum height of 30 feet (9.1 m), which is under the 35 foot (10.7 m) limit prevalent in most U.S. zoning jurisdictions.

Another consideration for siting your Windspire is ensuring sufficient room for assembly and erection. During assembly, your Windspire will occupy at least 30 feet (9.1 m) on the ground. Additional access is required for erection, which is achieved by pulling up your Windspire with a vehicle.

2.3 Installing the Foundation

The following is one typical foundation method for installing your Windspire. However, always verify that the installation method you choose is in accordance with the local building codes for the soil conditions in your area.

1.  Once you choose a location for your Windspire, the first step is to mark the location with white paint or a stake. Then check with the responsible authorities in your area to confirm that digging in that location will not disrupt or damage anything already in the ground. (For example, in Southern California, you can contact Dig Alert at 1-800-227-2600, www.digalert.org. This service is free and within two days the agency will sign off that the location is acceptable.)

- 2. Call a post-hole digging service to bore a 24 inch (0.61 m) diameter hole to a depth of 6 feet (1.8 m) at the marked location.

Figure 2-1: Post-Hole Digger



Figure 2-2: Foundation Hole



- 3. Cut a 1 inch (2.5 cm) diameter hole in the cardboard foundation tube (Sonotube). The Sonotube is 36 inches (0.91 m) long and 24 inches (0.61 m) in diameter. Cut the hole 30 inches (76 cm) down from whichever Sonotube opening will be the top (i.e. above ground). This opening will be used for conduit access later in the installation.

- 4. Use screws to attach two 3-foot (91 cm), 2x4 wood braces to the Sonotube (see Figure 2-3), one on each side.

Figure 2-3: Wood Braces



- 5. Attach two 3-foot (91 cm), 2x4 ground rest boards to the Sonotube, one on each side, using two wood screws from inside the tube (see Figure 2-4). Position the boards such that when the tube is in the hole, its top end will be level and approximately 12 inches (30 cm) above the ground surface.

Figure 2-4: Ground Rest Boards



- 6. Insert the Sonotube into the hole. The tube must be 12 inches (30 cm) above ground level and 24 inches (61 cm) below ground level. Rotate the tube until the 1 inch hole in its side is aligned with where the trench will be.

- 7. Attach two 1-foot (30 cm), 2x4 vertical support boards, one to each outer side of the Sonotube, with two wood screws from the inside. Rest the vertical support boards on the ground rest boards for added support during the foundation pouring process.
- 8. Attach two 3-foot (91 cm), 2x2 horizontal cross boards across the diameter of the Sonotube and to each side of the vertical support boards using wood screws. The cross boards must be supported above the top of the Sonotube such that the top end of the foundation rods (see Figure 2-6) will protrude 4.5 inches (11.4 cm) above the concrete foundation surface when finished (see Figure 2-9).

Figure 2-5: Foundation Rods—Bottom

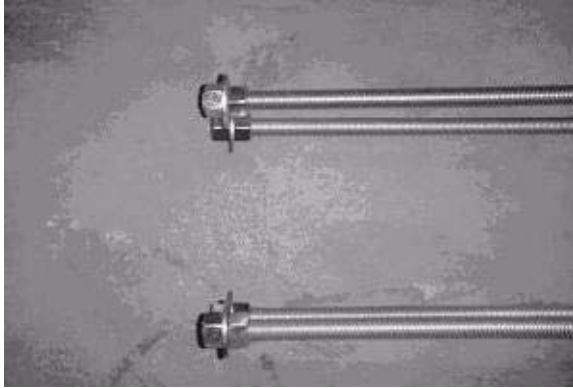
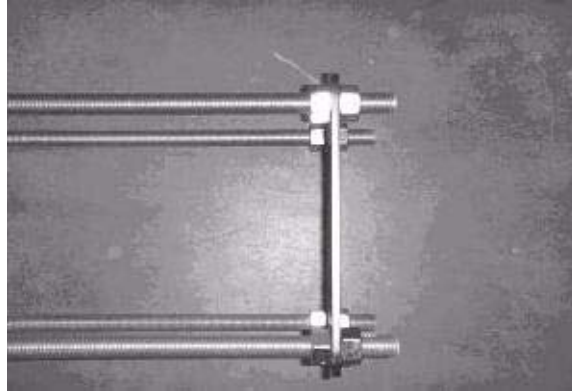


Figure 2-6: Foundation Rods—Top



- 9. Attach the four foundation rods to the foundation template using eight nuts. Thread four nuts on each side of the foundation template (i.e. for each rod, thread one nut on each side of the template) such that the rod ends are protruding 1 7/8" (4.8 cm) above the top nuts (see Figure 2-6).
- 10. At the bottom end of each foundation rod, attach a nut, then a washer, and then another nut (see Figure 2-5). Tighten all the nuts.
- 11. Wrap masking tape around the foundation rods just below the bottom nuts under the foundation template (see Figure 2-7). This is to shield the threads from the cement during pouring.

Figure 2-7: Protecting Foundation Rod Threads with Tape



- 12. Install the ground wire to the grounding plate using the lug screw.

- 13. Place the grounding plate and its attached ground wire into the bottom of the foundation hole (see Figure 2-8).

Figure 2-8: Ground Wire Attached to Grounding Plate in Foundation Hole



- 14. Place one shovel-full of dirt on top of the grounding plate to secure it in place and prevent it from becoming embedded in the concrete when the latter is poured.
- 15. Place the foundation rods into the foundation hole such that the template is at the top. You must center the foundation template and rest it on the cross boards (see Figure 2-9). Ensure that the rods are protruding 4.5 inches (11.4 cm) measured from the top of the Sonotube. Rotate the template such that the axis along which you will raise the base pole is parallel to two template sides and perpendicular to two other template sides.

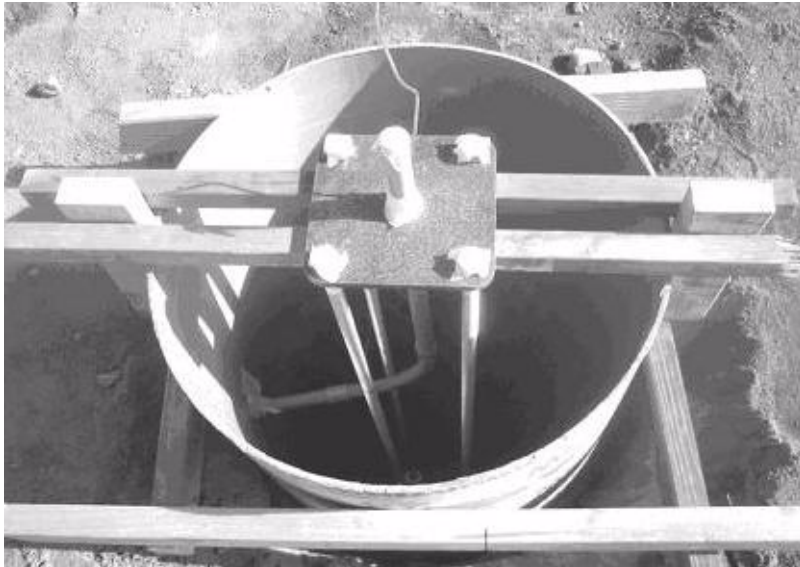
Figure 2-9: Foundation Template Installed in the Foundation Tube



- 16. Connect the PVC elbow and two PVC straight conduit sections together and press tightly.

- 17. Insert the bottom end of the pipe opening (i.e. the end of the 18 inch [46 cm] pipe) into the 1 inch (2.5 cm) diameter hole in the Sonotube and use tape to secure it there (see Figure 2-10).

Figure 2-10: PVC Conduit Secured to Foundation Template



- 18. Insert the top end of the PVC pipe (i.e. the end of the 24 inch [61 cm] pipe) through the center hole of the foundation template along with the grounding wire. Use tape to secure the pipe and wire to the template.
- 19. Secure the PVC conduit to the center of the foundation rods/template using wire.
- 20. Call a concrete delivery service and have 1 cubic yard (0.77 cubic m) of 6 sack concrete delivered and poured into the hole (see Figure 2-11). To maintain the desired alignment of the foundation rods, take care to pour evenly when starting. Fill the concrete to the top of the Sonotube.

Figure 2-11: Pouring the Concrete



- 21. Level the concrete surface with the appropriate tool (e.g. a spade or trowel) (see Figure 2-12). The top of the foundation rods should protrude 4.5 inches (11.4 cm) above the concrete surface.

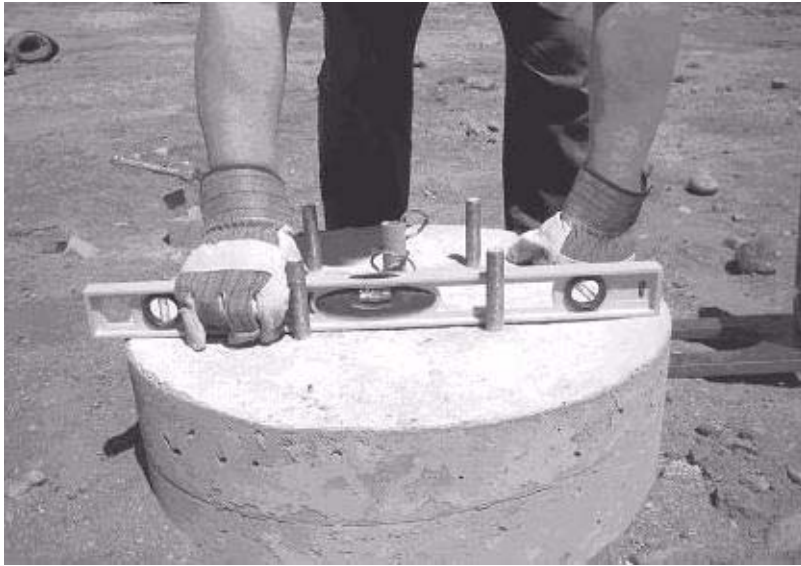
Figure 2-12: Leveling the Concrete to Be Even with the Sonotube



- 22. After the concrete settles, use a wire brush to clean off any concrete on the threads of the foundation rods.
- 23. Put a tarp or similar weather protection over the exposed concrete. Allow the concrete to cure for at least one week.
- 24. Remove all the boards.
- 25. Use a drywall knife to cut away the part of the foundation tube that is above ground level.
- 26. Remove the foundation template from the foundation rods.
- 27. Back fill the surrounding dirt around the concrete.

- 28. Verify that the top of the concrete is level (see Figure 2-13).

Figure 2-13: Verifying the Foundation Is Level



- 29. Dig a trench from the foundation to the planned connection point at the home or business (see Figure 2-14). The trench should be at least 18 inches (46 cm) deep.

Figure 2-14: Trench for Conduit



- 30. Feed one end of the UFB wire through the PVC pipe opening in the side of the foundation. Bend the wire over the top of the pipe to secure it in place.
- 31. Run the remaining length of the wire down the trench.



32. Back fill the trench to cover the wire. For rocky soils, sand may be required in the trench to isolate the UFB wire or conduit from the soil.

2.4 Wiring Diagrams

The following notes apply to the wiring diagrams in figures [2-15](#), [2-16](#) and [2-17](#).

- You must install equipment in accordance with NEC article 705.
- The AC output neutral is not bonded to ground.
- To reduce the risk of fire, connect only to a branch circuit provided with 20 amperes maximum branch-circuit overcurrent protection in accordance with the National Electric Code, ANSI/NFPA 70.
- To reduce the risk of fire, do not connect to an AC load center (circuit breaker panel) with multiwire branch circuits connected.
- To reduce the risk of fire, do not connect to a GFCI protected circuit, outlet or breaker.
- Hardware required for the termination to buildings varies by installation; the owner or installer should provide it.
- Mariah Power recommends, and most utilities require, that you run a dedicated line from the Windspire to the breaker panel to which it will connect.

Figure 2–15: Wiring Diagram—Single Connection, Single Phase

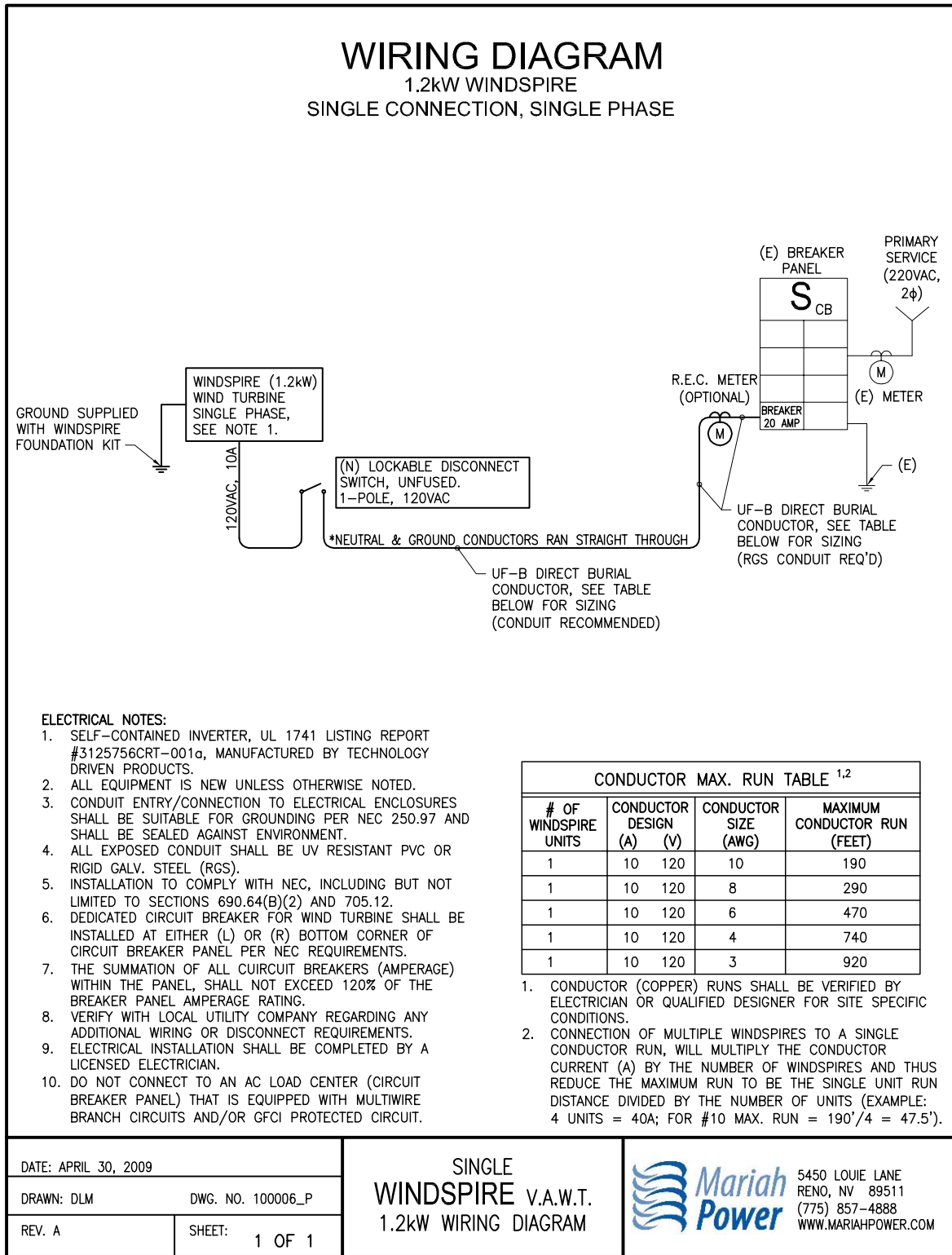


Figure 2–16: Wiring Diagram—Multiple Connection, Two-Phase

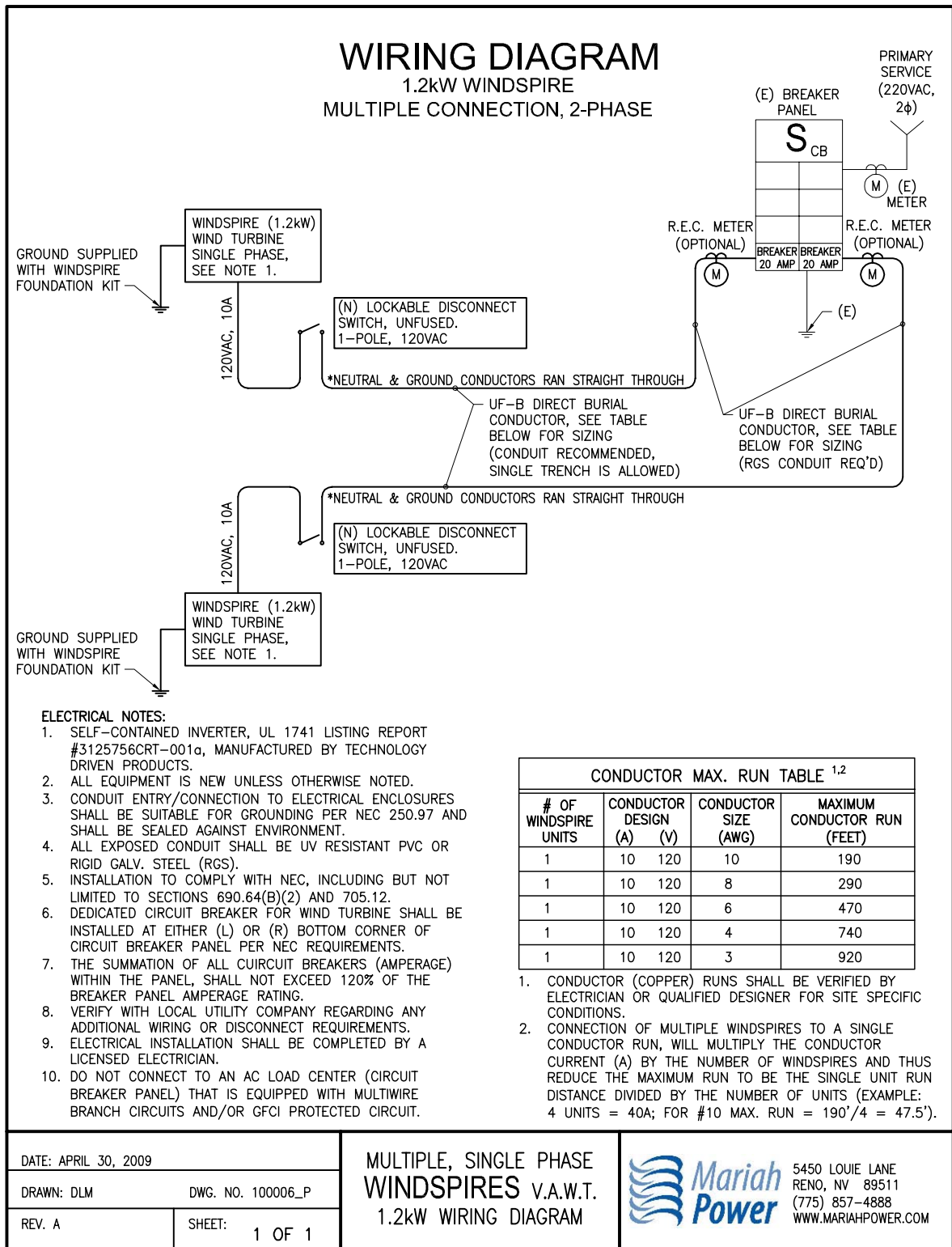
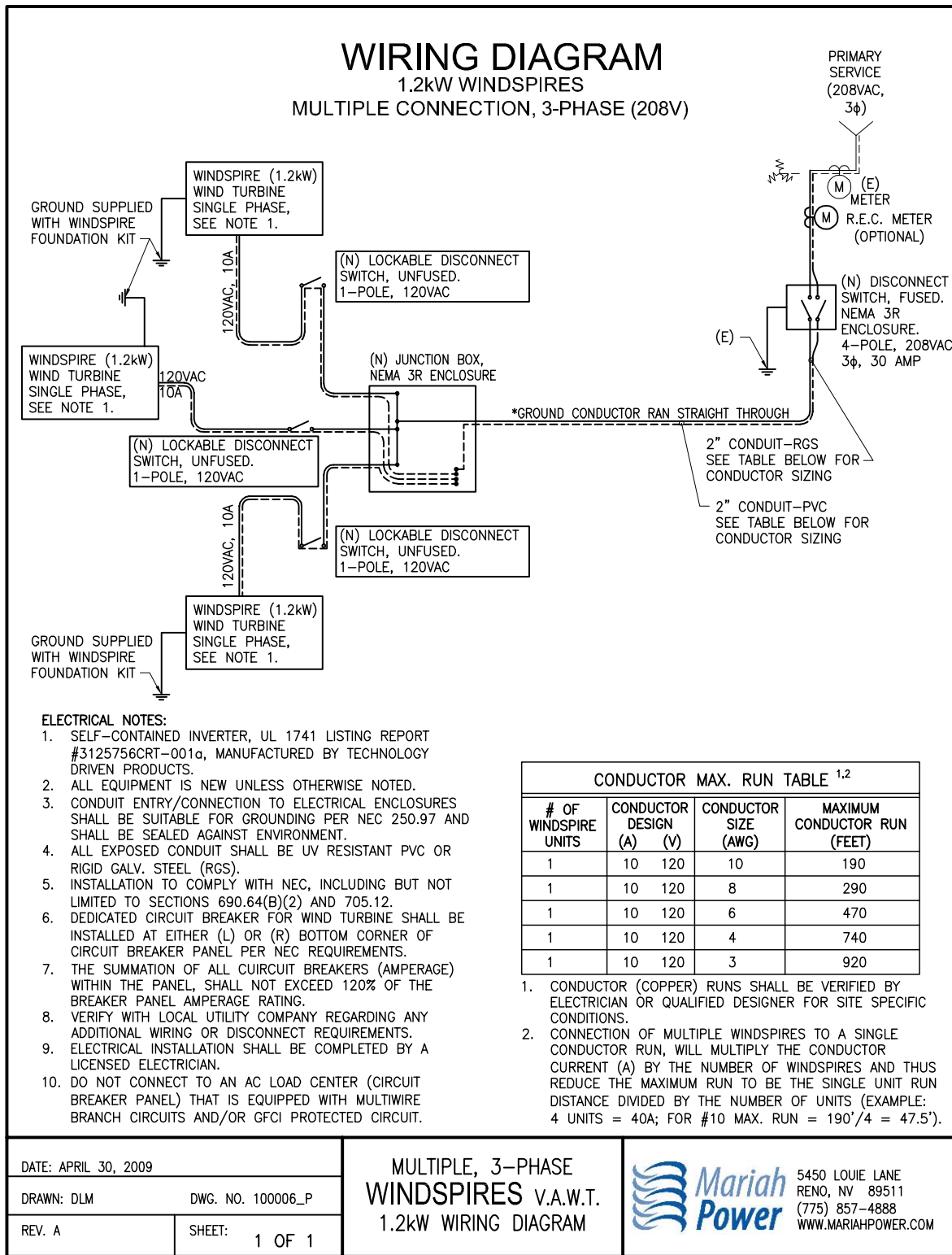
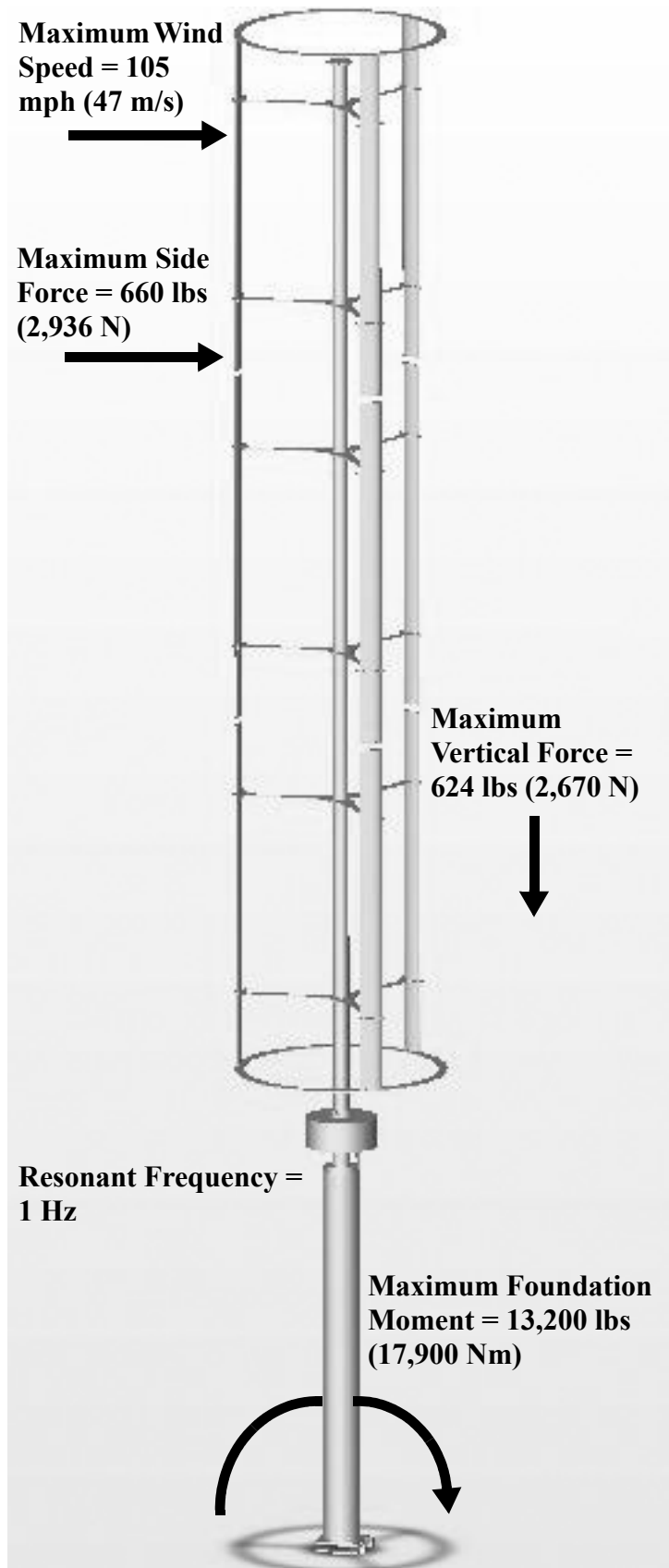


Figure 2–17: Wiring Diagram—Multiple Connection, Three-Phase



2.5 Load Diagram



2.6 International Transformer

Your Windspire was designed to be compatible for worldwide use. However, it is shipped with an initial configuration for connection with the U.S. electrical system of 110 VAC and 60 Hz. For connection with other electrical systems, you can install an optional international transformer between your Windspire and its power connection. The international transformers were specially designed to provide very high efficiency power conversion. Please select the correct transformer for the voltage in your area and load the software to change the frequency of the inverter, if required. Always check the local regulatory rules and make sure that the Windspire meets the required certifications for your area before installing.

2.7 Battery Charger

Your Windspire comes with an inverter for grid-tied connection to utility power. Alternatively, you can use your Windspire for off-grid applications by replacing the inverter with the optional battery charger modules.

Chapter 3: Glossary

- **Foundation rods**—The metal bars used to reinforce the foundation concrete.
- **Foundation template**—The square, metal plate to which the tops of the foundation rods attach.
- **Ground rest boards**—The 3' (91 cm) long 2x4 boards that are resting on the ground to support the Sonotube.
- **Ground wire**—The 8AWG wire that connects the grounding plate to the Windspire.
- **Grounding plate**—The copper plate that is buried below the foundation that attaches to the ground wire.
- **Horizontal cross boards**—The 3' (91 cm) long, 2x2 boards attached across the diameter of the Sonotube and to each side of the vertical support boards using wood screws.
- **Sonotube**—The 3' (91 cm) long, 2' (61 cm) diameter cardboard foundation tube into which you pour the foundation concrete.
- **UFB wire**—The cable that will conduct electricity from your Windspire to your residence or place of business.
- **Vertical support boards**—The 1' (30 cm) long 2x4 boards that are placed on top of the ground rest boards against the Sonotube for vertical support.
- **Wood Braces**—The 3' (91 cm) long 2x4 boards attached horizontally to either side of the Sonotube, resting on top of the ground rest boards.

Appendix A: Multiple Windspire Spacing

We recommend the following spacing for multiple Windspire turbines:

- The minimum spacing between each Windspire is 8 feet (2.4 meters) on centers when positioned side-by-side to directly face the prevailing wind direction.
- The minimum spacing between each Windspire is 50 feet (15.2 meters) on centers when positioned downwind from each other along the line of the prevailing wind direction.
- Figure A-1 and Table A-1 show the minimum spacing required if the desired placement of a row of Windspire turbines is at an angle offset from the prevailing wind direction.

Figure A-1: Spacing a Row of Windspire Turbines

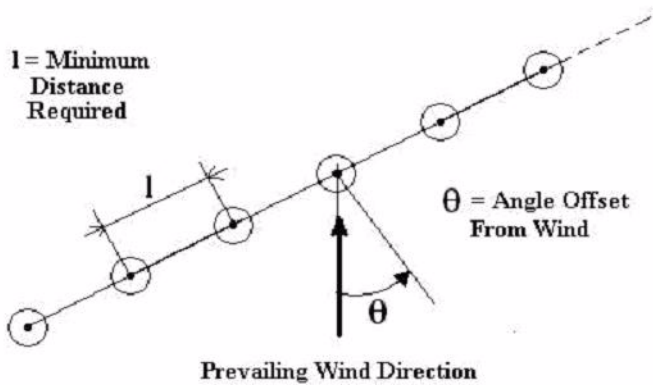


Table A-1: Spacing a Row of Windspire Turbines

Angle Offset from Wind (θ)	Distance Required (l) in Feet	Distance Required (l) in Meters
0	8.0	2.4
15	8.3	2.5
30	9.2	2.8
45	11.2	3.4
60	15.4	4.7
75	26.5	8.1

Note: Minimum downwind spacing (50 feet or 15.2 meters) does not change when the desired placement is at an angle offset from the prevailing wind direction.

Appendix B: Typical Pier Footing

GENERAL:

1. PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY THE APPROPRIATE UTILITY LOCATING SERVICE TO VERIFY LOCATION OF UNDERGROUND UTILITIES. THE CONTRACTOR SHALL NOTIFY THE OWNER IMMEDIATELY IF ANY UNIDENTIFIED EXISTING UNDERGROUND UTILITIES ARE DISCOVERED.
2. ALL WORK SHALL CONFORM TO THE MINIMUM STANDARDS OF THE FOLLOWING CODES:

2006 INTERNATIONAL BUILDING CODE (IBC)

AND ANY OTHER REGULATING AGENCIES WHICH MAY HAVE AUTHORITY OVER ANY PORTION OF THE WORK.

3. CONTRACTOR TO PROVIDE PROPER SHORING/BRACING WHERE NEEDED DURING CONSTRUCTION ACTIVITIES.

FOUNDATIONS:

- A. MAXIMUM ALLOWABLE FOUNDATION SOIL BEARING PRESSURE = 1500 PSF (72 KPa) FOUNDATIONS SOILS SHALL BE FREE OF ORGANIC SILTS, ORGANIC CLAYS, OR PEAT.
- B. FOR FROST PROTECTION, THE BOTTOM OF ALL EXTERIOR FOOTINGS SHALL BE A MINIMUM OF 24" (0.610m) BELOW ADJACENT FINISHED GRADE OR GREATER DEPTH DEPENDING UPON THE LOCAL JURISDICTION.
- C. ALL DISTURBED SOILS SURROUNDING FOOTINGS SHALL BE MOISTURE CONDITIONED AND COMPACTED IN 12" (0.305m) LIFTS, TO REACH 95 PERCENT OF THE MAXIMUM DENSITY AS DETERMINED BY ASTM D1557.
- D. BRACE SONATUBE OR FORM WALLS AS REQUIRED DURING BACKFILLING OPERATIONS.

CONCRETE:

ALL CONCRETE WORK SHALL CONFORM TO THE LATEST EDITION OF ACI 318, EXCEPT AS MODIFIED BY THE FOLLOWING SUPPLEMENTAL REQUIREMENTS:

- A. ALL FOUNDATION CONCRETE SHALL BE NORMAL WEIGHT CONCRETE.
- B. CONCRETE MIX DESIGN SHALL BE ESTABLISHED IN ACCORDANCE WITH CHAPTER 5 OF ACI 318.
- C. CEMENT II OR I/II PER ASTM C-150
- D. MAXIMUM SLUMP
 - 3 INCHES (0.076m) – PRIOR TO ADDITION OF WATER-REDUCING ADMIXTURE
 - 8 INCHES (0.203m) – WITH ADDITION OF WATER-REDUCING ADMIXTURE
- E. IF SULFATE CONCENTRATIONS IN SOILS ARE GREATER THAN 0.16% (OR ANTICIPATED TO BE GREATER THAN) TYPE V CEMENT SHALL BE USED.
- F. ADMIXTURES
 1. FLYASH PER ASTM C-618
 2. AIR ENTRAINING PER ASTM C-260
- G. MAXIMUM SIZE COARSE AGGREGATE: 1 INCH (0.025m) PER ASTM C-33
- H. 28-DAY COMPRESSIVE STRENGTHS (f'c):
 1. FOUNDATIONS = 3000 PSI (20,700 KPa) – FOR WORKABILITY, NOT STRENGTH
 2. CONCRETE DESIGN STRENGTH = 2500 PSI (17,200 KPa) – NO SPECIAL INSPECTION
- I. REINFORCEMENT FOR CONCRETE:
 1. ALL REINFORCING SHALL BE SUPPORTED IN FORMS SPACED WITH NECESSARY ACCESSORIES AND SHALL BE SECURELY WIRED TOGETHER IN ACCORDANCE WITH CRSI "MANUAL OF STANDARD PRACTICE" (1986)
 2. DEFORMED BARS – ASTM A615, GRADE 60 KSI (420 MPa)
- J. MINIMUM REINFORCEMENT LAP = 44 BAR DIAMETERS
- K. MINIMUM CONCRETE COVER OVER REINFORCEMENT:
 1. CONCRETE CAST AGAINST EARTH = 3 INCHES (0.076m)
 2. CONCRETE EXPOSED TO EARTH OR WEATHER = 1½ INCHES (0.038m)
- L. ALL CONCRETE SHALL BE MECHANICALLY VIBRATED INTO FOUNDATIONS AND FORMS

STRUCTURAL AND MISCELLANEOUS STEEL:

- A. ALL STRUCTURAL STEEL WORK SHALL CONFORM TO THE AISC AND AWS SPECIFICATIONS.
- B. ALL TOWER, BASE PLATE, AND WIND TURBINE DESIGNS BY MARIAH POWER.
- C. PROVIDE E70XX ELECTRODES FOR ALL WELDS, IN ACCORDANCE WITH AWS D1.4.
- D. ISO 898.1, CLASS 8.8 GALV. OR EQUAL, BOLTS FOR ALL STEEL TO FOUNDATION CONNECTIONS.



FOUNDATION NOTES		30' WINDSPIRE V.A.W.T. TYPICAL PIER FOOTING (1500 PSF MIN. SOIL BEARING CAPACITY)	 5470 LOUIE LN, STE. 104 RENO, NV 89511 (775) 857-4888 WWW.MARIAHPOWER.COM
DATE: FEB. 25, 2009	DENNIS MONTGOMERY, P.E.		
REV. A (#10006)	SHEET: 1 OF 4		

Figure B-1: Pier Foundation—Non-constrained Section Foundation View

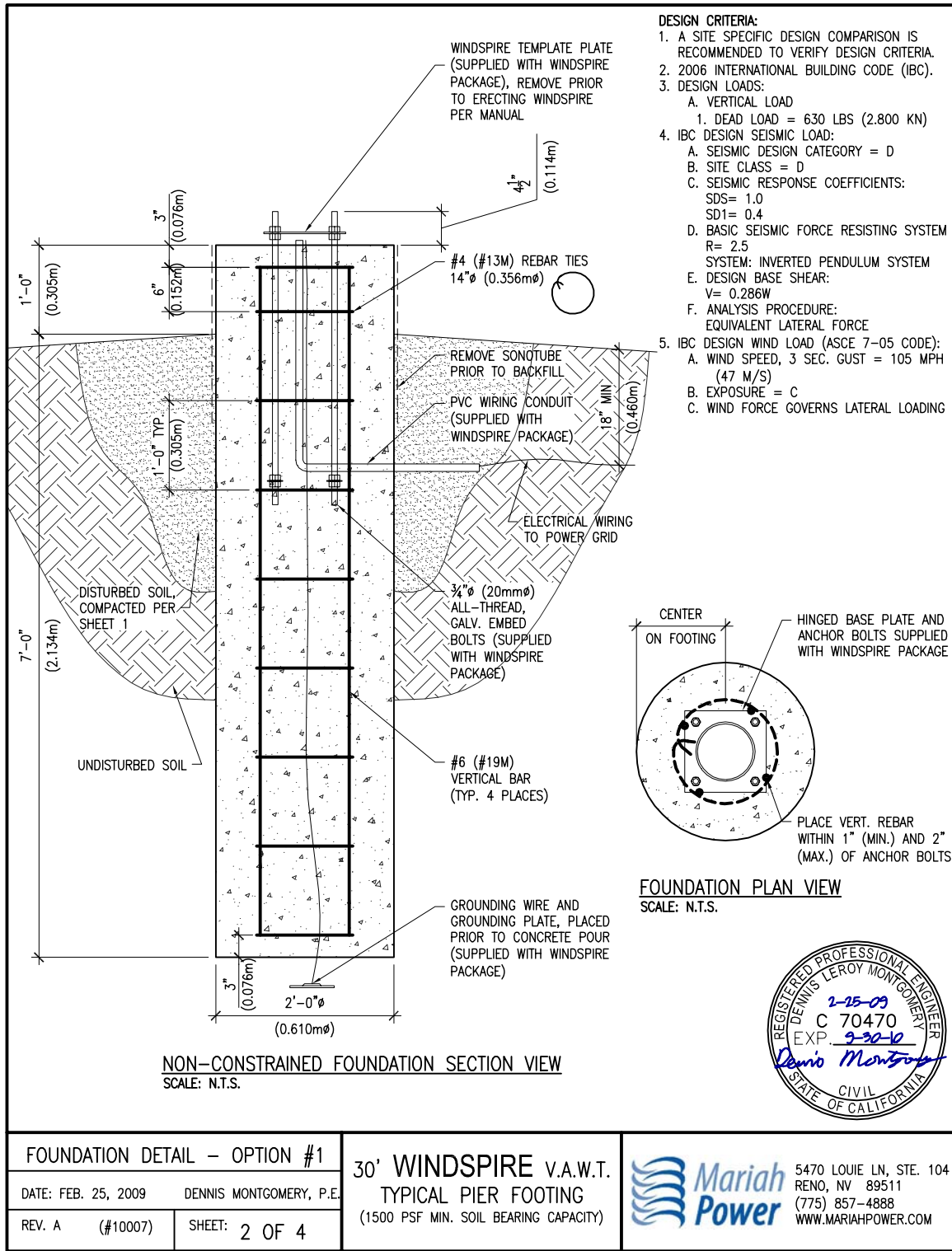
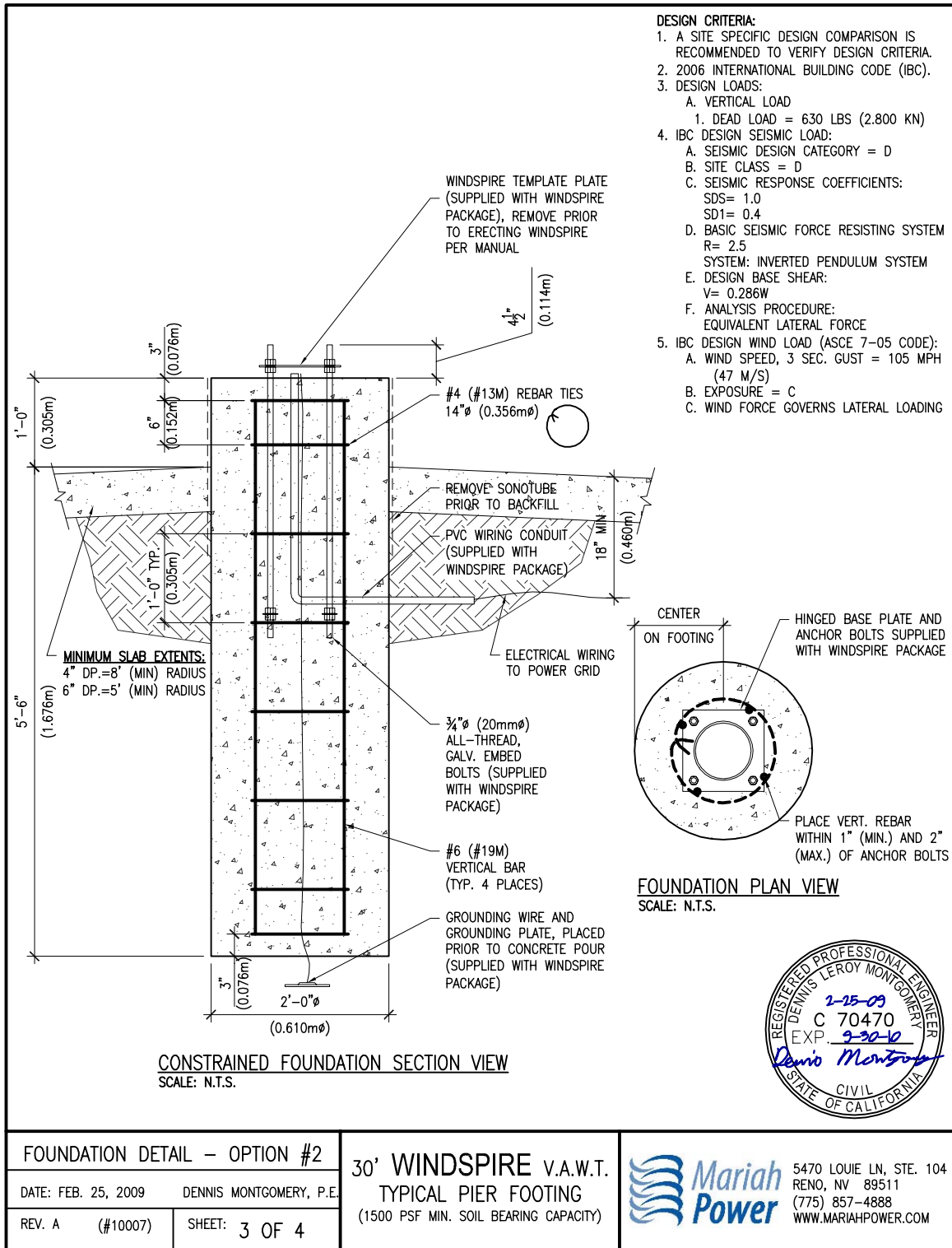


Figure B-2: Pier Foundation—Constrained Foundation Section View



FOUNDATION DETAIL – OPTION #2

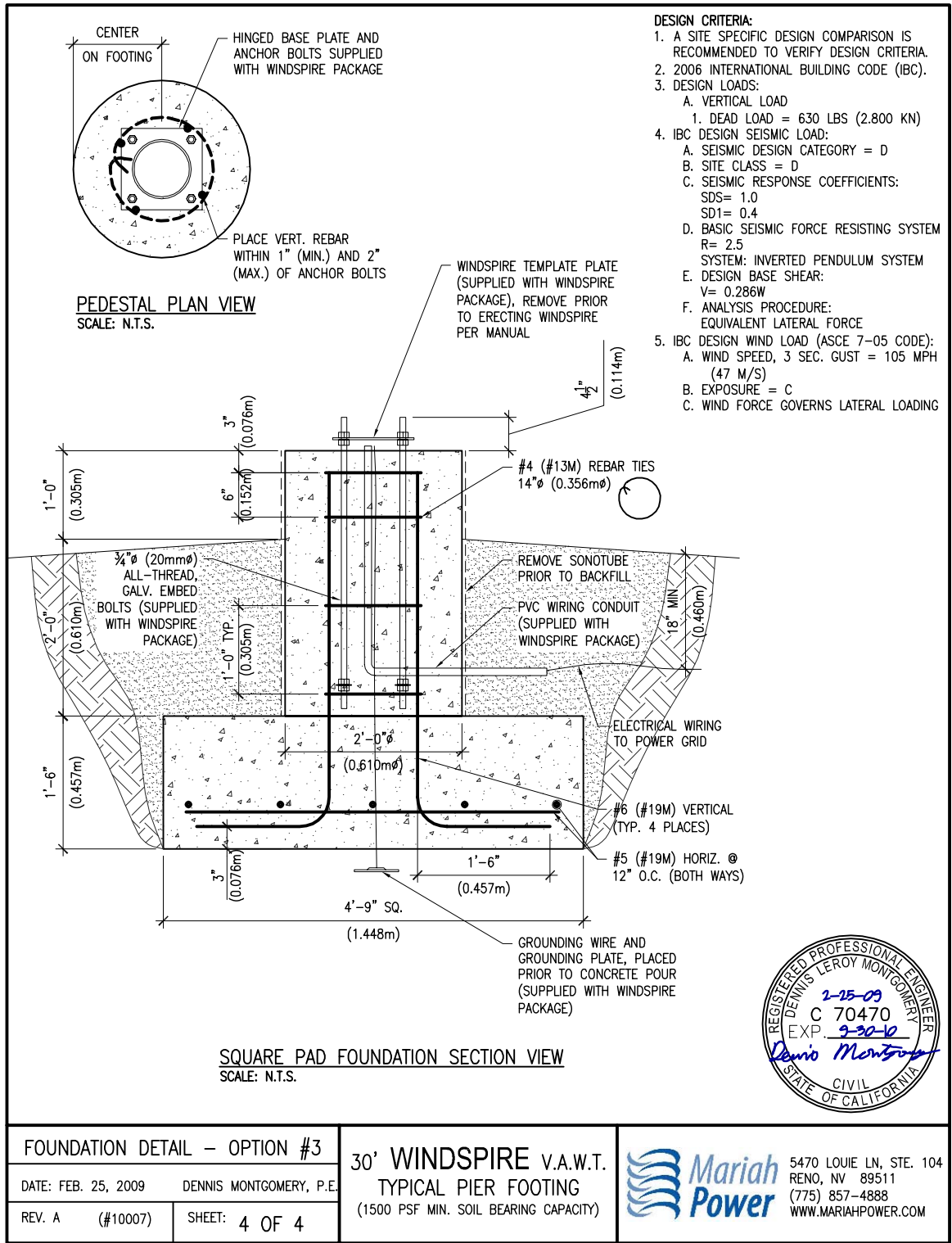
DATE: FEB. 25, 2009 DENNIS MONTGOMERY, P.E.

REV. A (#10007) SHEET: 3 OF 4

30' WINDSPIRE V.A.W.T.
TYPICAL PIER FOOTING
(1500 PSF MIN. SOIL BEARING CAPACITY)

5470 LOUIE LN, STE. 104
RENO, NV 89511
(775) 857-4888
WWW.MARIAHPOWER.COM

Figure B-3: Pier Foundation—Square Pad Section Foundation View



FOUNDATION DETAIL – OPTION #3

DATE: FEB. 25, 2009 DENNIS MONTGOMERY, P.E.

REV. A (#10007) SHEET: 4 OF 4

30' WINDSPIRE V.A.W.T.
TYPICAL PIER FOOTING
(1500 PSF MIN. SOIL BEARING CAPACITY)



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